Experiences with latent TB cascade of care strengthening for household contacts in Calgary, Canada

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SETTING: Identification, assessment, and treatment of latent TB infection (LTBI), collectively known as the LTBI cascade of care, is critical for TB prevention.

OBJECTIVE: The objective of this research, conducted within the ACT4 trial, was to assess and strengthen the LTBI cascade of care for household contacts at Calgary TB Services, a clinic serving a predominately foreign-born population in Western Canada.

DESIGN: Baseline assessment consisted of a retrospective LTBI cascade analysis of 32 contact investigations, and questionnaires administered to patients and health care workers. Four solutions were implemented in response to identified gaps. Solution impact was measured for 6 months using descriptive statistics.

RESULTS: Pre-implementation, 56% of household contacts initiated treatment. Most contacts were lost to care because the tuberculin skin test (TST) was not initiated, or physicians did not recommend treatment. Evening clinics, a patient education pamphlet, a nursing workshop, and treatment recommendation guidelines were implemented. Post-implementation, losses due to LTBI treatment non-recommendation were reduced; however, the overall proportion of household contacts initiating treatment did not increase.

CONCLUSION: Close engagement between researchers and TB programmes can reduce losses in the LTBI cascade. To see sustained improvement in overall outcomes, long-term engagement and data collection for ongoing problem-solving are required.

Canada will not meet WHO targets for TB elimination by 2035 without improvements to current care.^{1,2} Due to their high risk of progression to active TB, screening and preventive treatment for household contacts of patients with pulmonary TB is critical to reducing incidence.^{3,4} However, latent TB infection (LTBI) outcomes in many countries, including Canada, are known to be suboptimal and improvements are needed.^{5,6} Much research has been directed at increasing adherence to LTBI treatment once initiated.^{7,8} However, evidence shows that most eligible patients are actually lost to care before treatment is initiated; suggesting that greater public health impact could be achieved by reducing loss to follow-up during LTBI assessment.⁵

The 'LTBI cascade of care' is a framework used to conceptualise the multistage process of assessment and treatment.⁵ When applied to household contacts, the full cascade consists of eight steps: identification,

initiation of testing, completion of testing, initiation of medical assessment, completion of medical assessment, physician recommendation of treatment, initiation of treatment and completion of treatment.^{5,9} Navigating the LTBI cascade can be difficult. In Canada, initiating treatment can require four to six appointments spanning several months.³ Given that a majority of households affected by TB in Canada are comprised entirely or partially of people born outside the country,¹ reducing barriers to care for foreign-born individuals is critical to LTBI cascade strengthening. Documented barriers to care for this population include TB misperceptions, lack of transportation, language discordance, and a need to prioritise employment over seeking care.^{10–14}

The objective of the present study was to assess and strengthen the LTBI cascade of care for household contacts at Calgary TB Services. Specific aims were to describe cascade outcomes at baseline, solution implementation and monitoring, and cascade outcomes following solution implementation.

METHODS

Research setting

Calgary TB Services participated in the ACT4 study, a multisite international cluster randomised trial which tested an intervention of LTBI cascade evaluation and strengthening for household contacts.^{9,15} Calgary was randomised as an intervention site. McGill University, Montreal, QC, Canada, was the coordinating centre supporting four Canadian and four international sites. Coordinating researchers provided sites with training, assessment tools and analytic support. The primary outcome for ACT4 was to compare the number of household contacts initiating LTBI treatment in the 6 months prior to solution implementation to the last 6 months of the 1-year follow-up period. The ACT4 protocol was reviewed and approved by ethics boards at McGill University (15-291-MUHC), and the University of Calgary, Calgary, AB, Canada (REB15-3152).

Calgary TB Services is the sole provider of outpatient TB services for the municipality and surrounding areas, an approximate population of 1.4 million people.¹⁶ In 2017, 108 individuals were diagnosed with active TB in the Calgary zone; 90% of these individuals were born outside of Canada (Alberta Tuberculosis Programme, 2017 Active case report, unpublished). During the study period, care for household contacts in Calgary was provided free of charge for permanent

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FIGURE 1 Calgary TB Services household contact cascade of care. *TST result at 48–72 h post-administration ≥ 5 mm indicates a significant result. †Includes chest X-ray, symptom inquiry and physical examination. May also include sputum examination for acid-fast bacilli. TST = tuberculin skin test; + = positive; – = negative.

residents and citizens, and partially subsidised for visitors (who comprise <5% of household contacts annually).

