

Canadian Tuberculosis Standards

7th Edition

Chapter 12: Contact Follow-Up and Outbreak Management in Tuberculosis Control



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CHAPTER 12

CONTACT FOLLOW-UP AND OUTBREAK MANAGEMENT IN TUBERCULOSIS CONTROL

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KEY MESSAGES/POINTS

- Only respiratory tuberculosis (TB), with limited exceptions, is infectious; contact follow-up should be carried out for both sputum smear-negative and smear-positive cases. The objective of contact follow-up is to identify and treat any secondary cases, and to identify contacts with latent TB infection (LTBI) in order to offer preventive treatment. Source-case investigation is recommended for children under 5 years old with a diagnosis of active TB disease.
- Interviews with the infectious case to identify contacts should include questions about locations/activities of potential exposure as well as specific named contacts. The discussion of site-based, social network contact investigation as well as the section on contact follow-up in homeless populations has been expanded from the 6th edition of the *Standards*.
- Prioritization of contact follow-up is recommended by the infectiousness of the source case, extent of exposure and immunologic vulnerability of those exposed. Thus, the most effort is put into contacts who are most at risk of being infected and/or most at risk of developing active TB disease if infected.
- The classic concentric-circle approach to contact follow-up is no longer recommended. Rather, the initial follow-up should include non-household contacts from the outset when case infectiousness and contact vulnerability indicate, rather than waiting.
- Contacts may be grouped as follows:
 - High priority**
 - household contacts plus close non-household contacts who are immunologically vulnerable, such as children under 5 years.
 - Medium priority**
 - close non-household contacts with daily or almost daily exposure, including those at school and work.
 - Low priority**
 - casual contacts with lower amounts of exposure.

- For smear-positive/cavitary/laryngeal TB, it is recommended that the initial contact follow-up include both high- and medium-priority contacts. For smear-negative, non-cavitary pulmonary TB, the initial contact follow-up should be for high-priority contacts only. In both situations, contact investigation is iterative: it should be expanded if the initial follow-up results indicate that transmission has occurred.
- A single evaluation at least 8 weeks after the end of exposure (with tuberculin skin testing [TST] and symptom assessment) is recommended in most non-household contact settings, in order to maximize participation and minimize overdiagnosis of “conversion” related to boosting. Initial plus 8 week post-exposure TST is recommended for household and other high-priority contacts. Two-step TST is not recommended in the setting of a contact investigation.
- TST is no longer recommended as a primary assessment tool in the contact follow-up of elderly residents in long-term care, in whom it is less reliable and for many of whom the risks of treatment of LTBI in old age will outweigh any benefit. The focus for these individuals should be on early detection of secondary cases.

INTRODUCTION

The first priority of TB control programs is always recommended to be the early identification and successful treatment of all TB cases. This is because treatment rapidly reduces the risk of TB transmission to others. The next priority should be evaluation and follow-up of close contacts of active cases in order to identify secondary cases, source cases in some situations and those with recently acquired LTBI, to offer this group treatment.¹⁻³ Typically, 1%-2% of close contacts are found to have active disease at the time of contact investigation.⁴ In addition, about 5% of newly infected contacts will develop active disease within 2 years of exposure.⁵⁻⁸ TB programs in North America typically find a median of 4 (average 6) close contacts for each TB case.^{4,9}

Reporting of active TB is required in all Canadian jurisdictions. In part this is to ensure that contact investigation can be carried out quickly, in an organized, collaborative manner.

With limited exceptions, only TB in the respiratory tract is infectious and requires contact investigation.¹⁰ Patients who present with nonrespiratory disease can also have concomitant respiratory involvement; thus it is important for all TB patients to have chest radiography (and sputum testing if there are any respiratory symptoms or chest x-ray abnormalities) as part of their medical work-up. Patients with miliary TB are often culture-positive on sputum or other airway secretions and occasionally smear-positive.¹¹ Induced sputum cultures have been found to be positive in up to 50% of cases of pleural TB, even in the absence of pulmonary disease on chest x-ray.¹² Therefore, both miliary and pleural TB should also be considered as potentially contagious.

Factors associated with TB transmission are outlined in Chapter 2, Pathogenesis and Transmission of Tuberculosis. Cases who are sputum smear-positive or have cavitary disease on chest x-ray are significantly more infectious than smear-negative or non-cavitary cases.^{2,8,9} Adolescence, adult age, coughing, sneezing and singing also increase the risk of transmission.¹

Transmission is rarely thought to occur outdoors; however, indoor environments that are poorly ventilated, dark and damp can lead to increased concentration and survival of *Mycobacterium tuberculosis*.^{13,14} In infected contacts who are vulnerable because of young age (under 5 years), HIV or other causes of significant immune suppression infection may progress quickly to active disease;⁸ early diagnosis often depends on good contact follow-up.

Contact investigation often demands considerable time, expertise and coordination. It is usually best carried out by public health/TB control authorities in collaboration with treating clinicians and other providers. Anxiety, stigma and lack of knowledge about TB among those exposed may be major issues. Provision of clear, credible and consistent information about TB and the contact follow-up plan is important.

DEFINITIONS

Index case: the first case or initial active case from which the process of contact investigation begins.

Source case: the person who was the original source of infection for secondary case(s) or contacts. The source case can be, but is not necessarily, the index case.

Contact: a person identified as having been exposed to an active case of disease. The closeness and duration of exposure usually corresponds with the risk of becoming infected.

OBJECTIVES OF CONTACT INVESTIGATION

Contact investigation has three main objectives. In order of priority these are as follows:

1. Identify and initiate treatment of secondary cases of active TB disease.
2. Identify and treat the source case who infected the index case, if the index case is under 5 years old.
3. Identify contacts with LTBI in order to offer preventive treatment.

PRINCIPLES OF CONTACT INVESTIGATION

PRIORITIZE THE WORK

This is the most important principle. It is advisable to prioritize by the infectiousness of the source case, extent of exposure and immunologic vulnerability of those exposed. Thus, the most effort can be put into contacts who are most at risk of being infected and/or most at risk of developing active TB disease if infected. Contact investigation is iterative: it should be expanded if initial follow-up results indicate that transmission has occurred.

RAPID INITIATION OF CONTACT INVESTIGATION

Rapid evaluation of close contacts allows prompt identification of those who already have active disease and, if active disease has been excluded, allows initiation of treatment of LTBI for newly infected contacts before disease occurs.

As soon as a suspected case of TB has been reported, it is advisable for public health authorities to ensure that all the medical investigations to confirm the diagnosis and determine the degree of infectiousness are under way (chest radiography plus sputum collection as necessary, even for patients with suspected extrapulmonary TB) and that the patient is in airborne infection isolation. Initiation of adequate TB treatment is the most effective way to rapidly decrease infectiousness and the risk to others. If the clinical suspicion of pulmonary TB is sufficiently strong to begin TB treatment pending microbiologic confirmation, then investigation of household contacts should also begin promptly, especially for any children under 5 years old, HIV-infected contacts and others at high risk of disease progression if infected.¹⁰ A positive nucleic acid amplification test result is sufficient grounds to begin contact investigation (see also Chapter 3, Diagnosis of Active Tuberculosis and Drug Resistance). Investigation of contacts beyond the high-priority group (see below) should always await microbiologic confirmation of the diagnosis.

