

Tuberculosis screening on admission to long-term care homes in Ontario



Technical Report
May 2019

Public Health Ontario

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How to cite this document:

Ontario Agency for Health Protection and Promotion (Public Health Ontario). Tuberculosis screening on admission to long-term care homes in Ontario. Toronto, ON: Queen's Printer for Ontario; 2019.

ISBN: 978-1-4868-3101-2

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Public Health Ontario acknowledges the financial support of the Ontario Government.

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Acknowledgements

We would like to extend our sincere thanks to the members of Ontario's Provincial Infectious Diseases Advisory Committee on Communicable Diseases' (PIDAC-CD) Tuberculosis Working Group (TBWG) and its Chair, Dr. Elizabeth Rea (Appendix A), as well as members of PIDAC-CD for providing iterative guidance and feedback on the design and interpretation of this analysis. We are grateful to the public health units that participated in the chart reviews presented in this report.

We would also like to thank Dr. Doug Sider, Dr. Bryna Warshawsky, Dr. Shelley Deeks, Emily Karas, Michael Whelan, Harjot Kaur Dhaliwal, Kristen Cockburn, Karin Hohenadel and the Communicable Diseases team, and the Emergency Preparedness and Support and Knowledge Services teams at Public Health Ontario for their assistance with this document.

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Abbreviations

AFB: acid-fast bacteria

AP: anterior-posterior

BCG: bacille Calmette-Guérin

CASP: Critical Appraisal Skills Programme

CCRS: Critical Care Reporting System

CTBS: Canadian Tuberculosis Standards

ECDC: European Centre for Disease Prevention and Control

HIV/AIDS: human immunodeficiency virus/acquired immunodeficiency syndrome

HPPA: *Health Protection and Promotion Act*

IGRA: interferon-gamma release assay

IPAC: infection prevention and control

iPHIS: integrated Public Health Information System

LHIN: Local Health Integration Network

LTBI: latent tuberculosis infection

LTCF: long-term care facility

LTCH: long-term care home

MetaQAT: Meta-tool for quality appraisal of public health evidence

MIRU-VNTR: mycobacterial interspersed repetitive units-variable number of tandem repeats

MOHLTC: Ontario Ministry of Health and Long-Term Care

NNS: number needed to screen

OPHS: Ontario Public Health Standards

OUT-TB: Ontario Universal Typing of Tuberculosis

PA: postero-anterior

PHO: Public Health Ontario

PHU: public health unit

PIDAC-CD TBWG, or TBWG: Provincial Infectious Diseases Advisory Committee-Communicable Diseases, Tuberculosis Working Group

PTB: pulmonary tuberculosis

RAIMDS: Resident Assessment Instrument Minimum Data Set

TB: tuberculosis

TST: tuberculin skin test

UK: United Kingdom

US: United States

WDG: Wellington-Dufferin-Guelph

WHO: World Health Organization

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Executive Summary

Purpose and scope

This report addresses tuberculosis (TB) screening for residents on admission to long-term care homes (LTCHs) in Ontario. It focuses on evidence-informed considerations relevant to the use of chest radiograph (x-ray) as a TB screening tool, as part of the LTCH admission process in the Ontario context. This report can be used as a resource to help inform TB screening approaches or recommendations for residents being admitted to LTCHs in Ontario.

Background

The current *Canadian Tuberculosis Standards* (CTBS, 7th Edition) recommends a screening chest radiograph (x-ray) for active pulmonary TB on admission to LTCHs for persons born before 1966 in Canada and other low TB incidence countries and in other identified at-risk groups, including Aboriginal Canadians from high TB incidence communities, and persons born or who have lived in countries with high TB incidence.¹ A baseline two-step tuberculin skin test (TST) on admission is only recommended for LTCH residents aged 65 years and under with identified risk factors for TB progression (i.e., those who may benefit from preventive treatment for latent TB infection [LTBI]).¹

In Ontario, the *Long Term Care Homes Act* (LTCH Act) mandates that LTCH residents must be screened for active TB within 14 days of admission, unless already screened in the 90 days prior to admission, with documentation of this available to the LTCH; however it does not specify the method(s) to be used to screen LTCH residents for TB.² Past draft guidance from the Ontario Ministry of Health and Long-Term Care (MOHLTC) from 2011 had recommended a postero-anterior (PA) and lateral chest x-ray for new LTCH residents within 14 days of admission, unless documentation is available from a chest x-ray performed in the 90 days prior to admission.³ This draft 2011 MOHLTC guidance also recommended a baseline TST if the risk of active TB was increased in the LTCH population.³ However, current use of TST on admission to LTCHs is more likely to align with the current CTBS recommendations (i.e., limited to residents aged 65 years and under with identified risk factor for TB progression), as outlined above.¹

Implementing routine PA and lateral chest x-ray screening for TB on admission to LTCH is resource-intensive and can be logistically challenging for LTCHs and residents.⁴ These implementation challenges, along with the perceived low burden of active TB cases in LTCH residents, have led to local public health unit (PHU) interest in revisiting admission TB screening approaches for LTCH residents in Ontario.

Objectives and methods

1. Systematically identify, summarize, and appraise the quality of peer-reviewed literature on:
 - The burden of TB in residents of Ontario LTCHs; and

- Screening for active TB using chest x-ray among residents of LTCHs.
2. Estimate the burden of active pulmonary TB among residents of LTCHs in Ontario from 2006 to 2015 using available reportable disease data, continuing care administrative data, and chart reviews.
 3. Link reportable disease and laboratory data to identify genotyping evidence suggestive of TB transmission events associated with active pulmonary TB cases in Ontario LTCH residents from 2006 to 2015.
 4. Describe current TB screening recommendations for LTCH residents in a convenience sample of six selected Ontario PHUs with a range of TB rates, other Canadian provinces and territories, and other low TB incidence countries via jurisdictional scans.
 5. Use a screening analytic framework to integrate considerations in respect of the current method (i.e., universal chest x-ray) for TB screening on admission to LTCHs in Ontario.

Results

Evidence review

A systematic search of peer-reviewed literature identified three articles that met the inclusion criteria:

- An article on a TB outbreak in a LTCH in the Wellington-Dufferin-Guelph (WDG) PHU in 2010-2011;⁵ and
- A 1992 survey of Toronto-area LTCHs about their TB surveillance practices that did not assess the impact of screening chest x-rays on admission;⁶ and
- A cost-effectiveness analysis that compared LTCH admission screening for TB with chest x-ray versus TST in Alberta and concluded that neither intervention was cost-effective.⁷

Estimated burden of pulmonary TB in Ontario LTCH residents

Based on a review of data captured in Ontario's communicable diseases reporting system (i.e., the integrated Public Health Information System, or iPHIS) and verification by chart reviews conducted by PHUs, 38 pulmonary TB cases were confirmed to have occurred in LTCH residents in Ontario over the ten-year period from 2006 to 2015. The majority (17/38; 44.7%) of cases were from Toronto; York Region had next greatest burden of cases (5/38; 13.2%).

- The estimated average annual proportion of LTCH residents with pulmonary TB among all reported pulmonary TB cases in Ontario from 2006 to 2015 was 1.0%.
- The estimated average annual proportion of LTCH residents with pulmonary TB among all LTCH residents is very low, at 0.005%. Expressed as a rate per 100,000 population (to enable

comparison to rates in the general population), this translates to an average annual incidence rate of 4.6 pulmonary TB cases per 100,000 LTCH residents per year in Ontario from 2006 to 2015, compared to 7.1 pulmonary TB cases per 100,000 adults over age 70 years in the general population in Ontario over this time period.

- None of the 17 confirmed TB cases reported in Toronto in LTCH residents were detected through an admission screening chest x-ray; timing of diagnosis relative to LTCH admission screening was not assessed for cases in other health units.
- Complete genotyping results were available for 27 of the reported cases among LTCH residents; 18 had a genotype that did not match any other Ontario TB cases. Nine cases had an identical genotype match to at least one additional case: one cluster (n=3) with identical genotypes was associated with the previously reported LTCH outbreak in WDG, four isolates each matched another case, none of whom resided in a LTCH, and two were part of large clusters with low genetic diversity and were therefore unlikely to represent transmission events in LTCHs.

Jurisdictional scans

For the five Ontario PHUs in our sample with publicly accessible, LTCH-specific TB screening recommendations available online in 2017-18 (i.e., Halton Region,⁸ Peel Region,⁹ Toronto,¹⁰ Waterloo Region,¹¹ and Wellington-Dufferin-Guelph¹²), most recommended the following for LTCH residents on admission: universal chest x-ray, a two-step TST for those under 65 years of age, and a symptom review for active TB. None of the PHUs explicitly recommended a TB risk factor inquiry.⁸⁻¹²

The Canadian¹³⁻²⁴ and international²⁵⁻²⁹ jurisdictional scans identified a spectrum of approaches to TB screening on admission to LTCHs. The varied approaches in other Canadian provinces and territories and countries with low TB incidence ranged from no screening, to symptom and/or risk factor inquiry with chest x-ray only if symptoms/risk factors are present, to routine chest x-ray with or without TST.

Application of a screening analytic framework

The application of a screening analytic framework³⁰ to universal chest x-ray screening for TB on admission to LTCHs in Ontario highlighted multiple considerations, as well as knowledge gaps, regarding:

- The condition (e.g., low estimated burden of TB in LTCH residents, despite potential severity and impact of a single case);
- The test (e.g., suboptimal sensitivity of chest x-ray for diagnosing TB, and uncertain properties of chest x-ray as a screening tool for active pulmonary TB in people who are not sufficiently symptomatic to prompt health care seeking);
- The intervention (e.g., increased risk of complications from treatment in the elderly); and,
- Implementation (e.g., gaps in evidence on acceptability of undergoing a PA and lateral chest x-ray, which is taken in a standing position and may require transport off-site, in an elderly

population where mobility limitations and medical co-morbidities may make this particularly challenging; also, gaps in the evidence on cost-effectiveness of admission screening versus other interventions to prevent TB transmission in this setting).

Conclusions

Our estimates of TB burden in LTCHs suggest that a very small proportion of LTCH residents in Ontario develop pulmonary TB and that this represents a small proportion of all pulmonary TB cases in Ontario. Our findings also suggest that the pulmonary TB incidence rate among LTCH residents in Ontario is lower than the rate observed in the general population aged 70 years and older in Ontario. Our genotyping analysis also indicated that transmission among LTCH residents in Ontario was rare, with only the one example of transmission involving three cases. Together, these findings suggest that the overall burden of pulmonary TB among LTCH residents in Ontario is low.

A range of approaches to TB screening on admission to LTCH exists across Canada and in other low TB incidence countries. Although there are gaps in the available peer-reviewed literature evaluating the impact of universal chest x-ray screening on admission to LTCH, the findings of the lack of cost-effectiveness for both chest x-ray and TST for TB screening on admission to LTCHs in Alberta are relevant for considerations regarding screening for TB on admission to LTCHs in Ontario.⁷

In addition to considerations regarding the burden of TB in LTCH residents, considerations related to the screening test(s), the follow up interventions, and implementation in this population and setting are important in the Ontario context.

We anticipate that the findings and considerations highlighted in this report will be relevant to decision-makers considering admission screening for TB in LTCH residents in Ontario.

Introduction

Purpose and scope

This report addresses tuberculosis (TB) screening for residents on admission to long-term care homes (LTCHs) in Ontario. It focuses on evidence-informed considerations relevant to the use of chest radiograph (x-ray) as a TB screening tool, as part of the LTCH admission process in the Ontario context. This report can be used as a resource to help inform TB screening approaches or recommendations for residents being admitted to LTCHs in Ontario.

This work was initially conducted during 2015-16, and updated in 2017-18. Considerations with respect to TB screening for retirement home residents were beyond the scope of this work.

Background

Tuberculosis burden and transmission considerations

Canada has a low incidence of active tuberculosis (TB).³¹ In 2016, the Canadian TB incidence rate was 4.8 per 100,000 population, which corresponds to 1,737 new active and re-treatment TB cases.³² In comparison, the Ontario TB incidence rate in 2016 was 4.5 per 100,000 population, representing 632 new active and re-treatment TB cases.³³

Most people diagnosed with active TB in Canada, including Ontario, were born outside of Canada, in countries with much higher rates of TB.^{32,34,35} In 2016, foreign-born persons accounted for 87.8% of TB cases reported in Ontario.³⁴ This corresponds to an incidence rate of 13.3 cases per 100,000 population which is much higher than the rates reported among both Canadian-born Indigenous persons and Canadian-born non-Indigenous persons (2.4 and 0.5 per 100,000 population, respectively).³⁴

Another group that bears a disproportionate burden of TB is older adults. In 2016, the TB incidence rate in Ontario adults aged 60 to 69 years was 5.2 cases per 100,000 population (83 cases); this increased to 10.5 cases per 100,000 population (162 cases) for those aged 70 years and over.³³ Between 2006 to 2015, the average annual provincial TB incidence in adults aged 70 years and older was 10.1 cases per 100,000 per population (on average, 132 cases per year).³³ Most of these were pulmonary TB cases, which are the priority for preventing transmission of active TB. From 2006 to 2015, the average annual pulmonary TB incidence rates in adults 70 years and older in Ontario was 7.1 cases per 100,000 per year (on average, 93 cases per year).³⁶

Diagnosing TB in older adults can be difficult as it can present atypically or resemble other conditions, which can result in delayed or missed diagnoses.³⁷ Drugs used to treat TB and latent TB infection (LTBI) are more likely to be associated with serious adverse effects, such as hepatotoxicity, in older adults.^{38,39}

Some older adults in Ontario reside in LTCHs. Factors that have the potential to contribute to TB reactivation or transmission in the LTCH setting include:

- Host factors (e.g., older age of residents; comorbid conditions such as diabetes, end stage renal disease; immunosenescence [i.e., gradual deterioration of the immune system with age]; atypical chest radiograph findings which may delay the diagnosis and subsequent isolation of the resident); and
- Environmental factors (e.g., congregate setting with prolonged close contact among residents; building ventilation and air exchange; infection prevention and control (IPAC) practices; education/training of staff regarding TB).^{1,4}