Household contact investigations at the Calgary TB Services, Calgary, AB, Canada, are initiated as per national guidelines, through an interview with the index patient following pulmonary TB diagnosis.³ Ideally, interviews should be conducted within 3 days and assessment of household contacts should commence promptly thereafter.³ Identified contacts are assessed using symptom inquiry; LTBI testing, primarily done using the tuberculin skin test (TST); medical assessment; and chest X-ray as needed (Figure 1). Care is expedited for those who are symptomatic, immunosuppressed or under 5 years.

Baseline LTBI programme assessment

A baseline assessment consisting of quantitative analysis and interviewer-administered questionnaires was conducted in the Fall of 2016. LTBI cascade of care analysis was conducted to identify losses at each step and prioritise steps for intervention. Retrospective analysis of household contact investigations associated with all eligible index patients diagnosed between September 2015 and February 2016 was completed. Data were extracted manually from each household contact's electronic chart and entered into an Excel-based (Microsoft, Redmond, WA, USA) registry tool for analysis. Index patients must have received a microbiologically confirmed diagnosis of pulmonary TB within the Calgary Zone to be included. Household contacts' must have had their electronic chart labelled correctly and linked to an eligible index patient. The registry tool produced several displays depicting outcomes for the first seven LTBI cascade steps (i.e., identification to acceptance of treatment). To focus analysis on earlier cascade steps, completion of treatment was not included. Cas-

cade outcomes were binary in nature (e.g., TST initiated? Yes/no). The number of eligible participants completing a step was expressed as the proportion of the previous step, except for the identification and medical assessment steps. For identification, it was expected that each index case would have 4.1 household contacts.¹⁷ For medical assessment, the denominator was the sum of those with current or historical positive TST, previous TB treatment, symptoms, and those under 5 years of age. No estimates of sample size were completed a priori for the Calgary site. Validation of baseline assessment occurred when local researchers reviewed data collection procedures with coordinating centre staff and compared results extracted via different methods for the main trial.

Questionnaires were administered to gain insight on the experiences of patients and staff and to understand why cascade losses occurred. Questions focused on TB knowledge and perceived barriers and supports to LTBI care. In total, 37 participants, including 10 TB index patients, 11 adult contacts, 6 parents of child contacts and 10 TB health care providers completed the series of open- and closed-ended questions. A different questionnaire was used for each category of respondent. Following informed consent, phone or in-person questionnaires were administered by a trained member of the research team. Thirty-five questionnaires were conducted in English; confidential telephone language interpreters were used for two interviews. Results were analysed using descriptive statistics.

Solution selection

Solutions designed to strengthen the LTBI cascade were selected to address steps with greatest losses and barriers identified through the questionnaires. After reviewing baseline results, a list

TABLE 1 List of candidate solutions, implemented and not implemented

Targeted cascade losses	Identified concern	Implemented solutions	Solutions considered, not implemented	Rationale for selection
TST not initiated	<ul style="list-style-type: none"> Inaccessible clinic hours Misperceptions among patients 	<ul style="list-style-type: none"> Evening clinics Communication-focused workshop for nurses Patient education pamphlet 	<ul style="list-style-type: none"> Community-wide education Patient incentives 	<ul style="list-style-type: none"> Alternatives would have diluted impact or were not sustainable
LTBI treatment not recommended	<ul style="list-style-type: none"> Inconsistent practice 	<ul style="list-style-type: none"> Physician guidelines 	<ul style="list-style-type: none"> Chart reminders Physician education 	<ul style="list-style-type: none"> Alternatives were not sustainable or did not address the specific issue

TST = tuberculin skin test; LTBI = latent TB infection.

of candidate solutions (Table 1) was compiled and reviewed with management and clinicians prior to final selection.

Solution implementation monitoring and evaluation

Solutions were implemented between August and October 2017 and maintained throughout the 12-month follow-up period (October 2017–September 2018). Implementation was monitored through conversations with staff, audit and feedback, and appointment booking rates. Based on these indicators, implementation strategies were adjusted to promote uptake.