ASSESSMENT OF TRANSMISSION RISK

Infectiousness of the index case

The single greatest factor determining the extent of contact investigation is the degree of infectiousness of the index case. Neither drug-resistant TB nor coinfection with HIV increases the infectiousness of the case; therefore, the recommended approach and prioritization of the contact investigation is the same. However, treatment of LTBI among contacts should be guided by the drug sensitivity pattern of the source case.

Sputum status is the most reliable indicator of infectiousness. The “worst” (i.e. most positive) result is used to evaluate infectiousness.¹⁵ Cases of laryngeal TB are considered four to five times more contagious than smear-positive pulmonary cases, as they are likely to have a large number of bacteria due to extensive concurrent pulmonary disease.^{1,16,17}

Cavitary disease on chest x-ray has been repeatedly linked to higher infectiousness, independent of smear status. Chest CT (computed tomography) may detect smaller, early cavitation that is not apparent on the chest x-ray; however, it is not clear whether these individuals are as infectious as those who have cavitation visible on chest x-ray.¹⁰

Coughing is the least reliable indicator of infectiousness but is generally linked to it, particularly within households. There are several well-documented clusters of TB transmission related to cough-inducing medical procedures and to smoking crack cocaine.¹⁸ Singing and similar activities (e.g. playing wind instruments) are also associated with increased risk of transmission.¹⁹

In general, children under age 10 with TB are not considered infectious. However, in unusual circumstances, even very small children can transmit TB – for example, if there has been contamination and inadequate cleaning of respiratory equipment.²⁰ By contrast, adolescents can be very effective transmitters of TB, partly because they can have extensive disease by the time it is diagnosed, and particularly because in high school they can have large numbers of contacts.^{21,22} It is recommended that any child presenting with adult-type pulmonary TB (cough, cavitation on chest x-ray, smear-positive sputum) should be considered infectious and contact investigation undertaken.

Source case investigation

When active TB (whether pulmonary or extrapulmonary) is diagnosed in any child under 5 years old, an immediate search for an infectious source case close to the child is recommended.¹⁰ Most often the source case is an adolescent or adult in the household, or other care-giver. Source case investigation is also recommended when a cluster of TST conversions is identified in an institutional setting with no known source case. However, source case investigations usually give very low yield; even for young children a source case is identified in less than half of investigations.^{10,23} Source-case investigation is not recommended for adult TB cases, nor for children or adults who are well but have a positive TST result on a routine screening (outside of an institutional cluster of TST conversions, as above).

Nonrespiratory TB is considered noninfectious, so long as concurrent pulmonary disease has been ruled out; no contact follow-up is necessary. Rare exceptions involve aerosolizing medical procedures (e.g. autopsy, high-pressure irrigation of draining TB abscesses). Source-case investigations for nonrespiratory TB are not recommended other than for children under 5 years old, as above.¹⁰

Likely period of infectiousness

Cases of pulmonary TB are generally considered to become infectious at the time of onset of cough or worsening of a baseline cough. If no cough is reported or if the duration is difficult to determine, the onset of other symptoms attributable to TB may be used to estimate the onset of infectiousness. In practice, however, it is often difficult to know with certainty when symptoms began.

Generally, priority should always be given to contact tracing during the period when the TB patient had respiratory symptoms (e.g. a cough). However, guidelines published by the US Centers for Disease Control and Prevention¹⁰ recommend that the patient with smear-positive or symptomatic disease should be considered to have been infectious for 3 months before onset of respiratory symptoms or the first positive finding consistent with TB, whichever is longer.

Asymptomatic cases with a negative smear and no cavities seen on chest x-ray should be considered infectious 4 weeks before the date that TB was suspected. However, these guidelines are based on expert opinion rather than clear epidemiologic evidence.

For contact follow-up purposes, the period of infectiousness ends when the index case is in effective airborne isolation from others (this may be before or after diagnosis) or is no longer infectious, whichever comes first. Please see Chapter 15, Prevention and Control of Tuberculosis Transmission in Health Care and Other Settings, for a description of when isolation may be discontinued for a suspected or confirmed TB case.

Degree of exposure to the index case

The interview of an infectious TB patient for contact tracing is one of the most important parts of the investigation. It takes considerable skill and is most successful when done by staff with training/experience in public health interview techniques.²⁴ Trust and rapport are important for full disclosure, and the initial interview can also lay the foundation for long-term adherence to TB treatment. Face-to-face interviewing, in privacy, is ideal. Most TB patients in Canada were born in countries with high TB incidence or in First Nations/Inuit communities (see Chapter 1, Epidemiology of Tuberculosis in Canada), so language and cultural perceptions about TB and health are very important. Interviews are best carried out in the language the patient is most comfortable with. It is recommended that a professional interpreter or an objective third party (not a family member) be used for interpretation if possible, either in person or participating by telephone. Interviewers should always be respectful and sensitive to patient concerns and beliefs about TB, should incorporate education about TB and stress the confidentiality of contact investigations. Note that legislation may permit or require release of information about the case's diagnosis to specific individuals (e.g. to public health authorities) or in specific circumstances. For example, although precautions can be taken to avoid identification of the case in public or to contacts, some information may have to be shared with selected individuals (e.g. a school principal) in order to identify or reach contacts and ensure that they too get the medical follow-up they need.

Ideally, the treating physician and laboratory should report all new or suspect cases of TB to the appropriate public health authority within 48 hours. The first public health communication with a new infectious patient (and/or the health care providers if the patient is hospitalized) should ideally begin within 1 calendar day of the case being notified. The purpose of this brief initial communication is to achieve adequate airborne isolation, provide any urgent support, identify the household contacts and direct any who are ill to immediate TB assessment. Interviewing to determine the full set of contacts should be initiated within 3 working days. Interviewing is usually best extended over two (or more) sessions, a week or more apart, as the patient becomes more familiar with public health staff, and the initial stress and anxiety over the diagnosis are resolving. Proxy or supplemental interviews (ideally with patient permission) with family, close friends, coworkers, etc., may be helpful if patients are unable or unwilling to participate. It is important to include questions about the places where the case spends time regularly, not just names of individual people, and to get contact details whenever possible (name, alias/nickname, phone, address, email, age, nature of interaction).