Best practice recommendations for IPAC in LTCHs exist to help mitigate the risk of transmission of TB and other pathogens in this setting.^{1,40}

Canadian expert recommendations

The *Canadian Tuberculosis Standards* (CTBS) (7th Edition, 2014) define screening, as well as the goal of screening for active TB as follows:¹

Screening refers to a process that attempts to discover conditions suitable for early preventive or curative intervention. These conditions may not be sufficiently symptomatic to induce patients to seek medical help on their own. [...] In the case of active TB, the goal is to reduce unfavourable outcomes and interrupt transmission by instituting prompt and effective treatment.¹

The previous edition of the CTBS (6th Edition, 2007) noted that active TB is rare in most LTCHs; however, it recommended that LTCH residents routinely receive a chest radiograph (x-ray) on admission.⁴¹ It also suggested that decisions regarding baseline tuberculin skin test (TST) screening in this population take into consideration the incidence of active TB in the patient population served by the institution (LTCH).⁴¹

The current edition of the CTBS (7th Edition, 2014) continues to recommend a baseline postero-anterior (PA) and lateral chest x-ray for residents on admission to LTCHs in identified at-risk groups, including but not limited to:

- Persons born in Canada or other low TB incidence countries before 1966 (as of 2018, persons aged 52 years or older); and
- Indigenous Canadians from high incidence communities; and
- Persons born in, or who have lived in, high incidence countries in Asia, eastern Europe, Africa, and Latin America.¹

However, the current edition of the CTBS only recommends a baseline TST on admission to LTCHs for residents aged 65 years or under with risk factors for TB. It states:

Due to the decreasing utility of TST to diagnose LTBI after age 65 and the increasing risk of adverse effects from LTBI treatment in this age group, screening with a posterior-anterior and lateral chest x-ray for active TB is preferred upon admission for those over 65 years old. A baseline 2-step TST is still recommended upon admission for those 65 years old and under who also belong to an identified at-risk group.¹

These CTBS recommendations on LTCH resident TB screening reflect expert opinion. They do not cite specific evidence, or indicate the strength of their recommendation with respect to this intervention.¹

Of note, the CTBS also emphasize the “substantial limitations” of chest x-ray (with PA and lateral views) for the diagnosis of active pulmonary TB, which include suboptimal sensitivity (70%-80%) and specificity (60%-70%), and variable chest x-ray interpretation.⁴² These limitations, particularly in terms of sensitivity, may be relevant in the context of routine screening for active TB in the LTCH resident population.

Ontario regulatory context

In Ontario, the *Long Term Care Homes Act* (LTCH Act) mandates that LTCH residents must be screened for active TB on admission.² Notably, the LTCH Act does not specify the method(s) to be used for screening, however, it does set out specific timelines:

Each resident admitted to the home must be screened for tuberculosis within 14 days of admission unless the resident has already been screened at some time in the 90 days prior to admission and the documented results of this screening are available to the licensee.²

In Ontario, active TB is reportable under Regulation 559/91 of the *Health Protection and Promotion Act* (HPPA), RSO 1990.⁴³ The Ontario Public Health Standards (OPHS) and the related Tuberculosis Prevention and Control Protocol (TB Protocol) outline the responsibilities of Boards of Health for TB prevention and control.^{44,45} The HPPA, the OPHS, the TB Protocol and additional provincial guidance documents outline responsibilities for Boards of Health and Medical Officers of Health in respect of the prevention and control of certain communicable diseases and environmental health hazards in LTCHs in their jurisdiction.⁴³⁻⁴⁷ Local public health units (PHUs) maintain close relationships with the LTCHs in their jurisdiction, and routinely provide education and support for infection prevention and control, and as needed, for respiratory and gastroenteric illness outbreak management.

Ontario’s TB Protocol does not directly address TB screening for residents being admitted to LTCHs.⁴⁵ However, draft guidance from the Ontario Ministry of Health and Long-Term Care (MOHLTC) in 2011 called for a PA and lateral chest x-ray for new LTCH residents within 14 days of admission.³ This draft guidance also aligned with the CTBS’ (6th edition, 2007) recommendation for baseline TST testing⁴¹ by stating:

For screening purposes, [LTCH] residents should undergo a baseline posterior-anterior and lateral chest radiography within 14 days of admission to the institutions. Any documented TST results should be transcribed into their record. If the population of residents is at

increased risk of active TB, then a baseline TST is warranted. Serial TSTs are not required for residents.³

In 2018, the MOHLTC released an updated Tuberculosis Program Guideline in which the specific recommendation regarding the method of screening (i.e., chest x-ray and TST) has been removed.⁴⁸ This revised guidance document now states:

Residents must be screened for TB within 14 days of admission, unless the documented results of a TB screen within the last 90 days are available to the licensee of the home.⁴⁸

Ontario long-term care context

In Ontario, a LTCH is a place that is licensed as a LTCH under the *Long-Term Care Act*.² This does not include retirement homes (i.e., privately owned dwellings rented to seniors who require little outside help, where 24-hour nursing care is not provided)⁴⁹ which are beyond the scope of this review. In 2015, there were 626 LTCHs licensed and approved to operate in Ontario, with 76,569 long-stay beds; of these, 57% were privately owned, 24% were non-profit and/or charitable, 16% were municipally owned and operated, and 2% were categorized as other.⁵⁰ These 626 LTCHs reported a total of 58,024 admissions in 2015.⁵¹ As of 2015, approximately half (48%) of LTCHs in Ontario were considered old and needed to be renovated or rebuilt in order to meet current design standards.⁵⁰ In addition, some of these older buildings may not conform to current ventilation requirements,⁵ which may increase the risk of TB transmission if active TB occurs in these LTCHs.

Since 2010, stricter admission criteria for long-term care in Ontario has resulted in a shift toward LTCH residents with higher care needs, increasing age, and more medical co-morbidities.⁵⁰ The Ontario Long Term Care Association reports that in 2015, 97.4% of LTCH residents had two or more chronic medical conditions, and the vast majority required assistance with activities of daily living.⁵⁰

With respect to TB screening, the majority of LTCHs in Ontario are unlikely to have the capacity to perform chest x-rays on site. As such, LTCH residents would typically need to be transported to a nearby facility with radiography for their admission screening chest x-ray, or have access to mobile radiography. Some residents may have already had a chest x-ray performed in the 90 days prior to LTCH admission (e.g., if transferred from an acute care facility where a chest x-ray was performed); documentation of this may satisfy LTCH admission requirements for TB screening. The frequency with which recently performed chest x-rays satisfies the admission TB screening requirement for LTCH residents is unknown.

Implementing routine PA and lateral chest x-ray screening for TB on admission to LTCH is resource-intensive and can be logistically challenging for LTCHs and residents.⁴ Although a single-view, anterior-posterior (AP) chest x-ray may be easier to implement in this setting (e.g., via mobile radiography), the challenges of obtaining a PA and lateral chest x-ray at a facility that performs these tests, along with the perceived low burden of active TB cases in LTCH residents, have led to local PHU interest in revisiting admission TB screening approaches for LTCH residents in Ontario.

Objectives

1. Systematically identify, summarize, and appraise the quality of peer-reviewed literature on:
 - The burden of TB in residents of Ontario LTCHs; and
 - Screening for active TB using chest x-ray among residents of LTCHs.
2. Estimate the burden of active pulmonary TB among residents of LTCHs in Ontario from 2006 to 2015 using available reportable disease data, continuing care administrative data, and chart reviews.
3. Link reportable disease and laboratory data to identify genotyping evidence suggestive of TB transmission events associated with active pulmonary TB cases in Ontario LTCH residents from 2006 to 2015.
4. Describe current TB screening recommendations for LTCH residents in a convenience sample of six selected Ontario PHUs with a range of TB rates, other Canadian provinces and territories, and other low TB incidence countries via jurisdictional scans.
5. Use a screening analytic framework to integrate considerations in respect of the current method (i.e., universal chest x-ray) for TB screening on admission to LTCHs in Ontario.

Methods

This section describes the methods used to address each of the objectives outlined above, including: an evidence review, estimating the burden of pulmonary TB in Ontario LTCH residents, a jurisdictional scan, and the application of a screening analytic framework.

Evidence review

PHO Library Services performed a systematic search of peer-reviewed literature to answer two questions:

1. What is the burden of TB in residents of LTCHs in Ontario?
2. How effective is chest x-ray as a method of screening for active TB among residents on admission to long-term care?

We searched four indexed databases (i.e., MEDLINE, Embase, CINAHL, AgeLine). We conducted Boolean searches using MeSH (Medical Subject Heading) terms and key words to identify results that contained both “tuberculosis” and “long-term care” or their synonyms. The detailed search strategy is provided in Appendix B.

Articles were considered potentially eligible for inclusion if they:

- Described cases, outbreaks, or incidence of TB in residents of LTCHs in countries with low TB incidence; or
- Described the effectiveness or cost-effectiveness of screening for TB with chest x-ray in residents being admitted to long-term care;

AND

- Were written in English or French; and
- Were published between 1955 and 2015.

A single reviewer performed a screen of titles and abstracts, and potentially eligible full-text articles. Articles were summarized in a narrative synthesis if they met the above inclusion criteria, and:

1. Described TB cases in LTCH residents in Ontario; or
2. Described the effectiveness or cost-effectiveness of screening for TB with chest x-ray in residents being admitted to long-term care.

We used PHO's Meta-tool for Quality Appraisal of Public Health Evidence (MetaQAT) and Critical Appraisal Skills Programme (CASP) tools to inform quality appraisal of evidence included in the narrative synthesis.^{52,53}

Estimating the burden of pulmonary TB in Ontario LTCH residents

To estimate the burden of pulmonary TB (PTB) in Ontario LTCH residents, we calculated two proportions: 1) PTB cases in LTCH residents as a proportion of all PTB cases in Ontario, and 2) PTB cases in LTCH residents as a proportion of all LTCH residents in Ontario.

Numerator data

For both proportions, the numerator data (the number of pulmonary TB (PTB) cases reported in residents of Ontario LTCHs from 2006 to 2015) was estimated using three data sources:

1. TB case data reported in iPHIS (see Appendix C for technical notes and data caveats); and
2. TB case data reported in iPHIS (see Appendix C for technical notes and data caveats); and
3. A MOHLTC list of addresses of all licensed and operating Ontario LTCHs from 2006 to 2015; and
4. Confirmation of whether the case was a LTCH resident from PHU chart reviews.

We defined a TB case reported in iPHIS as a potential LTCH resident if:

- 'LTCF' (long-term care facility) was selected as a risk factor in iPHIS; or
- TB treatment was indicated to have started in a LTCH; or
- 'long-term care' (or a synonym) was captured in selected free-text fields; or
- Their address at the time of the TB episode matched an address of a LTCH operating in Ontario between 2006 and 2015 as per the list of addresses provided by the MOHTLC.⁵⁴

In addition, for TB cases identified in potential LTCH residents, PHUs conducted chart reviews to confirm whether the case occurred in a LTCH resident. We then described the number and proportion of TB cases confirmed via PHU chart review to have occurred in a LTCH resident, as well as whether the site of TB was pulmonary or extrapulmonary (see Appendix C). Our analysis focused exclusively on pulmonary cases, since only pulmonary TB is infectious, and the current chest x-ray screening at admission to LTCHs only detects TB in the lungs.

Denominator data (proportion 1): all PTB cases in Ontario

To estimate the total number of PTB cases reported in Ontario from 2006 to 2015, we extracted TB case data reported in iPHIS. The disease site (pulmonary vs. extrapulmonary) was determined based on the values entered for the field “Disease Code” (see Appendix C for technical notes and data caveats).

To estimate the proportion of all Ontario pulmonary TB cases that occurred in a LTCH resident each year from 2006 to 2015, we used the following:

$$\frac{\text{Estimated number of PTB cases in LTCH residents in a specified year}}{\text{Total number of PTB cases in Ontario in a specified year}}$$

Denominator data (proportion 2): all LTCH residents in Ontario

To estimate the total number of LTCH residents in Ontario each year from 2006 to 2015 (the denominator for the proportion of LTCH residents in whom TB occurred), we extracted the Ontario administrative data from the Continuing Care Reporting System (CCRS). The CCRS collects demographic, clinical, functional, and resource utilization information on individuals receiving continuing care services in LTCHs and hospitals among participating provinces and territories, which includes Ontario.⁵⁵ Data are collected on a quarterly basis using a clinical assessment tool called the Resident Assessment Instrument Minimum Data Set (RAI-MDS 2.0).⁵⁶ Data entry is not mandated for patients with a length of stay less than 14 days. Of note, CCRS data are linked to the corresponding Local Health Integration Network (LHIN), but not to the corresponding PHU. We restricted our analysis to LTCHs (i.e., we excluded hospital continuing care beds and retirement homes) and used the number of distinct persons identified in the CCRS who resided in any Ontario LTCH at some point during each of the years from 2006 to 2015.

To estimate the proportion of all Ontario LTCH residents in whom a PTB case occurred each year from 2006 to 2015, we used the following:

$$\frac{\text{Estimated number of PTB cases in LTCH residents in a specified year}}{\text{Total number of LTCH residents in that year}}$$

Genotyping analysis

Using both client and episode identification numbers, we linked iPHIS data on Ontario PTB cases diagnosed between 2006 to 2015 among those confirmed to be LTCH residents with all records from the PHO Laboratories Ontario Universal Typing of TB (OUT-TB) database with a diagnosis date between January 2006 to November 2016. We then searched for genotyping matches and confirmed non-matches using established methods (see Appendix C).

Jurisdictional scan

In 2015-16, we performed a jurisdictional scan of recommendations for TB screening on admission to LTCHs available in the public domain from:

- Selected local PHUs in Ontario; and

- All Canadian provinces/territories; and
- Selected other English-speaking countries with low TB incidence.

To describe examples of how local PHUs in Ontario have translated existing guidance into recommendations for LTCHs in their jurisdictions, we used convenience sampling to select the following six PHU jurisdictions with a range of TB incidence rates³³ and varied social, economic and demographic characteristics:⁵⁷ Halton Region, Peel Region, Porcupine, Toronto, Waterloo Region, and Wellington-Dufferin-Guelph.