During the follow-up period, the LTBI cascade was compiled quarterly and reviewed among local researchers and clinic staff. Solution impact was evaluated by comparing the baseline cascade to the cascade for the last 6 months of the follow-up period (April–September 2018). Follow-up cascade data were collected using the same methods as at baseline. Two Calgary researchers (DF and NB) validated follow-up data by independently extracting and comparing outcomes for a random sample of 8% of contact investigations. Perfect correspondence was achieved.

RESULTS

Baseline LTBI programme analysis

Baseline cascade analysis showed 130 household contacts were identified for 32 index patients. Forty-three household contacts initiated treatment, which represented cumulative retention in care rate of 56%. Thirteen contacts were lost because they did not initiate testing; 12 contacts were lost because the physician did not recommend treatment; and 6 contacts were lost because pa-

tients did not initiate treatment. The baseline cascade is presented in Table 2 and Figure 2.

Questionnaire analysis revealed that index patients and household contacts were concerned regarding TB exposure and were motivated to engage with TB services to protect their health and the health of others. Health care providers identified that that inconvenient clinic location and operating hours, and patient misperceptions impeded care provision.

Solution implementation

In response to identified barriers, four solutions were implemented in Fall 2017. Solutions consisted of evening hours for nurse clinics, a communication-focused contact investigation workshop for nurses, a patient education pamphlet, and practice guidelines for LTBI testing and treatment recommendation. Staff engagement in solution implementation was promoted through frequent updates at team meetings. Costs associated with solution implementation such as nursing and administrative staff salaries were shared between research and programme budgets. Programme managers were engaged early in the research process to facilitate support. Table 3 contains key implementation strategies.

Evening nursing clinics were intended to improve the accessibility of TST and reduce losses, which occurred because TST was not initiated. Hours were extended until 19:30 every other Monday and Wednesday. Nurses and clerical staff were reminded by researchers to offer evening appointments to patients for the first 2 months of implementation. Staff reported that evening appointments relieved stress on patients by reducing scheduling conflicts with employment and education. Families often at-

TABLE 2 Summary of LTBI cascade data baseline and follow-up

	Baseline period (September 2015–February 2016) <i>n</i>	Follow-up period (April–September 2018) <i>n</i>
Index patients	32	26
Household contacts identified	130	108
Household contacts lost because testing not initiated (denominator = household contacts identified), <i>n/N</i> (%)	13/131 (10)	13/107 (12)
Household contacts eligible for treatment*	62	58
Current/historical TST+ or previous TB treatment	43	44
Active TB	0	0
Under 5 years of age	19	14
Household contacts lost because treatment not recommended (denominator = eligible for treatment)	12/62 (19.4)	6/57 (10.5)
Household contacts lost because treatment not initiated (denominator = household contacts recommended treatment)	6/49 (12.2)	13/51 (25.5)
Household contacts initiating treatment	43	38

* Those eligible for treatment = those with positive TST, TB history, children under 5 years, minus those diagnosed with active TB.

TST = tuberculin skin test; LTBI = latent TB infection.

FIGURE 2 Cumulative percentage retained in the LTBI cascade of care at baseline. LTBI = latent TB infection.

tended evening appointments as a group, reducing transportation barriers. Nurses also reported that patients had more time to engage in TB education than during daytime hours.

The nursing workshop and patient education pamphlet were also intended to reduce losses related to initiation of testing. The 4-hour interactive workshop was based on materials developed by the US Centre for Disease Control (Atlanta, GA, USA) and focused on improving information exchange during the contact tracing interview.¹⁸ The pamphlet contained basic information about TB transmission, and the importance of LTBI testing and treatment. The pamphlet was developed by Minnesota Public Health (Minneapolis, MN, USA), used with their permission, and available in 16 languages.¹⁹ Informal conversations with staff and pamphlet re-stocking were used to monitor uptake of these solutions. Nurses found it challenging to incorporate workshop communication techniques into their practice because time constraints often forced interviews to be conducted by phone. Pamphlets were not practical for phone interviews and were not mailed to patients. Reminders from researchers were not effective at improving uptake of these strategies.