Interviews to identify contacts should include the following information:

- Any contact with children and their ages
- Any contact with immunosuppressed people (HIV positive, cancer patients, etc.)
- Description of the household/congregate setting; household contacts and their ages (includes anyone who regularly sleeps in the home)
- Close friends and relatives who are seen at least once per week – how often, for how long?
- Work or school location and description of setting (type of work, size of room, ventilation, etc.)
- Transportation to work/school – bus, car-pool, etc.
- Place of worship, clubs, sports teams, recreation programs or hobbies
- Any other places or groups the case has regularly been in or with while infectious
- Any contacts who are ill with potential TB symptoms or who have known TB
- Any major events (e.g. weddings, funerals, parties) the case attended while infectious
- Any recent travel or visitors staying at the home within the previous 2 years – if so obtain details

A site visit to assess the home is strongly recommended, even if the initial interview is carried out in hospital (for feasibility of home isolation, identification of additional household contacts, identification of any social/practical issues relevant to treatment adherence, etc.). Site visits to the school or workplace and other exposure locations are also very helpful to make contact follow-up decisions (environmental characteristics such as size, layout, use of the space and ventilation; interviews with a direct supervisor can help to identify potential contacts). Discretion is important, as a site visit may precipitate unnecessary anxiety and/or lead to a breakdown of confidentiality and repercussions for the case. In this regard, it is advisable to arrange site visits directly with senior personnel, such as a school principal, division manager or occupational health manager and emphasize with them the importance of maintaining confidentiality as much as possible. See Site-based screening below.

There are so many variables in TB transmission that it is very difficult to quantify the amount of exposure that constitutes a significant risk.²⁵ In theory, there is no amount of exposure to infectious TB that is absolutely without risk; in practice, each case should be evaluated on its specific characteristics. For context, one study of almost 3,000 contacts demonstrated that TST-positive contacts had a mean of 65 hours more exposure than TST-negative contacts.²⁶ By contrast, in an outbreak investigation among university students exposed to an index case with laryngeal and cavitary pulmonary TB, the risk of infection per hour of exposure was over 1% in many classes; some contacts converted with as little as 3-4 hours of exposure per week.²⁷ Exposure in cramped, ill-ventilated spaces may lead to transmission in much shorter exposure times, and genetic fingerprinting has occasionally discovered apparent transmission following close but very brief exposure.²⁸

Organized and Systematic Contact Investigation: Prioritizing Contacts

An organized, systematic approach will allow the TB program to put the most effort into those contacts at most risk. In the 6th edition of the *Standards*, the traditional “concentric circle” approach to prioritizing TB contact follow-up emphasized starting with contacts who have the most exposure (e.g. household contacts) and expanding stepwise to those with progressively less exposure whenever there is evidence of transmission, until the level of TB infection reaches background rates. However, this approach does not take into account contacts who may have less extensive exposure but, if infected, are immunologically vulnerable to rapid development of active TB. It can also lead to long delays in appropriate contact follow-up when the index case is already known to be highly infectious. A fundamental difficulty is that transmission can be very difficult to evaluate when the background rate of positive TST results is unknown or is high (for example, people who immigrated to Canada from high-incidence countries). This is often the case in Canada, where the majority of TB cases – and many of their close contacts – are foreign-born; it is also the context in many Aboriginal communities. A strictly concentric circle approach can also be difficult to apply in complex congregate settings.^{22,29}

Instead, recommended priorities for initial contact follow-up and criteria for expansion are outlined below. These are guidelines: it is always important to consider the specific circumstances, work from first principles of TB transmission and re-evaluate according to the results of the investigation as they become available.

For TB follow-up purposes, contacts may be categorized as follows:

Household contacts are those who regularly sleep in the same household as the infectious case on an ongoing basis (e.g. three or more times per week). This may include members of an extended family, room-mates, boarders, “couch-surfers,” etc. Household members often have the greatest exposure to the TB case.^{8,22,26}

Close non-household contacts are those who have regular, extensive contact with the index case and share breathing space daily or almost daily but do not sleep in the same household most of the time. Close non-household contacts may include caregivers, regular sexual partners, close friends or extended family. They also include daycare and primary/secondary school classroom contacts, and coworkers who work in close proximity, particularly in small rooms. The amount of time that high school classmates spend in the same room as the case will depend on the number of shared courses; prioritize those who share the most actual time together. Similarly, in almost all workplaces it is possible (and important) to define the group of colleagues who spend the most time in the same air space as the case. Regular contacts in specialized health care settings such as dialysis units or rehabilitation programs may also qualify. It is not social closeness to the TB case but, rather, the amount of time in a shared airspace that is the critical issue. For example, computer personnel may report working very closely with others in their group but spend little time together in shared air space if the work is largely done electronically.

Casual contacts are those who spend time regularly but less frequently with the infectious case. These may include high school classmates who share fewer courses with the case, classmates in college/university classes, less exposed colleagues at work; members of a club, team, weekly children’s play-group or other social/recreational/religious group; extended family members who are seen occasionally; other students on a school bus.

Community contacts are those living in the same community or attending the same school or workplace but in a different classroom or area of the workplace. Individuals who have only transient or occasional exposure are in this group.

The highest priority contacts are those with the most exposure and those with the highest risk of progression to active TB if infected, as follows:

- household contacts, including those exposed as “household members” in congregate settings such as homeless shelters, jails and long-term care facilities (generally, room-mates or cell-mates)
- contacts who are close non-household or casual contacts AND who are at high risk of progression of LTBI to TB disease, e.g. age under 5 years, HIV, dialysis, transplant, silicosis (see Chapter 4, Diagnosis of Latent Tuberculosis Infection, and Chapter 6, Treatment of Latent Tuberculosis Infection)
- contacts exposed (i.e. without an N95 mask) during bronchoscopy, sputum induction, autopsy or other aerosolizing medical procedures (see Chapter 15).

Medium-priority contacts are the close non-household contacts who are not at high risk of rapid progression from LTBI to active TB. Most close non-household contacts fall into the medium-priority group.

Casual contacts are low priority. It is generally recommended that the investigation be expanded to this group only if there is evidence of transmission or the case is considered to be extremely infectious (e.g. laryngeal TB, see Chapter 2, Transmission and Pathogenesis of Tuberculosis). However, the specific circumstances should always be considered. For example, a choir group meeting once per week may pose significantly more risk than a weekly outdoor soccer game; children riding on long daily school bus routes in winter, when windows are usually closed, may have considerable exposure.³⁰

It is rare for community contacts to need investigation (e.g. an entire school beyond the exposed classrooms, general customers of grocery stores or fast-food restaurants).³¹ Such an extensive investigation should be undertaken only in very unusual circumstances; consultation with experienced public health colleagues is advised.

For respiratory TB cases who are sputum smear-positive, or have cavitory disease, or have laryngeal TB, the initial investigation should include both high priority and medium priority contacts. If there is evidence of transmission (see below) within these two groups, consideration should be given to expanding contact follow up to casual contacts. *For laryngeal TB,* also consider including any casual contacts (social/recreational groups, etc.) from the outset.¹⁰

For smear negative respiratory TB cases, household members should always be assessed in the initial contact investigation, along with any other high-priority contacts. However, investigation should be expanded to medium-priority contacts (e.g. other close non-household contacts) only if there is evidence of transmission.^{10,15}

High-priority contacts should be assessed for both smear-negative and smear-positive cases. Whenever possible, initial assessment (TST and symptom assessment, then medical assessment and chest radiography if the TST result is ≥ 5 mm or the patient is symptomatic, plus sputum if symptomatic or the chest x-ray is abnormal) of the high-priority contacts should begin within 7 working days of their being identified as contacts and be completed within 1 month. High-priority contacts should ideally have both an initial and a second TST (at least 8 weeks from the last day of exposure) to identify conversion. Participation rates for TB skin testing may be higher if it is done directly by TB program staff, at home or at a TB clinic¹⁰.