To identify recommendations on TB screening on admission to LTCHs in Canadian provinces and territories, we reviewed TB guidance documents available online on provincial/territorial government/agency web sites for each jurisdiction.

For the international jurisdictional scan we searched for documents from selected English-speaking countries or regions with low TB incidence including the United Kingdom (UK), Ireland, Europe, Australia, New Zealand, and the United States (US).

We used iterative Google searches to identify relevant documents for each of these jurisdictional scans, beginning with a combination of the key terms ‘tuberculosis’ and ‘control’ and the name of the jurisdiction. If the documents identified through this search did not address TB screening in LTCHs, an additional Google search with the terms ‘long-term care’ (or synonyms) and ‘infection control’ and the name of the jurisdiction was performed. Only publicly-available government documents that addressed TB prevention and control with recommendations for screening of LTCH residents were reviewed.

In 2017-18, each of the three jurisdictional scans was updated to ensure that the summarized recommendations reflect the current, publicly available LTCH-specific TB screening recommendations for each jurisdiction. Only currently available, online recommendations were presented in the results. In the event that recommendations available in 2015-16 were no longer accessible, this was noted in the results.

Application of a screening analytic framework

We applied a public health screening program analytic framework to the universal screening of new LTCH residents for active TB using chest x-ray on admission. Specifically, we applied Public Health England’s “Criteria for appraising the viability, effectiveness and appropriateness of a screening programme”.³⁰ This screening framework builds upon seminal work commissioned by the World Health Organization (WHO) and authored by Wilson and Jungner in 1968.⁵⁹ We considered each of the framework’s 20 criteria, grouped into five categories: 1) the condition, 2) the test, 3) the intervention, 4) the screening program, and 5) its implementation.

Results

Evidence review

Search results

The peer-reviewed literature search yielded 555 unique results. The majority of search results (n=434) were excluded as non-relevant on title and abstract review. An evidence review search result flow diagram is presented in Appendix D.

In terms of evidence describing the burden of TB in LTCH residents in Ontario, the title and abstract review identified two articles (an outbreak report⁵ and a descriptive study⁶).

The title and abstract review also yielded 66 articles that addressed TB screening, surveillance, and/or prevention and control interventions in LTCHs. Of these, two specifically addressed the use of x-ray. On full-text review, one of these articles, a cost-effectiveness analysis from Alberta,⁷ presented original findings about the properties of chest x-ray as a screening test in LTCH residents. The second study, published in 1964, was excluded as the full-text article was not available for review.⁵⁹

Evidence on TB in Ontario LTCH residents

The first article addressing TB in Ontario LTCH residents, by Khalil et al., reported on a TB outbreak involving residents of an Ontario LTCH in 2010-11.⁵ The outbreak occurred in a 121-bed combined retirement residence and LTCH located in the Wellington-Dufferin-Guelph (WDG) PHU. The index (first-diagnosed) case was a staff member who had emigrated from an area of high TB endemicity in 2004, and developed classic TB symptoms in April 2010. Subsequently, three LTCH residents were diagnosed with active TB. Their presenting signs and symptoms included weight loss and worsening chronic cough. Genotyping confirmed that the four active cases were infected by an identical EuroAmerican strain. The most likely source case was determined to be not the index case, but a LTCH resident found to have been symptomatic for 10 months prior to diagnosis with TB. There were 15 new LTBI diagnoses among residents; six of these residents started and three completed treatment. Nine new LTBI infections were detected among staff; six of these staff started and completed treatment.

Environmental factors that may have contributed to TB transmission during this outbreak included sub-standard air exchanges rates, and higher than intended occupancy in some areas of the facility (as indicated by carbon dioxide testing). The article also highlighted the fact that other older LTCH facilities do not meet current guidelines regarding the minimum number of air exchanges per hour. In addition, the article suggested that suboptimal administrative controls in this LTCH may have played a role. For example, TST results were only available for 40% of the LTCH staff, and the delayed diagnosis of the most likely source case suggests that LTCH staff may not have considered TB, or sputum samples may have been difficult to obtain.

Of note, 54/56 (96.5%) of residents had undergone a two-step TST screen on admission to the LTCH as per the PHU's admission screening recommendations. This indicates that the admission TB screening practices in place at this LTCH were not effective in preventing or detecting this LTCH TB outbreak. Specifically, no resident cases diagnosed with LTBI on admission had taken preventive medication (consistent with elderly patients' inability to tolerate these medications well), and all resident cases, including the likely source case, were diagnosed long after their admission to the facility. However, the article does not comment on the proportion of residents (including cases) who had undergone a chest x-ray, in addition to TST, on admission to the LTCH; this limits the article's ability to evaluate the effectiveness of the screening chest x-ray. Also, the details provided do not allow us to determine whether the likely source (a LTCH resident symptomatic for many months) could have been identified through routine chest x-ray screening at LTCH admission. However, since this resident was in the facility for many years prior to diagnosis, it seems unlikely.

In terms of quality, this article was highly relevant as it documented TB transmission among residents of one LTCH in Ontario. Documented TB outbreaks in LTCHs are rare, although they are the primary rationale for TB screening in these congregate facilities. The findings are reliable, as the authors clearly described the approach to TB outbreak investigation and response in this LTCH, as well as the TB and LTBI case detection results. However, given the outbreak report design, the findings of this public health investigation are subject to bias, and may not be generalizable to other LTCH populations and settings.

The second article, by Naglie et al., presented the findings of a 1992 survey of Toronto-area LTCHs about their TB surveillance practices.⁶ The authors conducted a telephone survey of all 59 nursing homes and homes for the aged in the Toronto area, with a response rate of 93.2% (55/59 LTCHs). Persons considered to be most knowledgeable about each LTCH's TB policies were interviewed using a standardized questionnaire.

The authors found that, in 1992, 11 (20.0%) of the 55 Toronto LTCHs surveyed had had at least one resident with active TB in the past five years. However, this finding may not be generalizable to LTCHs outside of Toronto, or to the current context of LTCH in Ontario, as the findings are reflective of the TB burden and LTCH settings and practices in place 25 years ago. The remainder of the survey focused on the use of TST for TB screening and routine surveillance among residents.

In terms of quality, this article was highly relevant to Ontario at the time it was conducted, as it described incident TB cases among LTCH residents in the Ontario PHU that has the highest burden of TB, as well as a large number of LTCHs. However, it was conducted in 1992, which limits its applicability to the current Ontario LTCH context. Moreover, as it did not aim to assess the impact of admission TB screening practices (including chest x-ray) on TB incidence in LTCHs, this study is of limited relevance to considerations regarding admission screening for TB in LTCHs in Ontario at present.

Evidence on TB screening using chest x-ray

Our search identified a single, highly relevant 2013 article by Verma et al. that evaluated the cost-effectiveness of different TB screening modalities in long-term care settings in Alberta, Canada.⁷ The authors used a Markov model comparing three screening strategies on LTCH entry: no screening,

screening for LTBI with a baseline two-step TST, and screening for active TB with a chest x-ray. Due to the short life expectancy of LTCH residents in Alberta, the authors assumed a four-year time frame in the model. Although the perspective taken was not explicitly stated, we inferred it to be from the healthcare payer's (i.e., provincial health system's) perspective. Costs considered included the cost of screening and the cost of managing LTBI and active TB (including contact investigation); costs incurred by LTCH facilities and indirect costs were not considered. A discounting rate of 3.0% was applied.

The authors estimated the number-needed-to-screen (NNS) to prevent one case of active TB among LTCH residents in Alberta which was 1,410 for TST, compared to 1,266 for chest x-ray. The authors also estimated the cost-per-case-averted, which was \$109,913 for TST, compared to \$672,298 for chest x-ray. The authors concluded that neither the TST nor the chest x-ray were cost-effective screening strategies.

In terms of quality, this article was highly relevant and reliable; it directly addresses the cost-effectiveness of chest x-ray for screening LTCH residents for active TB and clearly describes the methodology used. With respect to internal validity, one concern we identified was the use of the sensitivity and specificity of chest x-ray as a *diagnostic* test for active TB in the general (symptomatic) population in the Markov model. This was due to the lack of available estimates of sensitivity and specificity of chest x-ray as a *screening* test for pulmonary TB (among asymptomatic LTCH residents) in the literature. This likely led to an underestimate of the NNS and cost-per-case-averted because we expect poorer sensitivity and specificity when chest x-ray is used as a screening test rather than as a diagnostic test (i.e., lower pre-test probability among asymptomatic adults).

With respect to external validity or applicability to the Ontario LTCH context, we expect that the authors' conclusions that neither the TST nor chest x-ray on admission are cost-effective methods for screening LTCH residents for active TB would likely hold true for Ontario. The authors report the TB incidence rate on admission to LTCHs in Alberta to be 67 per 100,000 LTC admissions (based on Alberta TB data from 2000-2010). Similar data are not available for Ontario. The TB incidence rate in Alberta's general population is slightly higher than in Ontario (5.6 per 100,000 in Alberta compared to 4.5 per 100,000 in 2016).^{32,33}

Estimated burden of pulmonary TB in Ontario LTCH residents

Table 1 shows the chart review results of the 78 cases identified as occurring in potential LTCH residents; 54 (69.2%) of these cases were categorized as pulmonary TB; the remainder (24) were extrapulmonary (i.e., non-infectious TB occurring in other parts of the body). PHUs determined via chart reviews that 38 pulmonary TB cases occurred in confirmed LTCH residents and the remaining 16 cases were determined not to have occurred in LTCH residents. Thirteen cases of extrapulmonary TB were also confirmed to have occurred in LTCH residents and five were determined not to have occurred in LTCH residents; the LTCH resident status of six extrapulmonary TB cases was not assessed.

Table 2 shows the distribution of the 38 pulmonary TB cases among LTCH residents by PHU and diagnosis year. The majority (17/38; 44.7%) of cases were from Toronto; York Region had next greatest burden of cases (5/38; 13.2%). The remaining cases were distributed across time and geography, with the exception of one cluster in Wellington-Dufferin-Guelph (WDG). Of note, while the timing of diagnosis relative to admission screening could not be determined for all cases, none of the cases from Toronto were diagnosed with TB through admission screening.

Table 3 describes the number of cases of pulmonary TB confirmed to live in LTCHs in relation to both the total number of Ontario pulmonary TB cases and the number of residents living in LTCHs in Ontario from 2006 to 2015. The estimated average annual proportion of LTCH residents with pulmonary TB among all reported pulmonary TB cases in Ontario from 2006 to 2015 was 1.0%. The estimated average annual proportion of LTCH residents with pulmonary TB among all LTCH residents is very low, at 0.005% corresponding to an average annual incidence rate of pulmonary TB of 4.6 pulmonary TB cases per 100,000 LTCH residents per year in Ontario from 2006 to 2015.

Table 1. Results of iPHIS search and PHU chart reviews of TB cases identified as potential LTCH residents, Ontario, 2006 to 2015

Site of infection	Potential LTCH residents (%)	Confirmed LTCH resident	Not a LTCH resident	Chart not reviewed
Pulmonary TB	54 (69.2)	38	16	0
Extrapulmonary TB	24 (30.8)	13	5	6
Total	78 (100.0)	51	21	6

Data sources: Ontario. Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2016 Feb 18]. Chart reviews were conducted by 16 PHUs with cases. Note: 77 TB cases had been identified as potential LTCH residents in the initial iPHIS search. Through PHU chart reviews, an extra resident was identified by a PHU.

Table 2. LTCH residents with pulmonary TB by PHU and diagnosis year, Ontario, 2006 to 2015

Year	Toronto	York Region	Wellington-Dufferin-Guelph	Peel Region	Other PHUs [†]	Total
2006	0	0	0	0	2	2
2007	4	1	0	0	3	8
2008	2	1	0	0	1	4
2009	2	0	0	0	0	2
2010	1	0	3	0	0	4
2011	2	1	0	1	0	4
2012	1	1	1	1	0	4
2013	1	1	0	0	1	3
2014	2	0	0	0	1	3
2015	2	0	0	1	1	4
Total (%)	17 (44.7)	5 (13.2)	4 (10.5)	3 (7.9)	9 (23.7)	38 (100.0)

Data sources: Ontario. Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2016 Feb 18]. Chart reviews were conducted by 16 PHUs with cases.

[†]Nine PHUs each reported one pulmonary TB case in a LTCH setting from 2006 to 2015: Brant County, City of Hamilton, City of Ottawa, Durham Region, Elgin- St. Thomas, Halton Region, Middlesex-London, North Bay Parry Sound, and Waterloo Region.

Table 3. Number (#) and percentage (%) of pulmonary TB (PTB) cases confirmed to be LTCH residents relative to total number of PTB cases and residents in LTCHs in Ontario: 2006 to 2015

Year	# of PTB cases confirmed to be LTCH residents ^a	Total # of PTB cases in Ontario ^b	% of PTB cases in Ontario confirmed to be LTCH residents	Total # of LTCH residents in Ontario ^c	% of LTCH residents in Ontario with PTB	Incidence rate (per 100,000) of PTB in LTCH residents
2006	2	386	0.5	47,506	0.004	4.2
2007	8	409	2.0	61,279	0.013	13.1
2008	4	380	1.1	75,757	0.005	5.3
2009	2	379	0.5	91,639	0.002	2.2
2010	4	371	1.1	101,286	0.004	3.9
2011	4	394	1.0	102,415	0.004	3.9
2012	4	343	1.2	101,979	0.004	3.9
2013	3	381	0.8	103,082	0.003	2.9
2014	3	343	0.9	104,940	0.003	2.9
2015	4	348	1.1	105,988	0.004	3.8
Total	38	3,734	1.0	-*	-*	-*
Average**	3.8	373.4	1.0	89,587	0.005	4.6

^a Data sources: Ontario. Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2016 Feb 18]. Chart reviews conducted by 16 PHUs with cases.

^b Data sources: Ontario. Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2016 Feb 18].

^c Ontario. Ministry of Health and Long-Term Care, IntelliHEALTH Ontario. Complex Continuing Care Reporting System, 2006 to 2015, extracted by Public Health Ontario [2016 Sep 30].