Practice guidelines were developed using consensus-based discussion among clinic physicians primarily to address issues related to inconsistent treatment recommendations. Guideline uptake was monitored by auditing consult letters and reporting aggregate findings at monthly meetings. Monitoring was discontinued after 9 months due to high adherence.

Post-implementation cascade of care analysis

During the follow-up period, 108 household contacts were identified for 26 index patients. Thirty-eight household contacts initiated LTBI treatment, which represented a 53% cumulative retention in care. Thirteen contacts were lost because TST was not initiated. Six were lost because the physician did not recommend treatment, half the number at baseline. However, the number of contacts who did not initiate treatment increased to 13. Compari-

son of baseline and follow-up periods can be seen in Table 2 and Figure 3.

As shown in Table 4, there was considerable variation in quarterly results over the 12-month follow-up period. The cumulative proportion of household contacts initiating treatment ranged from 27% to 73%. Each quarter saw a change in the cascade step responsible for the highest number of losses.

Solution sustainability

Physician guidelines were adopted as routine practice. Evening clinics were sustained for 11 months after the study concluded, ultimately discontinued due to budget constraints. Improved communication with index patients and household contacts has become a long-term, clinic-wide priority.

DISCUSSION

Improved screening and preventive treatment for household contacts is central to the WHO plan to eliminate TB.²⁰ This study evaluated the impact of four health service solutions intended to improve screening and treatment for household contacts in Western Canada. Following solution implementation, losses related to physician recommendation of treatment decreased; however, the overall proportion of household contacts initiating treatment did not increase. While conducting this research, important issues arose which may be valuable to others engaged in similar work. Specifically, we highlight the variable impact of solutions and implementation strategies, as well as challenges for LTBI cascade measurement in low incidence settings.

Variable impact of solutions and implementation strategies

Early and frequent engagement with staff, physicians, and management was essential for successful solution implementation (Table 3). We found frequent reminders were necessary to affect practitioner behaviour change in this busy clinic. Notably, the audit and feedback strategy was effective for increasing physician ad-

TABLE 3 Highlighted implementation strategies

Overarching theme	Implementation strategy	Impact
Early and frequent researcher engagement with management, physicians, and staff	Early communication with programme management	<ul style="list-style-type: none"> • Cost sharing • Administrative support • Increased sustainability
	Audit and feedback reminders	<ul style="list-style-type: none"> • Increased solution uptake
	Frequent communication with staff and management (e.g., informal discussions, staff meeting presentations)	<ul style="list-style-type: none"> • Staff feedback on solutions • Increased staff motivation • Increased sustainability

FIGURE 3 Cumulative percentage retained in the LTBI cascade of care, baseline and follow-up. LTBI = latent TB infection.

herence with guidelines. Reminders were not effective for increasing uptake of patient education solutions (i.e., pamphlet and workshop), because scheduling practices were likely a constraining factor and a more complex approach was required. Based on this experience and the available literature, we believe patient education at CTBS could be improved through stronger case management practices which incorporate multiple options for patient education (e.g., online resources, mailed print materials, longer phone conversations).^{21,22} Evening clinics would not have been possible without CTBS cost-sharing and administrative support, which was facilitated by early, intentional connection between researchers and programme managers. Although screening losses were not reduced after the introduction of evening clinics, these clinics were sustained because staff reported improved patient experience and reduction of many barriers known to be significant for our foreign-born population.^{10–14}

Challenges and suggestions for LTBI cascade measurement

To overcome methodological challenges associated with LTBI cascade strengthening in low-incidence settings, we encourage other researchers to plan for the collection of short-term indicators, as well as a long period of post-intervention engagement. Detailed short-term indicators are required because cascade outcomes alone do not explain why losses occurred and because there is a considerable time lag associated with cascade outcomes. At our centre, it can take 16 weeks or longer for a household contact to progress through the full cascade of care. During this time, we found short-term indicators (e.g., consult note auditing, staff feedback) invaluable for understanding and increasing solution

impact. We urge other researchers not to underestimate the value of these indicators and to explicitly incorporate them into study design.