Especially among non-household contacts, participation rates often drop significantly between initial and post-8-week screenings as the level of initial concern declines. Thus, in most non-household settings it is most practical to aim for a single round of screening after 8 weeks from the break in contact. In populations in which many people have prior exposure to TB or BCG vaccination (e.g. immigrants from high-incidence countries), this also avoids false TST “conversion” related to boosting. If casual contacts are investigated, only a single TST after 8 weeks from the last day of exposure is recommended.³²

Expanding Contact Investigation

Transmission is considered to have occurred if a secondary case is identified in any contact, if there are any TST converters, if the prevalence rate of TST ≥ 10 mm among contacts is significantly higher than expected (for example, 60% among contacts when the expected prevalence rate is 40%, see Table 1) or if a child contact under age 5 years is infected without another probable source. TST results in Canadian-born contacts, particularly children, may be the most useful in assessing transmission. A TST result is considered positive in contacts with a TST result of 5 mm or greater or in converters who have had an increase of 6 mm from a previous TST result of 5-9 mm. A history of BCG vaccination does not alter the interpretation of the TST results (see Chapter 4, Diagnosis of Latent Tuberculosis Infection, for more information). When there is evidence of transmission, the contact investigation should first address any high-priority contacts who have not yet been assessed and investigate moderate-priority contacts if this has not already been done. Consideration should then be given to expanding to casual contacts. Genotyping to compare index and secondary cases should be requested, but further contact tracing should not be delayed while results are pending.

Table 1. Expected range of prevalence of TST results (≥ 10 mm induration) in various Canadian populations*

| Population | Expected range of prevalence of TST ≥ 10 mm (%) | | |
|--|--|----------------|--------------------|
| | BCG status not specified | BCG vaccinated | Non-BCG vaccinated |
| Canadian-born non-Aboriginal children [†] | N/A | N/A | 1–3 |
| Canadian-born non-Aboriginal adults | 13 | 65 | 7 |
| Canadian-born Aboriginal children | 5–29 | 6–25 | 0–5 |
| Canadian-born Aboriginal adults | 14–30 | 29–50 | 17–21 |
| Foreign-born children | 15–23 | N/A | N/A |
| Foreign-born adults | 53–61 | 73 | 25 |
| Health care workers | 11–46 | 27–77 | 5–18 |
| Residents of long-term care facilities (age ≥ 60) | 6–25 | 71 | 18 |
| Residents of homeless shelters | 45 | N/A | N/A |
| Correctional facility inmates | 12–72 | 90 | 63 |
| Correctional facility staff | 5–33 | N/A | N/A |
| Injection drug users (TST ≥ 5 mm) | 31 | N/A | N/A |
| Injection drug users (TST ≥ 10 mm) | 66 | N/A | N/A |
| People with pre-existing medical conditions (TST ≥ 5 mm) | 14–24 | N/A | N/A |
| People with pre-existing medical conditions (TST ≥ 10 mm) | 18–26 | N/A | N/A |
| Overall community | 6–36 | N/A | N/A |

N/A = Non applicable

*Based on *Compendium of Latent Tuberculosis Infection (LTBI) Prevalence Rates in Canada*, Public Health Agency of Canada, 2012 (for an electronic copy of the full compendium, contact TB_surveillance@phac-aspc.gc.ca).

[†]Although the Aboriginal status was not specified in the study, it was assumed that the vast majority of the reference population belonged to the Canadian-born non-Aboriginal category.

There is often pressure on a public health department or physician to initiate widespread contact investigation – e.g. to an entire school – from the outset. If this is done, however, it is often impossible to interpret the results of a positive TST result (or interferon gamma release assay [IGRA]) in individual patients. Contacts may then be mistakenly identified as recently infected and the investigation expanded yet further. This can also lead to widespread concern about the risk of transmission to community contacts. If expansion of the investigation beyond high- and medium-priority groups is considered, the decision should be based on evaluation of any evidence of transmission in the initial investigation, the probability of finding infected individuals among less exposed contacts and the likelihood that these casual contacts will follow up on screening and LTBI treatment recommendations. Contacts with less exposure have a positive TST prevalence rate that is usually four to eight times less than that among household contacts.^{4,8,33,34} Also, contact participation rates in TB screening, follow-up and LTBI treatment tend to be lower in less close contacts, contacts of less infectious cases and in adults compared with children.³⁵

ADDITIONAL APPROACHES TO CONTACT TRACING

DNA genotype fingerprinting:

DNA fingerprinting is available to all Canadian TB control programs, on request or routinely, through the public health laboratories. It can be a useful adjunct to epidemiologic investigations to confirm or disprove suspected linkages between cases and to evaluate potential specimen mix-ups.^{36,37} It can be particularly helpful in populations in which contact follow-up is challenging and resource intensive, such as the homeless; routine use of fingerprinting for homeless cases may identify linkages not otherwise suspected and guide expanded contact investigation.^{38,39} Rapid fingerprinting techniques (spoligotyping, MIRU [*Mycobacterium Interspersed Repetitive Units*]) are helpful to quickly identify or rule out potential new cases in evolving clusters or outbreaks. Fingerprinting can also be very useful, and reassuring, in the evaluation of potential clusters if the results do *not* show matching outside known household secondary cases.

Location-based contact investigation and social network analysis:

All cases should routinely be asked about the locations where they spend time. Particularly when infectious cases are unable or unwilling to name specific contacts, or when cases are occurring without identifiable exposure risks or sources, identifying locations where the case spent time may be more productive than traditional name-based approaches.⁴⁰ Investigations have identified transmission occurring at bars, crack use sites, etc.,⁴¹⁻⁴³ which can then be targeted for broad location-based screening clinics and TB education/outreach. Epidemiologic links among cases can be enhanced when questions about common locations are included in case interviews.

Social networks analysis examines the social relationships between cases and contacts to identify settings and behaviours that characterize transmission events. Social network analysis has been extensively studied in sexually transmitted infections and more recently in the study of TB outbreaks.^{40,43-45} Formal social network analysis, using special computer software, may be particularly helpful in outbreaks (see <http://pajek.imfm.si/doku.php?id=pajek>).

Site-base screening and congregate settings:

In some settings, it is far more practical and feasible to carry out contact investigation for an entire group (such as a class at school or coworkers in a work setting) than attempt to identify the specific individuals who were most exposed. Practical factors, such as the ability to reliably measure the degree of exposure of different individuals in the setting, the administrative ability to provide efficient testing and TB education, and the ramifications of extending the investigation to a larger group later if it becomes necessary, should be taken into account in deciding on the extent and number of people to be tested. Similarly, in certain settings (e.g. shelters for the homeless) in which contacts may be difficult to identify or to find, it may be helpful to do wider testing from the outset.