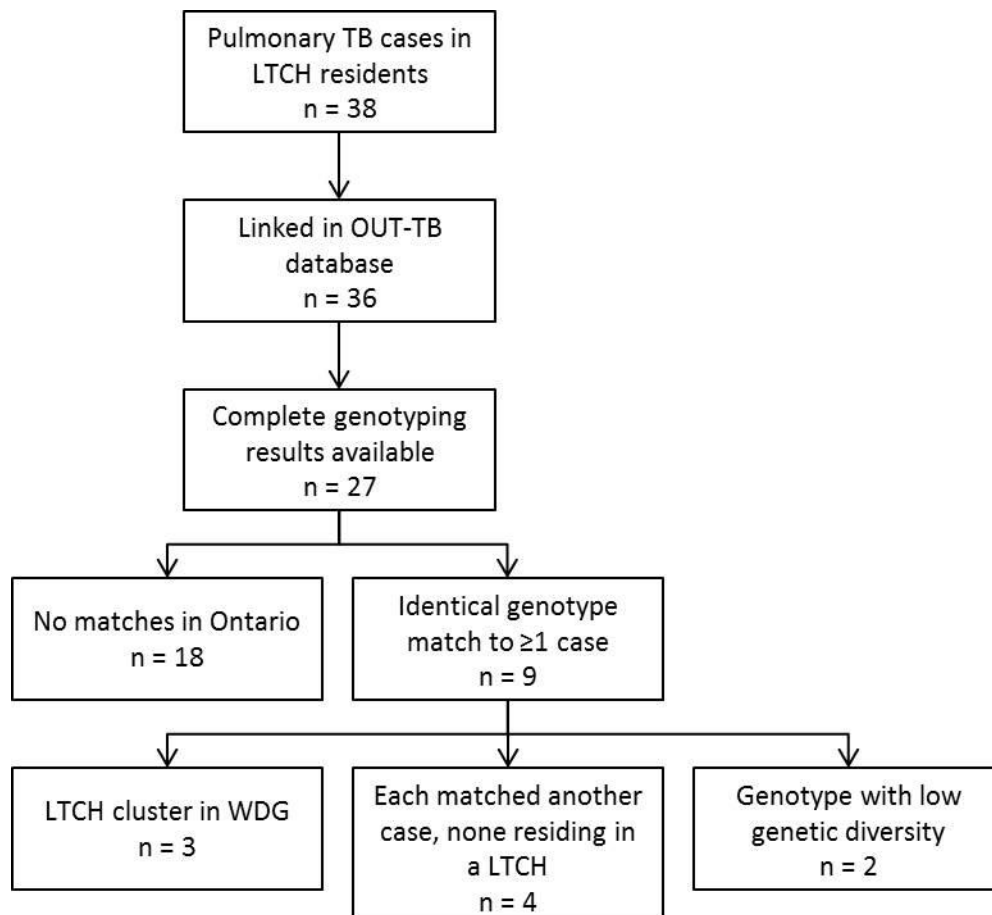
*The total number/percentage/incidence rate was not calculated as residents staying in a LTCH over multiple years are counted once in each year during their stay.

**The average of the annual total numbers/percentages/incidence rates from 2006 to 2015.

Genotyping analysis

Of the 38 pulmonary TB cases in confirmed LTCH residents, 36 were linked to records in the OUT-TB provincial genotyping database; of these, complete genotyping results were available for 27 cases (see Figure 1). Eighteen cases had a genotype that did not match any other TB cases in the province; nine cases had an identical genotype match with one or more cases. One cluster of three cases with identical genotype matches was identified; these cases were associated with a known LTCH cluster in WDG. Four other cases in LTCH residents had identical genotype matches, each to one other reported case of TB in Ontario, none of whom lived in a LTCH, indicating no subsequent transmission among LTCH residents was identified. Two additional cases in LTCH residents had identical matches to clusters that are known to have low genetic diversity and were therefore unlikely to represent transmission events in LTCHs.

Figure 1. Genotyping results for pulmonary TB cases reported in confirmed LTCH residents in Ontario, 2006 to 2015



Jurisdictional scan

Ontario PHUs

From the initial convenience sample of six PHUs, the jurisdictional scan updated in 2017-18 identified five PHUs with publicly accessible LTCH-specific TB screening recommendations (i.e., all except Porcupine⁶⁰) which were: Halton Region,⁸ Peel Region,⁹ Toronto,¹⁰ Waterloo Region,¹¹ and Wellington-Dufferin-Guelph¹². A table summarizing the detailed findings for each jurisdiction is available in Appendix E.

All five PHUs recommended a baseline PA and lateral chest x-ray for all new LTCH residents on admission; however, Waterloo restricted this to only those over 65 years of age. All five PHUs also recommended age-based TST screening for LTBI – of these, four PHUs (Halton, Peel, Toronto, and Wellington-Dufferin-Guelph) applied this recommendation to only those under 65 years of age whereas Waterloo Region included those 65 years of age and under.

Four PHUs (Halton, Peel, Toronto, and Waterloo) also explicitly included a symptom review for active pulmonary TB in their recommendations. Furthermore, Halton, Peel, and Toronto recommend sputum collection for those who are either symptomatic or who have x-ray findings suggestive of active TB.

Furthermore, four PHUs provided TB screening recommendations specifically for those admitted to LTCHs for short stays (e.g., respite care). Three PHUs (Halton, Peel, and Toronto) recommended that residents admitted for less than three months undergo a symptom screen followed by a chest x-ray only if symptomatic. The fourth PHU (Waterloo) specified that residents admitted to LTCHs for less than 14 days require no specific TB admission screening.

Other Canadian provinces and territories

Current LTCH-specific TB screening recommendations were found for seven provinces and territories: Alberta,¹³ British Columbia,¹⁴ Manitoba,¹⁵ New Brunswick,¹⁶ Newfoundland and Labrador,¹⁷ Nova Scotia,¹⁹ and Saskatchewan.²³ In the Yukon, recommendations exist for TB screening, however, they are applied at an individual-level based on risk and are not specific to the LTCH-setting and/or population.²⁴ In addition, Prince Edward Island documents state that LTCH residents are screened for TB on admission, however, no specific details are provided.²¹ A table summarizing the key findings for each jurisdiction is available in Appendix F.

The national jurisdictional scan revealed a wide variation in provincial and territorial recommendations for screening of LTCH residents for TB with respect to the following five approaches:

1. Risk factor inquiry:
 - British Columbia was the only province/territory to universally recommend a TB risk factor inquiry for all new admissions to a LTCH.

- Alberta and Nova Scotia do recommend a risk factor inquiry, however, only with regards to identifying those who should be screened for LTBI (i.e., not for active TB).
2. Symptom review:
 - Alberta, British Columbia, Newfoundland and Labrador, and Saskatchewan all recommend symptom screening for new admissions to LTCHs.
 - Nova Scotia also recommends symptom screening, however, only for those 65 years of age and older.
 3. Chest x-ray:
 - Alberta, Newfoundland and Labrador, and Saskatchewan recommend chest x-rays for all new admissions to long-term care.
 - In Manitoba, a chest x-ray is only recommended for specific populations (i.e., those born prior to 1955, Aboriginal Canadians, or those born in high TB incidence countries).
 - In both British Columbia and Nova Scotia, chest x-ray screening is only recommended for those who are symptomatic and/or TST positive; in Nova Scotia, chest x-ray screening is also reserved only for those 65 years of age and older.
 4. LTBI screening with TST:
 - Saskatchewan is the only province/territory to recommend TST screening for all new LTCH admissions.
 - British Columbia and Nova Scotia apply age-specific criteria restricting TST screening to those under 60 years of age (British Columbia) or under 65 years of age (Nova Scotia). Furthermore, Nova Scotia only recommends TST screening if risk factors for progression to active TB are present.
 - New Brunswick, Alberta, and Manitoba recommend TST screening (regardless of age) if risk factors for TB (New Brunswick) or progression to active TB are present (Alberta), or if indicated by facility risk and/or local epidemiology (Manitoba).
 5. Sputum collection:
 - Alberta and Saskatchewan are the only two provinces/territories to recommend sputum collection; however, in both jurisdictions, this is limited to those who are either symptomatic and/or have a prior history of TB disease.

Other low TB incidence countries

We identified relevant documents from Australia,²⁵ Ireland,²⁶ New Zealand,²⁷ and the US,^{28,29} in addition to the Canadian guidelines (CTBS).¹

Ireland, Australia, and New Zealand did not include LTCH residents among the special populations requiring TB screening.

Only the Canadian and US recommendations identified LTCH residents as a population warranting special screening for TB. As outlined in the Background section, the current CTBS (7th Edition) recommend a screening chest x-ray for active pulmonary TB on admission to LTCHs for persons born before 1966 in low TB incidence countries (including Canada) and in other identified at-risk groups.¹ The CTBS only recommend considering a two-step TST on admission for LTCH residents aged 65 years or under with identified risk factors for TB.¹ The CTBS differ considerably from the US Centers for Disease Control and Prevention²⁸ and Association for Professionals in Infection Control and Epidemiology²⁹ which recommend baseline two-step TST screening of all new LTCH residents, and restrict chest x-ray screening to those who are either symptomatic and/or have a TST ≥ 10 mm. A table summarizing the key findings from each jurisdiction with LTCH resident-specific TB screening recommendations is available in Appendix G.

Application of a screening analytic framework

We used a public health screening framework to analyze the current practice of universal chest x-ray screening for pulmonary TB in residents being admitted to LTCHs in Ontario (the role of TST was not considered).³⁰ The detailed analysis is provided in Appendix H. A summary of key considerations is presented here.

The condition

A single case of active TB in a LTCH resident can result in potentially severe disease for the affected person, and transmission to others, including residents or staff members.⁵ However, our estimates show that a very small proportion of LTCH residents in Ontario develop pulmonary TB (0.005% on average per year, 2006 to 2015). These cases also represent only a small estimated proportion of all pulmonary TB cases in Ontario (1.0% on average per year, 2006 to 2015). The estimated incidence rates of pulmonary TB in LTCH residents are also lower than rates in the general population in Ontario aged 70 years and older (4.6 vs. 7.1 per 100,000 population per year, 2006 to 2015). Overall, this raises questions about whether the burden of disease criterion is met for universal chest x-ray screening on admission to LTCHs in Ontario.

Critically, chest x-ray at admission is point-in-time screening; it detects TB prevalent at the time of admission, but does not detect incident TB that occurs later on, in the months or years after admission. In addition, universal chest x-ray screening for TB on admission to LTCH does not address risk-based considerations for disease progression within the LTCH resident population, whereby residents with known risk factors for progression from LTBI to TB could be identified on admission and followed more closely to support early identification of active TB should it develop.

In terms of optimizing primary prevention before considering screening, evidence from a recent TB outbreak in an Ontario LTCH identified shortcomings related to both administrative and environmental controls, including building ventilation.⁵ Moreover, hundreds of Ontario LTCH facilities need to be redeveloped due to aging infrastructure.⁴⁹ Some of these older facilities may not meet current IPAC standards or have optimal environmental controls for preventing TB transmission.

Knowledge gaps/beyond the scope of this review:

- Limitations of estimates of TB burden in LTCHs based on available reportable disease and continuing care administrative data (see Discussion).
- Whether TB was detected through chest x-ray screening on admission to a LTCH is not currently captured in reportable disease (iPHIS) or continuing care administrative (CCRS) data. As a result, there is a lack of data to estimate the prevalence of active TB in residents on or around admission to LTCH in Ontario (up to 90 days before and 14 days after admission).
- Evaluation of risk-based versus universal chest x-ray screening strategies in LTCH residents.
- LTCH compliance with IPAC best practices / environmental controls to prevent TB transmission.

The test

A chest x-ray is generally considered to be a safe test that delivers only a small quantity of ionizing radiation.⁶¹ However, whether a chest x-ray is a 'simple' test to administer to LTCH residents speaks to implementation considerations in this patient population and setting (see below).

Regarding test precision and validity, the chest x-ray has known limitations as a diagnostic tool for TB, including suboptimal sensitivity (estimated to be 70-80%) and specificity (60-70%).⁴² However, chest x-rays for screening purposes should seek to detect pulmonary TB that is "not sufficiently symptomatic" to prompt health care use.⁶² Sensitivity is of particular concern in the context of screening; ideally, a highly sensitive test should be used to confidently rule out disease, with minimal false-negative results.⁶³ The properties of chest x-ray as a screening test for asymptomatic or subclinical pulmonary TB may be different/inferior to the properties of chest x-ray as a diagnostic test for TB.

There is considerable inter-rater variability in the interpretation of chest x-rays, and poor agreement among those interpreting chest x-rays regarding the presence of cavitation, hilar lymphadenopathy and the presence of active disease.⁴² Given the underlying health issues that lead to LTCH placement, many LTCH residents could be expected to have abnormal chest x-rays on admission. This could contribute to challenges in detecting TB via chest x-ray in LTCH residents.

Given its non-invasive nature and the minimal dose of ionizing radiation,⁶¹ chest x-ray may be acceptable to LTCH residents. However, factors that may impact the acceptability of chest x-ray as a TB screening test for residents or substitute decision-makers may include: mobility and/or other health issues; need for transport to another facility for chest x-ray; infrequent detection of TB in this group.^{4,5,50} For some hospice and palliative care residents, a chest x-ray to screen for TB may not fit with their broader care goals. If the chest-x-ray suggests the possibility of active TB, further investigative tests may be required or recommended, including potentially invasive tests (e.g., bronchoscopy) with potential harms. From a health systems perspective, the costs of PA and lateral chest x-ray for LTCH residents, which in some circumstances may include costs related to transportation, may influence acceptability; we did not identify literature that directly addressed this.

Overall, consideration of test-related criteria identified challenges with respect to simplicity, validity, test interpretation, and potential challenges with acceptability of chest x-ray as a screening method for TB in LTCH residents.

Knowledge gaps/beyond scope of this review:

- Evidence on barriers to obtaining a chest x-ray for LTCH residents in Ontario, or the frequency with which these barriers may be encountered.
- Acceptability of chest x-ray screening of residents for TB on admission to LTCHs.
- Sensitivity, specificity, and positive predictive value of chest x-ray for the universal screening of LTCH residents for active TB, or the associated false-positive and false-negative rates.
- Inter- and intra-rater agreement for interpreting chest x-rays performed for screening purposes among LTCH residents.
- Potential barriers and/or risks to follow up diagnostic testing for LTCH residents with chest x-rays suggestive of active TB (e.g., access to sputum induction, risks associated with bronchoscopy).