Long-term engagement is crucial to LTBI cascade strengthening for two reasons. First, in a low-incidence setting, long engagement may be required to collect a large data set. Our smaller data set was likely influenced by household and patient-specific characteristics; significant quarterly variability limited our data interpretation. To facilitate the identification of stable trends we encourage others engaged in LTBI cascade research to plan for a longer follow-up period commensurate with local TB incidence. Second, long-term engagement is required to work through iterative problem-solving cycles, which may be needed to affect a change in the overall outcome.²³ In our study, the need for iterative problem-solving was demonstrated when reduced losses related to physician recommendation of treatment was followed by increased losses related to patient initiation of treatment. This seemingly contradictory finding is in keeping with other research, which has shown that improving outcomes at earlier LTBI cascade steps can unmask problems at later steps.²⁴

We did not collect data during the follow-up period to explain losses related to treatment recommendation and initiation but feel this is an important area for future research. During our study, anecdotal review of consult notes indicated that physicians' decision not to recommend treatment was often in keeping with national guidelines (e.g., previous TB treatment, history of liver disease),²⁵ and should not in fact have been considered a 'loss to care'. Mixed methods research could be particularly useful for exploring how physicians assess patient vulnerability when

TABLE 4 Post-implementation period by quarter

Quarter	Index patients <i>n</i>	Household contacts identified <i>n</i>	Household contacts eligible for treatment* <i>n</i>	Household contacts initiating treatment <i>n</i>	Cumulative proportion of household contacts initiating LTBI treatment† %	Cascade step associated with highest number of losses
1- October–December 2017	25	71	41	16	27	Contacts not identified (<i>n</i> = 29)
2- January–March 2018	9	58	20	15	73	Treatment not recommended (<i>n</i> = 6)
3- April–June 2018	15	71	41	25	53	Treatment not initiated (<i>n</i> = 10)
4- July–September 2018	11	37	17	13	54	Testing not initiated (<i>n</i> = 8)

* Those eligible for treatment = those with positive TST, TB history, children under 5 years, minus those diagnosed with active TB.

† Those who completed TST assessment with a negative TST or IGRA result are not included in the denominator.

LTBI = latent TB infection; TST = tuberculin skin test; IGRA = interferon-gamma release assay.

recommending treatment and patients' decision-making process when choosing whether to initiate treatment.

CONCLUSION

Close engagement between researchers and TB programmes can reduce LTBI cascade losses. For sustained improvement in overall outcomes, long-term engagement and data collection to support ongoing problem-solving are required.

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CONTEXTE : L'identification, l'évaluation et le traitement de l'infection tuberculeuse latente (LTBI) — collectivement connus sous le nom de « cascade de soins de la LTBI » — sont essentiels à la prévention de la TB.

OBJECTIF : L'objectif de cette étude, réalisée dans le cadre de l'essai ACT4, était d'évaluer et de renforcer la cascade de soins de la LTBI pour les contacts domestiques au *Calgary TB Services*, une clinique traitant principalement une population née à l'étranger dans l'ouest du Canada.

PLAN : Il s'agissait d'une évaluation initiale comprenant une analyse rétrospective de la cascade de soins de la LTBI de 32 recherches de contacts et des questionnaires administrés aux patients et aux professionnels de santé. Quatre solutions ont été mises en place en réponse aux lacunes identifiées. L'impact des solutions a été mesuré pendant 6 mois à l'aide de statistiques descriptives.

RÉSULTATS : Avant la mise en place des solutions, 56% des contacts domestiques avaient démarré un traitement. La plupart

des contacts ont été perdus de vue car l'intradermoréaction à la tuberculine (TST) n'avait pas été effectuée ou car les médecins ne recommandaient pas de traitement. Des solutions ont été mises en place, telles que l'ouverture des cliniques en soirée, un dépliant informatif pour les patients, un atelier de travail à destination des infirmiers et des directives thérapeutiques. Après la mise en place des solutions, les pertes dues à l'absence de recommandation de traitement contre la LTBI ont été réduites, mais la proportion globale de contacts domestiques démarrant un traitement n'a pas augmenté.

CONCLUSION : Une collaboration étroite entre chercheurs et programmes de lutte contre la TB peut réduire les pertes observées au cours de la cascade de soins de la LTBI. Afin d'obtenir une amélioration durable des résultats globaux, un engagement de long terme et un recueil des données sont requis pour résoudre les problèmes actuels.