School, workplace and other congregate setting investigations are usually best carried out on site. This leads to higher participation rates among contacts, better communication and less anxiety; it is usually the most effective and efficient way of carrying out the investigation and obtaining the necessary information. However, for this type of investigation it is important to be very organized. The following approach is recommended:

- Identify a single individual at the setting who will be responsible for organizational aspects of the contact investigation and act as liaison, usually a school principal, workplace manager or occupational health manager.
- Protect the confidentiality of the index case (Note investigations should be carried out in compliance with relevant legal/legislative requirements, and that provincial/territorial legislation may permit disclosure in specific circumstances). This may not be easy; there may be considerable pressure for details, and in many situations others may be able to guess the identity of the case. Particularly if the identity of the case is widely known or suspected, enlist the help of setting personnel (e.g. the principal or manager) to plan for successful reintegration of the TB case once noninfectious.
- Visit the site beforehand to get a sense of the environment and organize the screening arrangements; get input from the setting's liaison person to ensure that screening is carried out at a time and in a way that offers the best opportunity for contacts to come to the screening.
- Check that adequate staffing will be available for the screening.
- Include key players at the site, such as occupational health services, human resources or other administrative staff, and union health and safety representatives in planning and communication; they may benefit from information about TB ahead of a general information session as others will likely look to them for advice.
- Prepare a communication plan; identify one individual who will be responsible for media and communications to the general public if necessary; alert public health communications staff.
- Offer general information/education sessions about TB and the contact follow-up for all parents/employees/residents before the screening sessions; if the number of contacts is relatively small, a separate session specifically for them may be helpful.
- Identify the referral plan for contacts who are TST positive or symptomatic; treat all contacts referred for medical evaluation consistently, ideally by a limited number of health care providers working in coordination with public health. It can be confusing and alarming for a group of contacts if the work-up and treatment advice are inconsistent from person to person.
- Ensure the results of the medical evaluation are provided promptly to the appropriate public health authority.

Contact investigations carried out in work or school settings may be associated with high levels of anxiety. Good organization, communication and transparency (to the extent possible while protecting case confidentiality) are critical aspects of all site-based or expanded contact investigations. Anxiety and misinformation can be minimized by limiting the delay between contacting the site and conducting testing, ensuring that key people at the setting get the same information at the same time, and by holding general education sessions about TB and the investigation plan. Communication from all personnel involved in the investigation should be clear, credible and consistent, especially with regard to the actual level of risk involved, interpretation of the TST and decisions regarding treatment of LTBI.

A standard approach to the evaluation of contacts for the presence of active disease and evidence of recent infection:

All identified contacts should be interviewed systematically regarding their exposure to the case, presence of symptoms, risk factors for progression to active TB if infected and history of treatment of TB or LTBI. If there are any concerns, rapid evaluation to exclude active TB should be carried out. Once active disease has been excluded, contacts should receive a TST unless there is a history of prior treatment of TB or a documented prior positive TST result. The TST should be carried out and interpreted regardless of BCG vaccination status. A TST of 5 mm or more is considered positive for contacts. See also Chapter 4, Chapter 6 and Chapter 9, Pediatric Tuberculosis.

Note that TB assessment of contacts may involve TST or an IGRA (see Chapter 4, Diagnosis of Latent Tuberculosis Infection).

A two-step TST is not recommended in the setting of a contact investigation:

Skin test conversion can occur as early as 3 weeks after exposure, and it will generally be impossible to differentiate between true TST conversion and a boosted reaction in the setting of a contact investigation (see Chapter 2 and Chapter 4). This is another reason why only those with significant exposure should be considered contacts.

Window treatment of LTBI for those most susceptible:

Contacts who are at very high risk of progression to active disease if infected (children under 5 years; HIV positive or other immunosuppressed individuals) should receive window prophylaxis in the interval between a negative initial TST result and the definitive TST at least 8 weeks after the last day of exposure because of the high risk of progression to active TB if infected. See Chapter 6 and Chapter 9 for additional information.

Evaluation of Contact Investigation:

The results of each contact investigation should be reviewed as they become available, to guide expansion and/or additional follow-up efforts. In addition, program-wide outcomes should be reviewed annually. Along with qualitative assessment of successes and challenges, they are important elements for program evaluation and future planning. Key indicators should include the following:

- initial list of contacts for each infectious TB case, completed within 7 calendar days;
- assessment of close contacts completed and LTBI treatment started, if indicated and not contraindicated or refused, within 28 calendar days;
- proportion of contacts with a diagnosis of LTBI who begin treatment;
- proportion of contacts beginning treatment for LTBI who complete treatment; and
- proportion of contacts completing LTBI treatment who show active TB disease within 2 years after completion.

SUMMARY POINTS

Recommended Steps in Contact Investigation and Follow-Up

1. The treating physician and laboratory should report all new or suspected cases of TB within 48 hours to the appropriate public health authorities.
2. Each new active case should be interviewed by public health authorities to identify household and other close contacts promptly. TB programs should prioritize contacts by the infectiousness of the source case, the extent of the exposure and the risk of progression to active TB if infected.
3. Each contact should be interviewed regarding the circumstances and duration of exposure, presence of symptoms, previous history of tuberculosis, TB exposure and prior TST.
4. Public health authorities and the treating physician should collaborate to ensure that contacts with no previous history of TB or documented positive tests receive a TST and symptom assessment.
5. In the context of contact investigation, a positive TST result is 5 mm or greater on initial or repeat testing, or an increase of at least 6 mm from a previous TST of 5-9 mm. A history of BCG vaccination does not alter the interpretation of the skin test results for contacts. TST should be repeated at least 8 weeks after the last exposure for all high-priority contacts who had an initial negative test. See Chapter 4, Diagnosis of Latent Tuberculosis Infection, for guidance.
6. A medical evaluation to rule out active TB should be performed for all contacts who have symptoms compatible with TB; a positive TST result, whether before exposure or at initial or repeat testing; and (regardless of the results of the initial TST) all children under age 5, as well as contacts who are HIV seropositive or severely immunocompromised, according to the recommendations in Chapter 3, Diagnosis of Active Tuberculosis and Drug Resistance, Chapter 9, Pediatric Tuberculosis, and Chapter 10, Tuberculosis and Human Immunodeficiency Virus. This should include chest radiography, plus sputum collection as indicated.
7. Once active TB has been ruled out, treatment of LTBI should be offered according to the recommendations in Chapter 6, Treatment of Latent Tuberculosis Infection, Chapter 9, Pediatric Tuberculosis, and Chapter 10, Tuberculosis and Human Immunodeficiency Virus.
8. Public health authorities should determine the need to extend the contact investigation on the basis of the contagiousness of the index case, the results of the investigation of high-priority contacts and the nature of the exposure of additional contacts.
9. Extended contact investigations should be carried out in a systematic and organized manner; public health/TB control should coordinate these investigations.