The intervention

In terms of the wider benefits of screening, early identification of active TB in LTCH has the potential to reduce TB transmission in LTCH settings. Early detection and treatment of active TB with effective antibiotics can also lead to better patient outcomes.³⁷ However, elderly LTCH residents may be at a higher risk of severe treatment complications. For example, during the TB outbreak at the WDG LTCH,⁵ all three residents with active TB died while receiving TB treatment, either from TB treatment complications (one died as a result of isoniazid hepatotoxicity) or from other causes (TB was mentioned as a contributing factor in the other two deaths).

The 2014 CTBS provide evidence-based treatment guidelines for managing active TB, as well as the public health management of TB cases, contacts and outbreaks. However, it is not clear how readily these treatment guidelines can be applied to the LTCH resident population.

Knowledge gaps/beyond the scope of this review:

- Does early identification of active infectious TB lead to decreased TB transmission among LTCH residents?
- Does early treatment of active TB in LTCH residents lead to better patient outcomes?
- What factors (such as rural/remote geographic location, underlying medical conditions) may act as barriers to completing TB treatment in LTCH residents as well as public health contact follow-up?

The screening program

A cost-effectiveness analysis by Verma et al.⁷ on universal admission screening of LTCH residents for active TB compared chest x-ray to TST. It found that neither screening method was cost-effective in Alberta; it would be reasonable to expect similar results in the Ontario. However, considerations in respect of other aspects of the screening program (effectiveness, acceptability among health professionals and the public, harms, opportunity cost) identified many gaps in the published literature. Of note, universal chest x-ray screening on admission to LTCHs is the current practice in Ontario, but it is not supported by an organized screening program (quality assurance, training, etc.).

While admission screening with chest x-ray has the potential to identify active TB cases in LTCH residents *at the time of admission*, it may not impact early detection of active TB that develops several weeks, months or years *following* admission. Throughout the course of their stay in long-term care, the risk of progressing from LTBI to active TB may increase as residents age and develop additional or more severe co-morbidities.

Knowledge gap/beyond the scope of this review:

- What proportion (if any) of active TB cases among LTCH residents in Ontario was discovered through universal screening with chest x-ray on admission?
- Is a universal chest x-ray screening program effective at reducing TB transmission among LTCH residents and staff?
- Is the universal screening of LTCH residents for active TB using chest x-ray on admission clinically, socially and ethically acceptable to health professionals and the public?
- What are the harms of the universal screening of LTCH residents for active TB using chest x-ray on admission?
- What proportion of LTCH residents have an abnormal screening chest x-ray? Of those, how many go on to further testing and what are the yield (number of active TB cases detected) and the complications from each additional investigation?
- What is the cost-effectiveness of routinely screening residents for active TB using chest x-ray on admission to LTCH in Ontario?
- What is the opportunity cost of universal chest x-ray on admission to LTCHs in Ontario (in terms of other TB prevention and control activities) for LTCHs, local PHUs and the health system more broadly?

Implementation criteria

Consideration of the screening framework's implementation criteria identified multiple gaps or areas of uncertainty. A practical implementation consideration that was identified is that, given the level of care required to be eligible for LTCH admission, residents often have mobility and/or other health issues that

may complicate both the administration of the test (i.e., standing upright for a PA and lateral chest x-ray) and transport to the x-ray machine.^{4,5,50} This may impact the acceptability of this screening method for this group.

Knowledge gaps/beyond the scope of this review:

- What barriers to screening, diagnosis, and case and contact management are encountered by the LTCHs and local PHUs?
- What is/are the most effective and cost-effective method(s) for reducing TB transmission in LTCH settings in Ontario? What is the effectiveness and cost-effectiveness of other screening programs, such as symptom-based and/or or risk factor-based screening strategies?
- Is there a quality assurance process for the interpretation of chest x-rays if performed as part of a TB screening program for LTCH residents on admission (as previously recommended)? If not, how might one improve the quality of screening chest x-ray interpretation (e.g., should the reading of these chest radiographs be centralized and done by only a small number of physicians with TB expertise)?
- What information is provided to LTCH residents or their substitute decision-makers regarding participation in a routine chest x-ray to screen for TB on admission? How is this information provided? Who provides this information? How does this vary?

Discussion

The evidence review, disease burden estimation, jurisdictional scan and screening framework analysis presented in this report make a unique contribution to the available literature on admission screening for TB in LTCH residents in Ontario. The findings and considerations highlighted in this report may also be relevant in other low TB incidence settings. Several strengths and potential limitations of the information presented in this report merit consideration.

The review of evidence from the peer-reviewed literature used a systematic search strategy, and was guided by an appropriate tool for quality appraisal of public health evidence. However, the search strategy was not exhaustive, and a single reviewer performed the title and abstract screen and full-text review. In addition, we decided *a priori* to exclude articles on TB in LTCH settings in jurisdictions outside of Ontario if they did not assess chest x-ray as an admission screening tool; however, some of this literature may highlight relevant general considerations for TB burden or transmission in this setting.

To optimize the validity of our estimates of pulmonary TB cases in LTCHs in Ontario from 2006 to 2015, we used multiple data sources to identify LTCH residents, including a LTCH address list, and local PHU chart reviews to confirm that a TB cases involved a LTCH resident. However, the number of TB cases in iPHIS may underestimate of the actual burden of disease due to under-diagnosis or under-reporting, as iPHIS only captures cases that have made contact with the health care system and are reported to public health (see additional data caveats in Appendix C). We also relied on data entered into a system that is used for routine disease surveillance and case management, and not specifically designed to accurately reflect the number of TB cases who were LTCH residents. It is difficult to determine whether the cases identified were an overestimation (e.g. the case was in a hospital or retirement home that shares an address with a LTCH) or an underestimation (e.g. cases not captured as a LTCH resident anywhere in iPHIS).

Furthermore, we did not estimate the incidence of TB at the time of admission to LTCH, or the proportion of these cases that would have been detected by screening for TB on admission to LTCH, due to gaps in available iPHIS and CCRS data, as well as gaps in information from PHU chart reviews. Of note, some PHUs indicated that this information would not be routinely recorded in their case investigation charts. Because residents with a length of stay of less than 14 days in a LTCH may not be entered in the continuing care administrative database (CCRS), these data may underestimate the total number of LTCH residents. This would lead to an underestimation of the denominator in our pulmonary TB incidence calculations, and an overestimate of the pulmonary TB rate among LTCH residents. However, LTCHs may not require admission TB screening for stays less than 14 days, so this may not have affected our estimates. As well, the estimated number of pulmonary TB in LTCH residents is so low that it is unlikely to lead to a different interpretation even if the denominator was more precise.

The jurisdictional scan was conducted in 2015-16, and updated in 2017-18, and was limited to documents available in the public domain (i.e., online). The local Ontario PHU jurisdictional scan used a convenience sample of six PHUs, rather than a comprehensive review of recommendations from all 36

PHUs. However, the included PHUs reflected a range in terms of population size and mix and TB burden (including the PHUs with the majority of pulmonary TB cases identified in LTCH residents from 2006 to 2015), and captured similar LTCH admission screening recommendations. The international jurisdictional scan was limited to English-speaking low TB incidence countries, as these are the most relevant for comparison with the Ontario context; this may have excluded potentially relevant recommendations from non-English speaking countries.

Finally, the screening analytic framework provided a useful structure for considering key issues in this setting and population, related to the condition (pulmonary TB in LTCH residents in Ontario), the screening test (universal chest x-ray, follow up diagnostic testing), and the intervention (effectiveness of treatment for individuals screened, public health management).³⁰ Applying this framework also revealed multiple knowledge gaps and/or considerations that were beyond the scope of our review, particularly in the areas of other aspects of the screening program (e.g., quality assurance) and implementation (e.g., acceptability).

Conclusions

Our estimates suggest that a very small proportion of LTCH residents in Ontario develop pulmonary TB (0.005% on average per year, 2006 to 2015), and that this represents a small proportion of all pulmonary TB cases in Ontario (1.0% on average per year using data from 2006 to 2015). Our findings also suggest that, provincially, the incidence of pulmonary TB among LTCH residents is lower than the average annual incidence observed in the general population aged 70 years and older between 2006 to 2015 (4.6 vs. 7.1 per 100,000 population). The linked genotyping dataset indicated that transmission among LTCH residents in Ontario was rare. Despite some potential limitations associated with the data sources for these estimates, they suggest that the overall burden of pulmonary TB among LTCH residents in Ontario is low. Nevertheless, as the potential exists for LTCH residents to develop TB at any point in their LTCH stays, ongoing awareness is needed.

The lack of evaluative literature on chest x-ray as a universal screening method for TB on admission to LTCHs identified via our evidence review suggests that there are gaps in knowledge in this area. However, we did identify one relevant cost-effectiveness analysis from Alberta,⁷ which concluded that that universal screening of LTCH residents with chest x-ray on admission was not a cost-effective intervention. We did not carry out an economic analysis using Ontario data. However, the current practice of universal chest x-ray on LTCH admission requires tens of thousands of incoming LTCH residents to undergo screening chest x-rays each year (in 2015, there were 58,024 LTCH admissions in Ontario)⁵¹ in a low TB burden setting, despite considerable logistical and health system costs.

Our jurisdictional scan of six PHUs suggest that local PHUs in Ontario are currently recommending a universal screening chest x-ray for residents on admission to LTCH. However, the Canadian and international jurisdictional scan findings suggest that approaches to TB screening on admission to LTCHs vary across Canadian provinces and territories, and in other low TB incidence countries. Admission screening strategies for this population and setting range from no screening, to symptom and/or risk factor inquiry, to chest x-ray with or without TST.

Finally, considering universal chest x-ray screening for TB on admission to LTCH through the lens of a screening analytic framework enabled us to highlight key considerations in respect of the condition, the chest x-ray test itself, the follow up testing and treatment and public health interventions, as well as implementation in this population and setting. It also enabled identification of multiple knowledge gaps and considerations beyond the scope of this review.

In conclusion, we anticipate that many of the findings and considerations highlighted in this report will assist decision-makers in their considerations regarding admission screening for TB in LTCH residents in Ontario.

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Appendix A: PIDAC-CD TB Working Group

Members

Voting members

Dr. Elizabeth Rea, Chair
Associate Medical Officer of Health
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Dr. Sarah Brode
Physician Lead, TB Service
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Ex-officio members

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Public Health Physician
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Dr. Fran Jamieson
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Drew Swanson (former member)
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Dr. Rob Stirling (former member)
Senior Medical Advisor
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Appendix B: Journal databases search strategy

Databases

- MEDLINE
- Embase
- CINAHL
- AgeLine

Search limits

- Language of publication: English or French; and
- Year of publication: 1955-current (as of December 2015).

Inclusion/exclusion criteria: potentially eligible articles

- Exclude articles that do not describe TB cases or outbreaks in LTCHs; and
- Exclude non-research articles (e.g., editorials, news items, letters to the editor); and
- Exclude articles not related to low TB incidence countries.

Inclusion/exclusion criteria: summarized articles

- Exclude articles that do not:
 - Describe TB in LTCH residents in Ontario; or
 - Assess the effectiveness of chest x-ray as TB screening method in residents being admitted to long-term care.

Search strategy

Table 4. Search strategy 1: Ovid MEDLINE® In-Process and other non-indexed citations and Ovid MEDLINE® 1946 to current

#	Searches	Results
1	Tuberculosis/ or Tuberculosis, Pulmonary/ or Mycobacterium tuberculosis/ or exp Antitubercular Agents/ or Tuberculin Test/ or exp Tuberculosis, Multidrug-Resistant/ or (tuberculos* or tubercular or tuberculin or TB).ti,kw,kf.	212,498
2	Assisted Living Facilities/ or exp Nursing Homes/ or Group Homes/ or Halfway Houses/ or Homes for the Aged/ or Housing for the Elderly/ or (Institutionalization/	71,423

#	Searches	Results
	and (Aged/ or "Aged, 80 and over"/ or Frail Elderly/ or Aging/ or Geriatrics/ or "Health Services for the Aged"/)) or Intermediate Care Facilities/ or Long-Term Care/ or Residential Facilities/ or Skilled Nursing Facilities/ or ("aged care" or "assisted living" or "care home*" or "extended care facilit*" or "group home*" or "halfway home*" or "halfway house*" or "intermediate care" or ((institutionaliz* or institutionalis* or home? or housing) adj3 (elderly or geriatric* or aging or aged or "old age" or seniors or "older adult*" or "older people" or "older person*")) or "long term care" or LTC or "nursing facilit*" or "nursing home*" or "old age home*" or "residential care*" or "residential facilit*" or "residential home*").ti,kw,kf.	
3	1 and 2	317
4	limit 3 to (english or french)	251
5	4 not (comment or editorial or letter or news).pt.	232
6	limit 5 to yr="1955 -Current"	231
7	6 not ((exp Africa/ or exp South America/) not (North America/ or exp Canada/ or exp United States/ or exp Australia/ or New Zealand/ or exp Europe/ or exp Developed Countries/))	228
9	remove duplicates from 7	218

Table 5. Search strategy 2: Embase 1974 to current

#	Searches	Results
1	exp *drug resistant tuberculosis/ or *lung tuberculosis/ or *Mycobacterium tuberculosis test kit/ or *Mycobacterium tuberculosis/ or *tuberculin test/ or *tuberculosis control/ or *tuberculosis rapid test/ or *tuberculosis/ or *tuberculostatic agent/ or (tuberculos* or tubercular or tuberculin or TB).ti,kw.	186,714
2	assisted living facility/ or halfway house/ or home for the aged/ or (institutionalization/ and (aged/ or very elderly/ or frail elderly/ or aging/ or geriatrics/ or elderly care/)) or long term care/ or nursing home/ or residential home/ or ("aged care" or "assisted living" or "care home*" or "extended care facilit*" or "group home*" or "halfway home*" or "halfway house*" or "intermediate care" or ((institutionaliz* or institutionalis* or home? or housing) adj3 (elderly or geriatric* or aging or aged or "old age" or seniors or "older adult*" or "older people" or "older person*")) or "long term care" or LTC or "nursing facilit*" or "nursing home*" or "old	161,596