The results of the contact investigation should be evaluated by the TB management program.

CONTACT INVESTIGATIONS IN SPECIAL SETTINGS

HOMELESS AND UNDERHOUSED PEOPLE AND THOSE WITH DRUG ADDICTIONS

Contact tracing for cases who are homeless, heavy users of illicit drugs and other highly marginalized individuals is very challenging and resource intensive. It is easy to become frustrated and overwhelmed. These challenges can be made more manageable and successful by recognizing that such cases are not “business as usual,” keeping priorities clearly in mind, training staff and allocating adequate resources.

Many homeless TB cases may suffer from alcoholism, drug addiction or mental illness, which complicates the management of their TB.⁴⁶ They may have poor access to health services and multiple medical comorbidities, resulting in delayed TB diagnosis, worsening of the disease, prolonged periods of infectiousness and thus large numbers of contacts who need to be assessed. High baseline prevalence rates of TST positivity also mean that a large number of contacts will require further assessment and possible treatment of LTBI.⁴⁷⁻⁵¹

Information that is easily collected from other individuals with TB can prove very difficult to gather from homeless individuals. They may not know the names of friends/associates or only a street name, or where to find them; recall may be severely limited by addiction or mental illness and sometimes by mistrust of authorities. Drug users may be very reluctant to implicate those they use drugs with for fear of legal prosecution. It may be most productive to try to identify any particularly close friends by name and otherwise to focus on setting-based follow-up. Cases may be highly mobile, with many locations exposed. Shelters may have bed logs, which can be used to identify room-mates; in large shared rooms, prioritize those who spent the most nights with the case and slept closest. Bear in mind that ventilation patterns, including fans, can affect transmission. Rooming houses (also known as single-room occupancy hotels) are often very cramped and poorly ventilated. Homeless shelters may be closed during the day; ask about meals, drop-in centres providing services for the homeless (day-use shelters), libraries, bars, parks, etc. Shelter staff or social service agency workers may be able to identify daily patterns, or friends, and family of the case. If there are gaps in the available history during the infectious period, it may also be worthwhile to check for recent hospitalizations or detainment in a correctional facility. It will be extremely helpful to involve staffs who are familiar with the local homeless sector in contact follow-up.

Homeless contacts are often difficult to locate, and have significant challenges following through on screening, medical evaluation, and preventive treatment for LTBI.⁵² Non-judgmental and supportive TB staff, and judicious use of incentives and enablers may help increase participation rates. Active participation and encouragement from trusted staff at the shelter or day-program (e.g. a drop-in centre or soup kitchen) during screening clinics is especially helpful. Persistence and flexibility are critical. Someone who is not co-operative one day may be willing to participate another time; interventions which can be carried out on-site or in a single session generally have more success than those involving extra visits or travel (e.g. sputum collection on site, portable chest x-ray, IGRA vs TST planting and reading).⁵³⁻⁵⁵ The primary focus should generally be on early detection of secondary cases; LTBI should be assessed and treated only if individuals meet the medical and social criteria for treatment of LTBI.

See also Chapter 15, Prevention and Control of Tuberculosis Transmission in Health Care and Other Settings, for additional discussion on the prevention of TB in homeless shelters.

CORRECTIONAL FACILITIES

Residents of correctional facilities often have a higher prevalence of TB infection and disease; large outbreaks of TB have occurred in prisons in the United States, Russia and elsewhere.⁵⁶⁻⁵⁸ Older facilities in particular are often overcrowded and poorly ventilated, increasing the risk of spread. Some residents have comorbid medical conditions, such as HIV infection, that increase progression of TB infection to active disease; mental illness and mistrust of authorities can make clinical assessment difficult.

When an infectious case of TB is identified in a correctional facility, contacts can include fellow inmates and employees at the facility, transportation staff, visitors, courthouses, and family or community members exposed before the case was incarcerated. Multiple corrections facilities may be involved, as both provincial and federal inmates are often moved between sites, and both case and contacts may have had multiple incarcerations during the infectious period.⁴⁵ However, where inmates are given a TST on admission and/or annually, these results may be available as a baseline for contact follow-up. To assist in the identification of contacts, correctional facilities should track inmate transfers, releases and movement within a facility and within the system.

Levels of anxiety may be very high among corrections staff during a TB investigation and have sometimes resulted in facility closures or work stoppages. Ongoing relationships with local public health/TB control staff can help mitigate this. It is extremely helpful to include senior corrections staff, particularly chiefs/directors of health care, and union health and safety representatives early in planning and communication; if multiple facilities are involved, provincial/territorial or senior federal corrections officials should be included. If suspect cases are identified during contact follow-up, they should be removed from the general ranges/shared cells pending diagnostic confirmation. Suspect and confirmed infectious cases should be kept in airborne isolation rooms if available within correctional facilities or transferred to hospital.

Correctional Service Canada has developed guidelines for TB prevention and control in institutions that house inmates sentenced to 2 years or longer. Contact publichealth@csc-scc.gc.ca to obtain a copy.

HEALTH CARE INSTITUTIONS

Hospital TB contact follow-up benefits from close coordination and collaboration between public health/TB control staff and hospital infection control/occupational health staff. While almost every type of health care institution has been implicated in nosocomial transmission, there is very little by way of published hospital contact follow-up studies to guide thoughtful contact follow-up.⁵⁹⁻⁶¹ Unless the contact investigation is conducted in an organized, systematic fashion, with the basic principles of transmission in mind, it may result in hundreds of “contacts” with limited or unknowable exposure and often dismal participation and follow-up completion rates. It is often very useful to measure air exchange rates in specific hospital exposure locations, in order to help prioritize contact follow-up. It is also important to confirm whether there were any unprotected aerosolizing procedures, such as intubation, carried out on the infectious case (i.e. when staff did not use N95 masks). Some types of patients are extremely vulnerable (e.g. transplant patients) and even short exposures may be relevant (see Chapter 6).

Visitors to the case and to room-mates may have significant exposure. Hospital infection control and occupational health departments often take advantage of TB exposures to get staff TST documentation up to date, but within this larger group of staff being tested it is important to distinguish those who have the most actual exposure to the infectious case – particularly if there are conversions detected. Pooling the results of contact follow-up within and outside of the hospital can help to focus the investigation and determine the need, if any, for expansion. Notification of contacts may come from the hospital and/or public health authority, and testing can be done by the hospital, public health authority or personal physicians, but the plan should be agreed on by all parties to avoid confusion and gaps.

Individuals who are immunosuppressed are at much higher risk of TB disease after infection with TB; thus, TB exposures in specialty services or clinics may pose an especially high risk. For example, among dialysis patients in British Columbia, the annual rate of TB was 25 times higher than among age-matched population controls.⁶² Nosocomial transmission of TB to people with HIV is well documented in both inpatient and outpatient settings.^{63,64} See Chapter 4, Diagnosis of Latent Tuberculosis Infection, Chapter 6, Treatment of Latent Tuberculosis Infection, and Chapter 10, Tuberculosis and Human Immunodeficiency Virus, for additional information on assessment and management of these contacts. See also Chapter 15, Prevention and Control of Tuberculosis Transmission in Health Care and Other Settings.