#	Searches	Results
	age home*" or "residential care*" or "residential facilit*" or "residential home*").ti,kw.	
3	1 and 2	533
4	exp drug resistant tuberculosis/ or lung tuberculosis/ or Mycobacterium tuberculosis test kit/ or Mycobacterium tuberculosis/ or tuberculin test/ or tuberculosis control/ or tuberculosis rapid test/ or tuberculosis/ or tuberculostatic agent/ or (tuberculos* or tubercular or tuberculin or TB).ti,kw.	236,826
5	*assisted living facility/ or *halfway house/ or *home for the aged/ or (*institutionalization/ and (aged/ or very elderly/ or frail elderly/ or aging/ or geriatrics/ or elderly care/)) or *long term care/ or *nursing home/ or *residential home/ or ("aged care" or "assisted living" or "care home*" or "extended care facilit*" or "group home*" or "halfway home*" or "halfway house*" or "intermediate care" or ((institutionaliz* or institutionalis* or home? or housing) adj3 (elderly or geriatric* or aging or aged or "old age" or seniors or "older adult*" or "older people" or "older person*")) or "long term care" or LTC or "nursing facilit*" or "nursing home*" or "old age home*" or "residential care*" or "residential facilit*" or "residential home*").ti,kw.	61,481
6	4 and 5	251
7	3 or 6	600
8	limit 7 to (english or french)	525
9	8 not (conference proceeding or "conference review" or editorial or erratum or letter or note).pt.	463
10	9 not ((exp Africa/ or exp South America/) not (North America/ or Canada/ or United States/ or exp "Australia and New Zealand"/ or exp Europe/ or developed country/))	439
11	limit 10 to yr="1955 -Current"	439
12	limit 11 to embase	343
13	remove duplicates from 12	343

Table 6. Search strategy 3: CINAHL Plus with full text

#	Query	Results
S1	(MH "Antitubercular Agents+") OR (MH "Mycobacterium Tuberculosis") OR (MH "Tuberculin Test") OR (MH "Tuberculosis") OR (MH "Tuberculosis, Multidrug-Resistant") OR (MH "Tuberculosis, Pulmonary") OR TI(tuberculos* or tubercular or tuberculin or TB)	18,110
S2	(MH "Assisted Living") OR (MH "Halfway Houses") OR (MH "Housing for the Elderly") OR ((MH "Institutionalization") AND ((MH "Aged") OR (MH "Aged, 80 and Over") OR (MH "Frail Elderly") OR (MH "Aging") OR (MH "Geriatrics") OR (MH "Health Services for the Aged")))) OR (MH "Long Term Care") OR (MH "Nursing Home Patients") OR (MH "Nursing Home Personnel") OR (MH "Nursing Homes") OR (MH "Residential Facilities") OR (MH "Skilled Nursing Facilities") OR TI("aged care" or "assisted living" or "care home*" or "extended care facilit*" or "group home*" or "halfway home*" or "halfway house*" or "intermediate care" or ((institutionaliz* or institutionalis* or home# or housing) N3 (elderly or geriatric* or aging or aged or "old age" or seniors or "older adult*" or "older people" or "older person*"))) or "long term care" or LTC or "nursing facilit*" or "nursing home*" or "old age home*" or "residential care*" or "residential facilit*" or "residential home*")	55,122
S3	S1 AND S2	101
S4	S3 AND ((LA "English") OR (LA "French "))	101
S5	S4 AND (DT 19550101-20151231)	101
S6	S5 NOT PT (Brief Item OR Commentary OR Editorial OR Letter)	91
S7	S6 NOT (((MH "Africa+") OR (MH "South America+")) NOT ((MH "North America") OR (MH "Canada+") OR (MH "United States+") OR (MH "Europe+") OR (MH "Developed Countries") OR (MH "Australia+") OR (MH "New Zealand")))	91

Table 7. Search strategy 4: AgeLine

#	Query	Results
S1	TI (tuberculos* or tubercular or tuberculin or TB) OR SU (tuberculos* or tubercular or tuberculin or TB)	14
S2	("aged care" or "assisted living" or "care home*" or "extended care facilit*" or "group home*" or "halfway home*" or "halfway house*" or "intermediate care" or ((institutionaliz* or institutionalis* or home# or housing) N3 (elderly or geriatric* or aging or aged or "old age" or seniors or "older adult*" or "older people" or "older person*")) or "long term care" or LTC or "nursing facilit*" or "nursing home*" or "old age home*" or "residential care*" or "residential facilit*" or "residential home*")	30,104
S3	S1 AND S2	6

Appendix C: Data caveats and technical notes for iPHIS and OUT-TB genotyping data

Data caveats related to the iPHIS data presented in this report:

- iPHIS is a dynamic disease reporting system which allows ongoing updates to data previously entered. As a result, data extracted from iPHIS represent a snapshot at the time of extraction and may differ from previous or subsequent reports.
- The data represent only those cases reported to public health and recorded in iPHIS. As a result, all counts will be subject to varying degrees of underreporting depending on factors such as disease awareness, medical seeking behaviours, changes in laboratory testing, reporting behaviours, and severity of illness.
- Changes to provincial surveillance case definitions and disease classifications have occurred over the years. Cases are classified in iPHIS according to the Ontario Ministry of Health and Long-Term Care's (MOHLTC) surveillance case definitions used at the time the case was identified. Please note that the case definitions available online as part of the Infectious Diseases Protocol represent the most recent definitions, and cases reported in prior years may have been classified according to different case definitions or disease classifications which may impact analysis of trends.
- Case counts include only the following classifications: Confirmed.
- Cases of TB are reported based on 'Diagnosis Date'.
- Orientation of case counts by geography is based on the Diagnosing Health Unit (DHU). DHU refers to the case's public health unit of residence at the time of illness onset and not necessarily the location of exposure. Cases for which the DHU was reported as MOHLTC (to signify a case that is not a resident of Ontario) or Muskoka Parry Sound (a public health unit that no longer exists) have been excluded.
- Cases for which the 'Disposition Status' was reported as ENTERED IN ERROR, DOES NOT MEET DEFINITION, DUPLICATE-DO NOT USE, or any variation on these values have been excluded.
- The possibility of duplicates exists because duplicate sets were not identified and excluded unless they were resolved prior to data extraction either at the local or provincial level.
- Pulmonary TB cases included cases where the 'Disease Description' was entered as either Primary Respiratory Tuberculosis, Tuberculosis of Larynx, Trachea and Bronchus, or Tuberculosis of Lung.

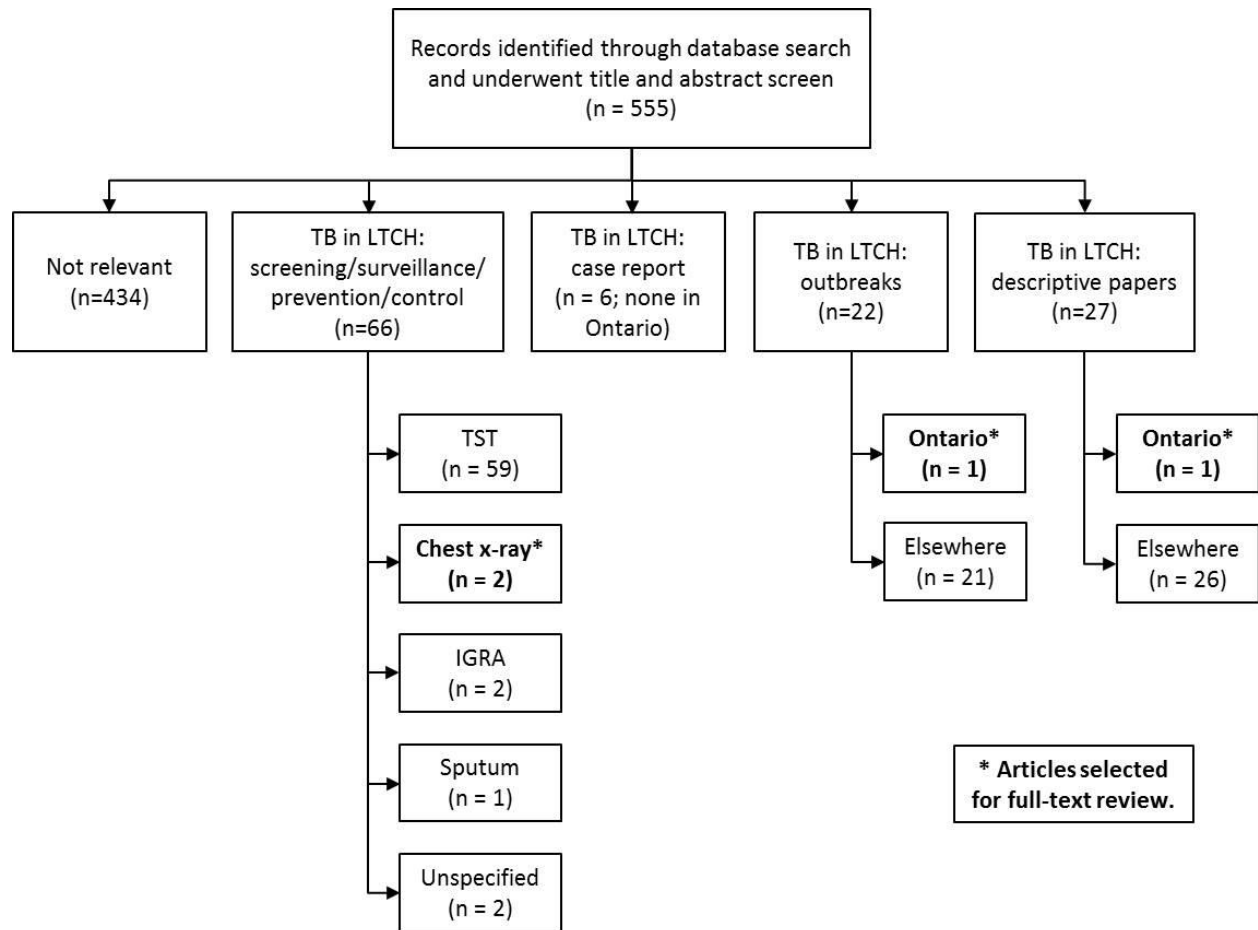
Technical notes and data caveats regarding the OUT-TB genotyping database:

- Prospective genotyping of all TB isolates started in 2008, so isolates predating this may have been typed as requested by health units or as part of smaller studies.
- Some isolates may only have had partial genotyping results due to technical issues.
- Detailed iPHIS and OUT-TB linkage methodology:

- Merged genotyping data from OUT-TB onto iPHIS line list of pulmonary TB cases in confirmed LTCH residents.
- Added field indicating whether or not linkage was possible for each record.
- Checked for genotyping matches by using SM24 number and then confirming non-matches using combination of MIRU-24 and octal code from spoligotyping (see description of genotyping terms below).

Genotyping term	Description
SM24	Number indicating known cluster as identified by matching genotypes
MIRU-24	24-digit code denoting genotype by 24-loci MIRU-VNTR (mycobacterial interspersed repetitive units-variable number of tandem repeats)
Octal code	15-digit code denoting genotype by spoligotyping

Appendix D: Evidence review search results flow diagram



Appendix E: Ontario public health unit jurisdictional scan

Public health unit	2016 TB incidence rate ³³	Summary of screening recommendations	Detailed screening recommendations
Halton Region ⁸	2.3	<p>Residents staying three months or more:</p> <ul style="list-style-type: none"> • Symptom review • Chest x-ray • TST (only if <65 years of age) • Sputum collection (if indicated) <p>Residents staying less than three months:</p> <ul style="list-style-type: none"> • Symptom review • Chest x-ray (only if symptomatic) 	<p>All new residents must undergo a history and physical examination within 90 days prior to admission or within 14 days after admission. This assessment should include:</p> <ul style="list-style-type: none"> • A symptom review for active pulmonary TB (PTB) disease. • A chest x-ray (CXR) (PA and lateral) taken within 90 days prior to admission. • If signs or symptoms and/or CXR indicates potential active PTB disease, the resident should not be admitted until three sputum samples (each taken at least eight hours apart) are submitted to the public health lab for testing (AFB and culture) and the results are negative. • In addition to the above, for residents <65 years of age who are previously TST negative or unknown, a two-step TST is recommended. A TST is not recommended for residents with a previous positive TST. • TSTs are not recommended to be done upon admission for residents ≥65 years of age. If a TST was previously done, record the date and result of the most recent TST. <p>Residents admitted to short-term care of less than three months (e.g., respite care):</p> <ul style="list-style-type: none"> • Assessment and symptom review to rule out active PTB within 90 days prior to admission or within 14 days after admission. • If the symptom review indicates potential active PTB disease, a CXR must be obtained and active TB disease ruled out. • A TST for residents in short term care is not recommended.

Public health unit	2016 TB incidence rate ³³	Summary of screening recommendations	Detailed screening recommendations
Peel Region ⁹	9.2	<p>Residents staying three months or more:</p> <ul style="list-style-type: none"> • Symptom review • Chest x-ray • TST (only if <65 years of age) • Sputum collection (if indicated) <p>Residents staying less than three months:</p> <ul style="list-style-type: none"> • Symptom review • Chest x-ray (only if symptomatic) 	<p>All new residents must undergo a history and physical examination within 90 days prior to admission or within 14 days after admission. This assessment should include:</p> <ul style="list-style-type: none"> • A symptom review for active PTB disease. • A CXR (PA and lateral) taken within 90 days prior to admission. • If signs or symptoms and/or CXR indicates potential active PTB disease, the resident should not be admitted until three sputum samples (each taken at least eight hours apart) are submitted to the public health lab for testing (AFB and culture) and the results are negative. • In addition to the above, for residents <65 years of age who are previously TST negative or unknown, a two-step TST is recommended. A TST is not recommended for residents with a previous positive TST. • TSTs are not recommended to be done upon admission for residents ≥65 years of age. If a TST was previously done, record the date and result of the most recent TST. <p>Residents admitted to short-term care of less than three months (e.g., respite care):</p> <ul style="list-style-type: none"> • Assessment and symptom review to rule out active PTB within 90 days prior to admission or within 14 days after admission. • If the symptom review indicates potential active PTB disease, a CXR must be obtained and active TB disease ruled out. • A TST for residents in short term care is not recommended.
Porcupine ⁵⁹	0.0	No LTCH-specific recommendations	Although screening recommendations were available in 2015-16, no current LTCH-specific screening recommendations are accessible in public domain.

Public health unit	2016 TB incidence rate ³³	Summary of screening recommendations	Detailed screening recommendations
Toronto ¹⁰	10.5	<p>Residents staying three months or more:</p> <ul style="list-style-type: none"> • Symptom review • Chest x-ray • TST (only if <65 years of age) • Sputum collection (if indicated) <p>Residents staying less than three months:</p> <ul style="list-style-type: none"> • Symptom review • Chest x-ray (only if symptomatic) 	<p>All new residents must undergo a history and physical examination within 90 days prior to admission or within 14 days after admission. This assessment should include:</p> <ul style="list-style-type: none"> • A symptom review for active PTB disease. • A CXR (PA and lateral) taken within 90 days prior to admission. • If signs or symptoms and/or CXR indicates potential active PTB disease, the resident should not be admitted until three sputum samples (each taken at least eight hours apart) are submitted to the public health lab for testing (AFB and culture) and the results are negative. • In addition to the above, for residents <65 years of age who are previously TST negative or unknown, a two-step TST is recommended. A TST is not recommended for residents with a previous positive TST. • TSTs are not recommended to be done upon admission for residents ≥65 years of age. If a TST was previously done, record the date and result of the most recent TST. <p>Residents admitted to short-term care of less than three months (e.g., respite care):</p> <ul style="list-style-type: none"> • Assessment and symptom review to rule out active PTB within 90 days prior to admission or within 14 days after admission. • If the symptom review indicates potential active PTB disease, a CXR must be obtained and active TB disease ruled out. • A TST for residents in short term care is not recommended.

Public health unit	2016 TB incidence rate ³³	Summary of screening recommendations	Detailed screening recommendations
Waterloo ¹¹	2.0	<p>Residents staying 14 days or more:</p> <ul style="list-style-type: none"> • Symptom review • Chest x-ray (only if >65 years of age) • TST (only if ≤65 years of age) <p>Residents staying less than 14 days:</p> <p>No screening required</p>	<p>All new resident admissions to long-term care homes:</p> <ul style="list-style-type: none"> • Medical assessment and symptom review to rule out active TB. • Residents >65 years of age require a baseline CXR (PA and lateral views). • Residents ≤65 years of age require a two-step TST (this may be offered by the facility). <p>Note: if stay is less than 14 days, no TB screening required.</p>
Wellington-Dufferin-Guelph ¹²	3.1	<p>All residents:</p> <ul style="list-style-type: none"> • Chest x-ray • TST (only if <65 years of age) 	<p>All residents when admitted must have a baseline chest x-ray (PA and lateral).</p> <p>Note: TSTs are no longer required for residents ≥65 years of age. If a TST was previously done, record the date and the result of the most recent TST.</p>

Appendix F: Canadian provincial/territorial jurisdictional scan

Province/ territory	2016 TB incidence rate ³⁴	Summary of screening recommendations	Detailed screening recommendations
Alberta ¹³	5.6	<ul style="list-style-type: none"> • Risk factor inquiry • Symptom review • Chest x-ray • TST (only if risk factors present) • Sputum collection (only if history of prior TB) 	<p>Pre-admission TB screening:</p> <ul style="list-style-type: none"> • PA and lateral chest x-rays (CXR) must be performed within six months of application for admission as part of the pre-placement exam. • TB history and symptom inquiry. • Three sputum samples should be submitted for AFB smear and culture if individuals found to have a history of prior active TB disease. <p>Admission protocol:</p> <ul style="list-style-type: none"> • Repeat CXR if >12 months have passed since application (pre-admission) CXR was performed (or if symptoms suggestive of active TB disease). • Repeat TB symptom inquiry. • Baseline TST should only be performed if the resident has no documentation of previous TB disease (treated or untreated) or previous positive TST AND is at increased risk of progressing to active TB disease related to any of the following: <ul style="list-style-type: none"> • HIV/AIDS, silicosis, diabetes mellitus (all types), chronic renal failure requiring dialysis, transplantation (related to immunosuppressant therapy), carcinoma of head or neck, treatment with glucocorticoids or tumor necrosis factor (TNF) alpha inhibitors, less than ideal body weight (<90% ideal body weight); recent infection with MTB (≤2 years); abnormal radiograph – e.g., fibronodular or other changes suggesting prior TB disease

Province/ territory	2016 TB incidence rate ³⁴	Summary of screening recommendations	Detailed screening recommendations
British Columbia ¹⁴	4.6	<p><60 years of age:</p> <ul style="list-style-type: none"> • Risk factor inquiry • Symptom review • TST • Chest x-ray (only if TST positive and/or symptomatic) • TST <p>≥60 years of age:</p> <ul style="list-style-type: none"> • Risk factor inquiry • Symptom review • Chest x-ray (only if symptomatic) 	<p>Due to potential for the booster effect in older individuals (i.e., those who may have acquired infection with MTB many years prior), if TST is indicated, a two-step TST should be done if the initial TST is negative unless there is documentation of a valid prior two-step TST.</p> <p>Entering adult residential care facility: <60 years old:</p> <ul style="list-style-type: none"> • Symptom screen to rule out active TB. This should be done before admission into facility and be accompanied by a TB risk factor assessment and TB testing history. • Screen for LTBI (TST). May be done within one month of admission if asymptomatic. Previous TST results are valid if done within the past six months and no new TB risk factor or no new TB signs or symptoms present. • CXR only if TST positive and/or symptomatic. • If TST positive and/or CXR done, refer to provincial TB Services. <p>Entering adult residential care facility: ≥60 years old:</p> <ul style="list-style-type: none"> • Symptom screen to rule out active TB. This should be done before admission into facility and be accompanied by a TB risk factor assessment and TB testing history. • CXR only if symptomatic. • If CXR done, refer to provincial TB Services.

Province/ territory	2016 TB incidence rate ³⁴	Summary of screening recommendations	Detailed screening recommendations
Manitoba ¹⁵	15.2	<ul style="list-style-type: none"> • Chest x-ray (only for specified populations) • TST (only if indicated) 	<p>Baseline PA and lateral CXR is recommended on admission to a LTCH for the following populations:</p> <ul style="list-style-type: none"> • Persons born in Canada prior to 1955; • Aboriginal persons; • People born in or previously residing in countries with high TB incidence. <p>Baseline TST upon admission is not required for all residents. Facility risk assessment/local epidemiology should inform the decision.</p>
New Brunswick ¹⁶	1.7	<ul style="list-style-type: none"> • TST (only if at increased risk) 	<p>Routine baseline TST testing of LTCH residents is not generally recommended. If an individual is at increased risk of TB (e.g., individuals from a high TB incidence country, Canadian individuals residing or having resided in communities with high incidence of TB, former urban poor/homeless, HIV infected etc.), then a baseline two-step TST should be performed.</p> <p>Annual TST screening is not necessary for LTCH residents.</p>
Newfoundland and Labrador ¹⁷	5.3	<ul style="list-style-type: none"> • Symptom review • Chest x-ray 	<ul style="list-style-type: none"> • Screen all residents for symptoms of TB on admission to LTCHs. • Screen residents with a PA and lateral CXR prior to admission.
Northwest Territories ¹⁸	6.7	No LTCH specific recommendations	Although screening recommendations were available in 2015-16, no current LTCH-specific screening recommendations accessible in public domain.

Province/ territory	2016 TB incidence rate ³⁴	Summary of screening recommendations	Detailed screening recommendations
Nova Scotia ¹⁹	0.2	<p>≥65 years of age:</p> <ul style="list-style-type: none"> • Symptom review • Chest x-ray (only if symptomatic) <p><65 years of age:</p> <ul style="list-style-type: none"> • Risk factor inquiry • TST (only if part of an 'at-risk' group) 	<p>All new residents to LTCF who are ≥65 years of age are monitored for symptoms of active TB (i.e. cough of 2-3 weeks duration, with or without weight loss, and fever). If symptoms are present then TB is considered as part of the differential diagnosis and a CXR should then be done.</p> <p>All new residents who are <65 years of age AND belong to one of the 'at risk' population groups should have a TST to screen for LTBI. These include the following:</p> <ul style="list-style-type: none"> • People with a history of active TB • Former staff/residents of homeless shelters • Former staff/inmates of correctional facilities • Former injection drug users • Aboriginal Canadians • People infected with HIV • People born or previously residing in countries with a high TB incidence <p>People with high risk conditions including organ transplantation (related to immune-suppressant therapy), silicosis, chronic renal failure requiring hemodialysis, carcinoma of head and neck, abnormal CXR (e.g., fibronodular disease).</p>
Nunavut ²⁰	142.9	No LTCH specific recommendations	Although screening recommendations were available in 2015-16, no current LTCH-specific screening recommendations accessible in public domain.

Province/ territory	2016 TB incidence rate ³⁴	Summary of screening recommendations	Detailed screening recommendations
Prince Edward Island ²¹	2.7	No LTCH specific recommendations	<p>There are measures in place for prevention of communicable diseases within the facility including screening in accordance with Department of Health and Wellness (DHW) guidelines* and facility policy, including new residents upon admission [moving in] for tuberculosis. <i>(No specific details provided)</i>.</p> <p>*The above recommendation specifically pertains to private nursing homes. There is reference to a “DHW Policy for Tuberculosis Screening of Health Care Workers and Residents in Long-Term care Facilities (September 2005)”, but this specific policy document could not be located.</p>
Quebec ²²	3.0	No LTCH specific recommendations	Although screening recommendations were available in 2015-16, no current LTCH-specific screening recommendations accessible in public domain.
Saskatchewan ²³	7.9	<ul style="list-style-type: none"> • Symptom review • Chest x-ray • TST • Sputum collection (only if symptomatic) 	<p>On admission:</p> <ul style="list-style-type: none"> • TST within 30 days if no previous record of skin test. Re-test within two weeks if reaction less than 10 mm (to identify booster responders). • Chest x-ray to be done for TB, if not obtained within 90 days of admission. • Sputum for AFB smear and culture if coughing for more than one month. Obtain gastric washing if sputum not obtainable.
Yukon ²⁴	2.7	No LTCH specific recommendations	Although screening recommendations were available in 2015-16, no current LTCH-specific screening recommendations accessible in public domain.

Appendix G: Low TB incidence countries jurisdictional scan

Country	2015 TB incidence ⁶⁴	Summary of TB screening recommendations for residents on admission to long-term care homes
Canada ¹	5.1	Chest x-ray (if >65 years of age) TST (if ≤65 years of age)
Australia ²⁵	6.0	No LTCH specific recommendations
Ireland ²⁶	7.2	No LTCH specific recommendations
New Zealand ²⁷	7.4	No LTCH specific recommendations
United States ^{28,29}	3.2	Symptom review Chest x-ray (if TST ≥10mm and/or symptomatic) TST Sputum collection (if symptomatic)

Appendix H: Screening analytic framework criteria and considerations

The following screening framework criteria and considerations were taken from Public Health England's "Criteria for appraising the viability, effectiveness and appropriateness of a screening programme".³⁰ Each of the framework's 20 criteria were grouped into five categories: 1) the condition, 2) the test, 3) the intervention, 4) the screening program, and 5) its implementation. The considerations to be applied for each category, and the corresponding evidence and knowledge gaps are described in detail below.

The condition

1. The condition should be an important health problem as judged by its frequency and/or severity. The epidemiology, incidence, prevalence and natural history of the condition should be understood, including development from latent to declared disease and/or there should be robust evidence about the association between the risk or disease marker and serious or treatable disease.

From 2006 to 2015, we estimated that an average of four cases of pulmonary TB per year were reported in LTCH residents in Ontario. A single case of active TB in a LTCH resident can result in transmission in the facility, and clinically severe disease for affected individuals.⁵ However, our estimates show that pulmonary TB in LTCH residents in Ontario is infrequent. The estimated number of pulmonary TB cases in LTCHs in Ontario each year represented 1.0% of the annual provincial average of all pulmonary TB cases (373 cases) reported in Ontario each year over this period. Based on this estimate, the relative burden of pulmonary TB in LTCH residents is a very small proportion of the overall burden of pulmonary TB in the province.

We found that an estimated 0.005% of LTCH residents in Ontario from 2006 to 2015 had a reported case of pulmonary TB. This suggests that, among LTCH residents in Ontario, reported pulmonary TB is rare, as does the corresponding rate of 4.6 pulmonary TB cases reported per 100,000 LTCH residents per year. If we consider only the years in which the annual number of LTCH residents became more stable (2010 and onwards), the average annual incidence rate is even lower, at 3.6 pulmonary TB cases reported per 100,000 LTCH residents. This is lower than the average annual incidence rate of 7.1 pulmonary TB cases per 100,000 population among adults 70 years of age and older in Ontario from 2006 to 2015.³⁵ Overall, assessment of this criterion highlights that a very small proportion of LTCH residents in Ontario develop pulmonary TB, and the corresponding low incidence rates in this group.

In terms of considering universal chest x-ray screening in the context of the natural history of TB, progression from LTBI to active TB is partially understood. Known medical risk factors for TB reactivation include diabetes, end-stage renal disease, hemodialysis, HIV, and other immunocompromising conditions.^{1,4} Living or being born in an area where TB is highly endemic and increasing age are also established risk factors for reactivation TB.^{1,4} The CTBS recommends admission TST screening only for

LTCH residents under age 65 years “*who also belong to an identified at-risk group*”.¹ However, universal chest x-ray screening for TB on admission to LTCH does not address risk-based considerations for disease progression within this population.