LONG-TERM CARE

Many of the same issues for hospitals apply to TB exposures in long-term care facilities. For residents who are contacts of an infectious case of TB, the most critical follow-up is assessment for active disease through careful symptom evaluation, chest radiography and sputum testing. Diagnosis of active TB in the elderly can be difficult, and expert clinical consultation may be necessary. Gastric washings may be easier to obtain than spontaneous or induced sputum in demented or very elderly residents. TST is not recommended as a primary contact assessment tool for residents over 65 years.⁶⁵ Interpretation of TST results in the elderly is often complicated by both immune suppression and the potential for boosting related to remote TB exposure or BCG.⁶⁶⁻⁶⁹ As well, for many elderly contacts the risks of LTBI treatment outweigh the potential benefits. However, contacts among staff and visitors ≤65 years old should receive a TST. In the absence of secondary cases, their results are likely to be a more reliable indicator of transmission in the facility.

REMOTE COMMUNITIES

Contact investigation in a remote community may be especially challenging. Access to diagnostic tests, staffing, TB expertise and resources may be difficult. In remote First Nations or Inuit communities there may also be significant language and cultural barriers to successful contact tracing. Nowhere are organization, education, communication and a collaborative, nonjudgmental approach more important. The provincial/territorial TB program, the local public health/TB control program, Health Canada's First Nations and Inuit Health Branch if it is involved in the delivery or funding of health services in the community, local health care providers and the community should work closely together to identify secondary cases and contacts quickly, and then to see that they are properly managed over the duration of medical investigation and treatment.

A mobile or portable radiography unit may need to be brought to the community; liberal use of sputum screening may also be useful in coordination with the public health laboratory. Otherwise, a special effort should be made to facilitate the timely transport of people with suspected TB to a larger medical centre for investigation. Directly observed preventive therapy is a treatment option for newly infected contacts in First Nations and Inuit communities.⁷⁰ See also Chapter 14, Tuberculosis Prevention and Care in First Nations, Inuit and Métis Peoples.

CONTACTS DURING AIR TRAVEL AND OTHER PUBLIC TRANSPORT

The World Health Organization (WHO) publishes guidelines⁷¹ outlining the procedures for notifying certain contacts of people with infectious TB who have travelled on an international flight with a total duration of ≥ 8 hours within the previous 3 months. The 8 hour duration is based on epidemiologic studies reviewed in the WHO guidelines. In Canada, reports of people with TB who report a history of air travel while infectious should be made to the Public Health Agency of Canada (PHAC) through the provincial/territorial TB program (even if the flight occurred more than 3 months ago, as passenger records are usually still available). The reporting form and detailed guidelines can be found at <http://www.phac-aspc.gc.ca/tbpc-latb/reports-eng.php>. The report to PHAC should be made as soon as possible (even if culture and antibiotic sensitivity results are still pending), as this speeds up the process of risk assessment and securing the necessary passenger information from the airline. However, a systematic review of 12 studies suggests that the value of actively screening airplane passengers is limited.⁷²

The few published reports of contact tracing after exposure to TB on buses and trains indicate that transmission is sometimes possible on repeated daily exposure, such as on school buses or on long-distance trips.⁷³ Such events appear to be rare, involving highly infectious cases and specific environmental circumstances (e.g. daily travel on a crowded long-duration school bus route in winter). There is no evidence to support contact tracing related to local public transportation, particularly given the logistic hurdles and considerable inefficiency of contact tracing in these circumstances.⁷³

POSSIBLE CONTACT WITH INFECTIOUS TB CASES DURING RESIDENCE OR TRAVEL IN A COUNTRY WITH HIGH TB INCIDENCE

Please refer to Chapter 13, Tuberculosis Surveillance and Screening in Selected High-Risk Populations.

MANAGEMENT OF A TB OUTBREAK

TB outbreaks generally last for several years; response and control are major undertakings.⁷⁴⁻⁷⁶ In addition, outbreaks are more likely to occur in already challenging settings, such as homeless, impoverished, or other marginalized populations, isolated Inuit or First Nations communities, etc.^{44, 54}

DEFINITION

The definition of an outbreak of any disease is the occurrence of more cases in a given population than expected in a given time. Spatial or temporal associations may suggest ongoing transmission and an outbreak. TB outbreaks may be identified only retrospectively, after cases have been found to be linked epidemiologically or by genetic analysis. Any such clustering within the last 2 years should suggest a possible outbreak and prompt further investigation.

The following working definition of outbreak for planning investigations is based on that proposed by the U.S. Centers for Disease Control and Prevention.²²

- During and because of a contact investigation, two or more of the identified contacts are diagnosed as secondary cases of active TB; or
- Any two or more cases occurring within 1 year of each other are discovered to be linked, but the linkage is recognized outside of a contact investigation. For example, two patients who received a diagnosis of TB independently, outside of a contact investigation, are found to work in the same office, yet they were not previously identified as contacts of each other. A more extreme example is when a second generation of transmission has already occurred at the time an index case is diagnosed – i.e. secondary cases have already generated their own secondary cases. The linkage between cases should be confirmed by genotyping results if cultures are available.

This definition emphasizes the pace of secondary cases occurring and the ability of the TB program to keep up with multiple contact investigations. In practice, the ability of the local TB program to manage a growing cluster of TB cases and the concurrent contact investigations in a timely way, within its usual operations, is also a key factor in determining whether or not to consider the situation an outbreak for response purposes. Most situations that have been recognized as TB outbreaks involve chains of many more than two secondary cases, or one previously unrecognized link to a secondary case, and extend over several years. The above definition is an operational one intended to help identify and contain rapidly evolving clusters. Note that a slower cluster of linked cases that spans several years may still require heightened TB program response for an identifiable population group yet not be an “outbreak” by the above definition.

GOALS

The goals of the investigation and management of an outbreak of TB are as follows:

- to promptly identify the source case or cases, so that the risk of ongoing transmission of infection is rapidly reduced by isolation and initiation of appropriate treatment;
- to rapidly identify new cases of active TB within the at-risk population, and initiate airborne isolation and treatment;
- to identify people with recently acquired LTBI, so that preventive therapy can be given before active disease develops.

MANAGING AN OUTBREAK

Organization and resources

Given the scale and duration of most TB outbreaks, it is important that there be adequate staffing and resources for investigation and management from the onset of the response efforts. Assistance from outside the TB program may be necessary. Advice from experienced colleagues who have managed TB outbreaks elsewhere can be invaluable.