Of note, our jurisdictional scan identified three Canadian provinces that currently include a risk factor inquiry in their recommendations for TB screening on admission to LTCH.^{13,14,19} However, none of the five PHUs included in the Ontario jurisdictional scan currently explicitly advise LTCHs to assess a new resident’s risk factors for TB as part of admission screening, although some recommend a symptom screen.

- Knowledge gaps:
 - Our estimates of pulmonary TB burden in Ontario LTCH residents have several potential limitations, as the numerator and denominator estimates rely on provincial reportable disease and continuing care administrative databases (iPHIS and the CCRS) that were not designed specifically for ongoing surveillance of TB in this particular group and setting (see Discussion for more details).
 - If the objective of screening with chest x-ray on admission to a LTCH is to detect subclinical pulmonary TB disease at the time of admission, then it would be even more relevant to consider the incidence of active TB in residents on or around admission to LTCH (for example, within the 90 days before admission and up to 14 days after admission, as specified in the LTCH Act). However, whether TB was detected through chest x-ray screening on admission to a LTCH is not currently captured in iPHIS or in the CCRS.
 - Our review did not identify evidence evaluating whether a risk-based chest x-ray screening program would perform better than a universal one, or the optimal combination of risk factors to consider in a risk-stratified approach.

From 2006 to 2015, we estimated that an average of four cases of pulmonary TB per year were reported in LTCH residents in Ontario. A single case of active TB in a LTCH resident can result in transmission in the facility, and clinically severe disease for affected individuals.⁵ However, our estimates show that pulmonary TB in LTCH residents in Ontario is infrequent. The estimated number of pulmonary TB cases in LTCHs in Ontario each year represented 1.0% of the annual provincial average of all pulmonary TB cases (373 cases) reported in Ontario each year over this period. Based on this estimate, the relative burden of pulmonary TB in LTCH residents is a very small proportion of the overall burden of pulmonary TB in the province.

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per 100,000 population among adults 70 years of age and older in Ontario from 2006 to 2015.³⁶ Overall, assessment of this criterion highlights that a very small proportion of LTCH residents in Ontario develop pulmonary TB, and the corresponding low incidence rates in this group.

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 - Our estimates of pulmonary TB burden in Ontario LTCH residents have several potential limitations, as the numerator and denominator estimates rely on provincial reportable disease and continuing care administrative databases (iPHIS and the CCRS) that were not designed specifically for ongoing surveillance of TB in this particular group and setting (see Discussion for more details).
 - If the objective of screening with chest x-ray on admission to a LTCH is to detect subclinical pulmonary TB disease at the time of admission, then it would be even more relevant to consider the incidence of active TB in residents on or around admission to LTCH (for example, within the 90 days before admission and up to 14 days after admission, as specified in the LTCH Act). However, whether TB was detected through chest x-ray screening on admission to a LTCH is not currently captured in iPHIS or in the CCRS.
 - Our review did not identify evidence evaluating whether a risk-based chest x-ray screening program would perform better than a universal one, or the optimal combination of risk factors to consider in a risk-stratified approach.

2. All the cost-effective primary prevention interventions should have been implemented as far as practicable.

Best practice recommendations are available to guide infection prevention and control (IPAC) for primary prevention of TB transmission in LTCH settings, including administrative and environmental controls.^{1,41} These controls include facility-level risk assessment, staff education about TB, and minimum

air-exchanges per hour for ventilation systems.^{1,4} However, evidence from a recent TB outbreak in an Ontario LTCH identified shortcomings related to both administrative and environmental controls.⁵ Moreover, the MOHLTC has identified hundreds of Ontario LTCH facilities that need to be redeveloped.⁵⁰ Some of these older facilities may not meet current IPAC standards or have optimal environmental controls for preventing airborne or droplet TB transmission, which suggests that this screening framework criterion may not be met in many Ontario LTCHs.

- Knowledge gap: It was beyond the scope of this report to identify evidence, if available, on Ontario LTCHs' compliance with recommended administrative and environmental controls to prevent TB transmission, including IPAC best practices.
3. If the carriers of a mutation are identified as a result of screening the natural history of people with this status should be understood, including the psychological implications.

This criterion does not apply to chest x-ray screening for TB.

The test

1. There should be a simple, safe, precise and validated screening test.

In terms of safety, chest x-ray is generally considered to be a safe test that delivers only a small quantity of ionizing radiation.⁶¹ However, whether chest x-ray is a 'simple' test to administer to LTCH residents speaks to implementation considerations in this patient population and setting. LTCH residents often have mobility and/or other health issues that may complicate both the administration of the test (i.e., standing upright for a PA and lateral chest x-ray) and transport to the x-ray machine.^{4,5}

Regarding precision and validity, chest x-ray has known limitations as a diagnostic tool for TB, including suboptimal sensitivity (estimated to be 70%-80%) and specificity (60%-70%).⁴¹ However, chest x-ray screening should seek to detect pulmonary TB that is "not sufficiently symptomatic" to prompt health care use.⁶¹ Sensitivity is of particular concern in the context of screening; ideally, a highly sensitive test is used to rule out disease, with minimal false-negative results.⁶³

Overall, consideration of this criterion identified challenges with respect to the simplicity, precision and validity of chest x-ray as a screening method for TB in LTCH residents.

- Knowledge gaps:
 - We did not identify any published evidence that described the barriers to obtaining a chest x-ray for LTCH residents in the Ontario, or the frequency with which these barriers may be encountered.
 - The properties of chest x-ray as a screening test for asymptomatic or subclinical pulmonary TB are likely different (and more suboptimal) than the properties of chest x-ray as a diagnostic test for active TB. However, our review did not identify any literature on the sensitivity, specificity, and positive predictive value of chest x-ray for the universal

screening of LTCH residents for active TB, or the associated false-positive and false-negative rates.

2. The distribution of test values in the target population should be known and a suitable cut-off level defined and agreed.

There is great inter-rater variability in the interpretation of chest x-rays, and there is poor agreement among those interpreting chest x-rays regarding the presence of cavitation, hilar lymphadenopathy and the presence of active disease.⁴² Given the underlying health issues that lead to the need for LTCH placement, many LTCH residents could be expected to have abnormal chest x-rays on admission. This could contribute to challenges in detecting TB via chest x-ray in LTCH residents.

- Knowledge gap: Relevant questions that were beyond the scope of our review include: How common are chest x-ray abnormalities in LTCH residents? What proportion of abnormal chest x-rays are actually active TB? What is the inter- and intra-rater agreement for interpreting chest x-rays performed for screening purposes among LTCH residents?

3. The test, from sample collection to delivery of results, should be acceptable to the target population.

Given its non-invasive nature and the minimal dose of ionizing radiation,⁶¹ chest x-ray may be acceptable to LTCH residents. However, factors that may impact the acceptability of chest x-ray as a TB screening test for residents (and potentially for their substitute decision-makers, caregivers and/or LTCH staff) include: the mobility and/or other health issues that many LTCH residents face, the potential need for transport to another facility to obtain a chest x-ray, and, the infrequency with which TB is detected in this group. Furthermore, for some hospice and palliative care residents, undergoing a chest x-ray to screen for active TB may not be consistent with their broader care goals.

- Knowledge gap: We did not identify any published evidence on the acceptability of chest x-ray to screen residents for TB on admission to LTCHs, although this was not an explicit goal of our literature search.

4. There should be an agreed policy on the further diagnostic investigation of individuals with a positive test result and on the choices available to those individuals.

The 2014 CTBS provide guidelines for the diagnosis of active TB.⁴² A chest x-ray suggestive of active TB disease would typically be followed with sputum smear and culture and sensitivity. If the LTCH resident was unable to produce sputum spontaneously, sputum induction may be arranged. If sputum induction failed to produce adequate sputum, bronchoalveolar lavage may be considered.

- Knowledge gap: In the LTCH resident population, what are the barriers to the implementation of the CTBS recommendations for additional diagnostic testing for persons with chest x-rays suggestive of active TB (e.g., access to sputum induction, bronchoscopy)?

The intervention

1. There should be an effective intervention for patients identified through screening, with evidence that intervention at a pre-symptomatic phase leads to better outcomes for the screened individual compared with usual care. Evidence relating to wider benefits of screening, for example those relating to family members, should be taken into account where available. However, where there is no prospect of benefit for the individual screened then the screening programme shouldn't be further considered.

In terms of the wider benefits of screening, early identification of active TB in LTCH has the potential to reduce TB transmission in LTCH settings, among residents and staff. Also, early detection and treatment of active TB generally leads to better patient outcomes,³⁸ except in the presence of contraindications or severe treatment complications. However, the benefits to the individual screened may not always be obtained in the LTCH resident population; during the TB outbreak at the Wellington-Dufferin-Guelph LTCH,⁵ all three residents with active TB died while receiving TB treatment, either from TB treatment complications (one died of isoniazid hepatotoxicity) or from other causes (TB was mentioned as a contributing factor in the other two deaths).

- Knowledge gap: Relevant questions that were not addressed in evidence identified in our review include: Does early identification of active infectious TB lead to decreased TB transmission among LTCH residents, and is this reduction significant in situations where environmental controls (e.g., air exchanges) are optimized? Does early treatment of active TB in LTCH residents lead to better patient outcomes? What proportion of LTCH residents die before completing / from complications of TB treatment?
2. There should be agreed evidence-based policies covering which individuals should be offered interventions and the appropriate intervention to be offered.

The 2014 CTBS provide evidence-based treatment guidelines for managing active TB, as well as the public health management of TB cases, contacts and outbreaks. Evidence-informed case and contact management, in accordance with the CTBS and the Ontario TB Protocol,⁴⁵ can be carried out when TB occurs in a LTCH resident. However, it is not clear how readily clinical treatment guidelines can be applied to the LTCH resident population, particularly if severe treatment complications arise.

- Knowledge gap: It was beyond the scope of our evidence review to consider: What factors (such as rural/remote geographic location, underlying medical conditions) may act as barriers to completing TB treatment in LTCH residents?

The screening program

1. There should be evidence from high quality randomised controlled trials that the screening programme is effective in reducing mortality or morbidity. Where screening is aimed solely at providing information to allow the person being screened to make an “informed choice” (such as Down’s syndrome or cystic fibrosis carrier screening), there must be evidence from high quality trials

that the test accurately measures risk. The information that is provided about the test and its outcome must be of value and readily understood by the individual being screened.

Through our literature review, we identified no studies of the effectiveness of a universal screening program for active TB among LTCH residents using chest x-ray on admission. We identified no evaluations of current universal screening programs for active TB among LTCH residents using chest x-ray on admission.

- Knowledge gap: What proportion (if any) of active TB cases among LTCH residents in Ontario was discovered through universal screening with chest x-ray on admission? Is a universal chest x-ray screening program effective at reducing TB transmission among LTCH residents?
2. There should be evidence that the complete screening programme (test, diagnostic procedures, treatment/ intervention) is clinically, socially and ethically acceptable to health professionals and the public.
 - Knowledge gap: Is the universal screening of LTCH residents for active TB using chest x-ray on admission clinically, socially and ethically acceptable to health professionals and the public?
 3. The benefit gained by individuals from the screening programme should outweigh any harm for example from over-diagnosis, overtreatment, false positives, false reassurance, uncertain findings and complications.
 - Knowledge gap: What are the harms from the universal screening of LTCH residents for active TB using chest x-ray on admission? What proportion of LTCH residents has an abnormal screening chest x-ray? Of those, how many go on to further testing and what are the yield (number of active TB cases detected) and the complications from each additional investigation?
 4. The opportunity cost of the screening programme (including testing, diagnosis and treatment, administration, training and quality assurance) should be economically balanced in relation to expenditure on medical care as a whole (value for money). Assessment against this criterion should have regard to evidence from cost benefit and/or cost effectiveness analyses and have regard to the effective use of available resource.

Verma et al.⁷ conducted a cost-effectiveness analysis of the universal screening of LTCH residents for active TB using chest x-ray compared to TST on admission; they found that neither screening method was cost-effective in Alberta. Based on this study's findings, and assuming the epidemiology of TB in LTCHs in Alberta is likely comparable to that in Ontario, we would expect similar results in the Ontario context.

- Knowledge gap: What is the cost-effectiveness of screening LTCH residents for active TB using chest x-ray on admission? What is the opportunity cost of chest x-ray screening on admission to LTCHs in Ontario (in terms of other TB prevention and control activities), for LTCHs, local PHUs and the health system more broadly?

Implementation criteria

1. Clinical management of the condition and patient outcomes should be optimized in all health care providers prior to participation in a screening programme.
 - Knowledge gap: Is case and contact management optimized in all LTCHs? What are some of the barriers (e.g., remote geographic location, underlying medical conditions, and inadequate environmental controls) to optimal case and contact management?
2. All other options for managing the condition should have been considered (such as improving treatment or providing other services), to ensure that no more cost-effective intervention could be introduced or current interventions increased within the resources available.
 - Knowledge gap: What is/are the most effective and cost-effective method(s) for reducing TB transmission in LTCH settings in Ontario? What is the effectiveness and cost-effectiveness of other screening programs, such as the symptom-based screening program used in Alberta, British Columbia, Newfoundland and Labrador, and Nova Scotia (Appendix F)?
3. There should be a plan for managing and monitoring the screening programme and an agreed set of quality assurance standards.
 - Knowledge gap: Is there a quality assurance process for the interpretation of chest radiograph performed as part of screening LTCH residents for active TB using chest x-ray on admission? If not, how might one be implemented (e.g., should the reading of these chest radiographs be centralized and done by only a small number of physicians with TB expertise)? What could be learned from other Canadian jurisdictions with more centralized TB control and clinical care?
4. Adequate staffing and facilities for testing, diagnosis, treatment and programme management should be available prior to the commencement of the screening programme.
 - Knowledge gap: What barriers to screening, diagnosis, and case and contact management are encountered by the LTCHs and local PHUs?
5. Evidence-based information, explaining the purpose and potential consequences of screening, investigation and preventative intervention or treatment, should be made available to potential participants to assist them in making an informed choice.
 - Knowledge gap: What information is provided to LTCH residents or their substitute decision-makers regarding participation in the universal screening program for active TB using chest x-ray on admission? How is this information provided? Who provides this information? Is there variation between LTCHs and between PHUs?

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