The following components are recommended in any TB outbreak response:

- an identified outbreak manager, appointed for the duration, with overall responsibility for management and coordination of the outbreak response;
- public health/TB control staff to register and case-manage patients with TB, define infectiousness, coordinate the investigation and provide consultation and communication with those in the field;
- sufficient field staff to carry out the contact investigation and follow-up; for outbreaks dispersed across remote communities, mobile specialized teams may be an effective strategy to support local staff;
- information technology (IT)/database and epidemiologic support;
- consistent, coordinated clinical and diagnostic supports with expertise in TB:
 - prompt, local access to chest radiography of adequate quality,
 - identified medical consultants with expertise in TB to review chest radiology, evaluate patients for TB, hospitalize if necessary, and manage suspected cases and contacts in a consistent manner, without delay; for remote communities telemedicine links (including review of digital radiology) can be extremely effective,
 - hospital facilities that can offer airborne isolation rooms, diagnostic examinations and treatment without delay,
 - links to public health laboratories for specialized supports (arrangements to handle larger numbers of specimens, fingerprinting, etc.),
 - rapid and safe transportation of specimens and, if necessary, patients;
- sufficient case-management and DOT staff to provide supervision of the complete course of drug treatment for all active cases – at least 1 year's additional staffing after the outbreak is over may be required;

- communications personnel to provide regular updates to the media and community on the status of the investigation;
- staff and resources to carry out the evaluation.

Roles and responsibilities

It is crucial, from the onset of the investigation, that the roles of all those involved in the investigation and management are clearly defined. Establishing an outbreak coordinating group, including the key individuals from public health/TB control, clinical expert care, hospitals, laboratory, the affected community and communications, can be very helpful. Collaboration and regular feedback among all levels of health care are important. There should be clear agreement to be followed in the investigation and the management of suspected cases and contacts, and written protocols.

Communication with health care providers

Local health care providers, particularly those who are most likely to first see new cases of TB in the outbreak population (emergency room, primary care in the outbreak neighbourhood, etc.) are key partners. Presentation at medical rounds, written notification about the outbreak and other ongoing communication will help to raise the index of clinical suspicion for TB, provide up-to-date information about TB diagnosis and management, and help decrease barriers to care, including early hospitalization for suspected infectious cases when necessary.

Staff training

Given the scale of TB outbreaks and response, many staff involved may not be experienced in TB work; including training and education/clinical rounds at all the organizations involved in the response plan can be helpful.

Prompt isolation and treatment of cases of active disease

An outbreak should markedly raise the index of clinical suspicion for TB when anyone in the affected community presents with compatible symptoms, particularly for respiratory (i.e. infectious) TB. All suspected infectious cases should be promptly isolated – in hospital if necessary – and investigated to confirm the diagnosis and the degree of infectiousness. Suspect cases should not return to congregate settings until infectious TB has been ruled out.

Case-finding, identification of source case, and contact investigation

In outbreaks among homeless and other marginalized populations, outreach street nursing, primary care clinics on site at shelters or other homeless services, and other low-threshold types of care are often critical for early diagnosis.^{44,52,75,76} Shelter staff may be the first to identify an ill resident; training about TB and infection control precautions, basic symptom screening on admission, and mechanisms to rapidly isolate and refer suspect TB cases for medical evaluation should be implemented.

If not apparent, the source case or cases should be identified through aggressive investigation of all symptomatic individuals in the at-risk community. Once the initial investigation is under way, a review of the history of TB in the community is important. Review of “old cases” by provincial/territorial and local public health/TB programs may identify previously inadequately treated cases. In some circumstances it may be helpful to locate and reassess previously identified high-risk contacts who were lost to follow-up or did not take or complete treatment for LTBI.

In small communities or in closed settings it may be more efficient to screen the entire community or those in the facility at baseline, especially as it may be difficult to determine the exact level of contact in a small, close-knit community. In some settings, especially if members are very mobile, offering on-site active case-finding (sputum and/or chest radiography as well as symptom screening) on an ongoing basis over an extended period of time may be the only way to ensure that most contacts are identified and screened.^{53-55,75-77} Many remote communities have members who travel back and forth frequently to other communities; tracking these individuals is particularly difficult, yet they can be a conduit to spread the outbreak to additional communities. Coordination and shared follow-up arrangements with TB programs in these other communities may be very helpful in the assessment and management of mobile contacts and cases.

In populations in which treatment of LTBI is not realistic as a major outbreak control strategy, the primary emphasis should be on early detection and treatment-to-cure of active cases, rather than extensive efforts to do skin testing. Examples include elderly residents (over 65 years) in long-term care facilities and some homeless populations (e.g. older alcoholics). See also Chapter 15.

A heightened index of clinical suspicion and perhaps case finding efforts should be maintained for several years after the outbreak subsides, as there is usually a pool of recently infected people remaining in the community. It may be possible to follow infected contacts who refuse or are not eligible for treatment of LTBI in order to detect early TB disease (e.g. periodic clinical assessment for 2 years after exposure).

Data management and epidemiologic support

Contact investigation and management in a TB outbreak is very data-heavy. Tracking hundreds of contacts, often through multiple sites and assessments, demands a good database and IT support. Rapid, thoughtful evaluation of the aggregate results as they become available requires a dedicated epidemiologist.

Identify fundamental causes

TB outbreaks mainly take place in settings where rapid transmission is possible – inadequate housing (overcrowding, inadequate ventilation) and prolonged infectiousness often related to limited health care access. A high prevalence of vulnerability factors among contacts accelerates the development of secondary cases: the presence of many young children, diabetes and other causes of immunosuppression, smoking, malnutrition, etc. In facility-based outbreaks (homeless shelters, hospitals, jails) a systematic assessment of conditions and practices, including ventilation, may identify areas for intervention (see also Chapter 15). Individual cases can be treated and cured, but it is very difficult to contain outbreaks or reduce endemically high rates of TB without addressing the fundamental causes. These aspects, too, should be recognized, and when possible addressed in the outbreak response.

Community outreach and education

TB outbreaks can be anxiety-provoking and stigmatizing. Often they take place in a context of limited or inaccurate information about TB and sometimes quite negative cultural/historical associations. All these can prolong the situation through delayed diagnosis if individuals either do not recognize the significance of their symptoms or are afraid to receive a diagnosis of TB. It

is crucial to provide information about TB and the outbreak response to the affected community or setting as early as possible in the investigation of the outbreak, with regular updates for them and for the general local population. The information should be in a style and format that is accessible and takes into account the cultural and practical setting of those affected. Standard materials may need to be adapted, ideally with input from community members. Peer outreach may be very useful, particularly for hard-to-reach individuals. This will help reduce the level of anxiety and will likely lead to greater cooperation and adherence to recommendations.

Evaluate the process and outcome of the outbreak investigation

Ongoing evaluation and a formal evaluation at the end of the outbreak, including both the process and outcome of the outbreak investigation, are crucial. DNA genotyping of isolates may be useful in identifying the presence of an outbreak, mapping its extent and evaluating the results of the outbreak investigation and control. Identification of key contributing factors, often social determinants of health, may point to future non-TB-specific interventions.

■ ■ ■

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