More than 10 days of fever or 13 days of cough differentiated adolescent patients presenting to a pediatric emergency department with infectious tuberculosis (TB) from most patients with pneumonia. Upper lobe involvement was significantly more common in patients with TB. Symptom- and radiograph-based algorithms could minimize TB exposure and aid diagnosis.

Keywords. adolescent; emergency department; infection control; tuberculosis.

Delay in identification and isolation of patients with pulmonary tuberculosis (TB) may lead to TB transmission in health care facilities including emergency departments (EDs) [1–4]. Diagnosis of TB is often delayed in adolescents in low-TB-burden settings [5–7]. Older adolescents with pulmonary TB are more likely to have adult-type reactivation TB and may pose an infectious risk to others [8]. If clinical characteristics of adolescents with infectious TB presenting to North American pediatric EDs are different from those of adolescents with other more common respiratory conditions, this may assist with their earlier identification and appropriate isolation. Following a delayed diagnosis of TB in a patient who attended the ED, we studied the epidemiology, presenting symptoms, and clinical features of all 12- to 18-year-old patients with undiagnosed infectious TB who made ED visits to a large children’s hospital, and compared selected characteristics with those of a cohort of patients with radiologically confirmed pneumonia presenting to the ED during a calendar year.

METHODS

From the clinic visit data of the Hospital for Sick Children (SickKids) TB program, we retrospectively reviewed records of all patients ultimately diagnosed with TB and treated at SickKids between 1 January 2002 and 31 December 2015 to identify all patients 12–18 years of age who had made at least 1 visit to the SickKids ED with undiagnosed infectious respiratory TB. Diagnosis required a positive culture from sputum, gastric aspirates, and/or bronchoalveolar lavage. Based on the ED record, we excluded patients already suspected of having TB before their first SickKids ED visit. From both ED records and prospectively populated TB clinic entry database forms, we abstracted information about epidemiology, visits to physicians and health care facilities, presenting symptoms and their duration, and results of investigations. We determined whether airborne-isolation rooms were used during their ED visits. We then reviewed records of a convenience sample of all patients 12–18 years of age who made SickKids ED visits between 1 January and 31 December 2019 and had radiologically confirmed pneumonia to determine their symptom duration and radiological features and compared these to those of the patients with infectious TB.

The study was approved by the SickKids Research Ethics Board (REB number 100056049). Statistical analysis was performed using SAS version 9.4 software (SAS Institute, Cary, North Carolina). For comparisons between patients with TB and those with pneumonia, the Mood median test was used for continuous data and Fisher exact test was used for categorical data. All tests were 2-tailed.

RESULTS

As shown in Supplementary Figure 1, 40 of 198 (20%) patients with TB managed at SickKids during the study period were 12 years or older and had infectious pulmonary TB. Of these, 19 (48%) made SickKids ED visits during the study period; 9 had a known possible diagnosis of TB before the visit, leaving 10 patients who were included in the study. The clinical signs and symptoms of these patients are shown in Table 1.

The median age of the patients was 15.8 years (interquartile range [IQR] between 14.7 and 16.8 years). All 10 patients had at least 1 foreign-born parent and 9 of 10 patients (90%) were born outside Canada: TB disease occurred a median of 6 years (range, 6 months–12 years) after arrival in Canada. No patient had a known immunocompromising condition.

The 10 patients had collectively made a minimum of 36 visits to health care facilities when they were potentially contagious.
These included visits to the SickKids ED, primary health care providers, ambulatory services, and walk-in clinics. Patients made a median of 3 visits (range, 2–7 visits) to any facility before diagnosis. In 2 patients, the diagnosis was made at the sixth and seventh visits, respectively. Nine patients (90%) had antibiotics prescribed for community-acquired pneumonia, 6 of whom had >1 course of antibiotics.

We identified 17 contagious visits to the SickKids ED by the 10 patients. Airborne precautions were instituted in 7 visits (41%) and droplet/contact precautions in 4 visits (24%). Reported symptoms were cough in 10 (100%), night sweats in 9 (90%), fever in 7 (70%), chest pain in 7 (70%), weight loss in 6 (60%), and hemoptysis in 3 (30%) (Table 1). All 3 patients with hemoptysis were placed in airborne isolation. Five of the 6 patients (83%) who reported 4 or more of classical TB symptoms (cough, fever, night sweats, weight loss, and hemoptysis) were isolated as compared with 1 of 4 patients (25%) with fewer symptoms \((P = .02)\). All 9 patients with recorded symptom durations had at least 1 symptom for >2 weeks (Table 1).

The TB patients had a median body mass index (BMI) on the 47th percentile, (range, 10th–92nd percentile). Recorded examination findings included wheeze (2 cases), crackles/crepitations (4 cases), and focal reduced air entry (2 cases). One patient had intra-abdominal involvement and another a draining peripheral lymph node.

Chest radiographs were obtained in all patients. All were abnormal; 7 patients (70%) had upper lobe airspace disease (1 had evidence of cavitation), and 4 patients (40%) had pleural effusions (Table 1).

No sputum samples were collected in the ED. Sputum was collected a median of 7 days (range, 1–66 days) from the first symptomatic ED visit; 4 by induction, 1 by spontaneous expectoration, and 5 by both methods. Seven patients had sputum specimens that were positive on smear for acid-fast bacilli (Table 1); of these, 6 of 7 (86%) had upper lobe airspace disease.

Following the first SickKids ED visit, 5 patients were discharged with instructions to return to the ED (2 patients) or see their primary care provider (2 patients) if not improved, or with no follow-up instructions (1 patient). Five patients were admitted: 2 with suspected pulmonary TB and 3 for workup of a pleural effusion, neck mass, and an abdominal mass.

### Comparison Sample of Patients With Pneumonia

Of the 101 nonduplicate visits for pneumonia during 2019 identified through the ED electronic medical records, 35 (35%) patients had medical complexity or conditions predisposing to pneumonia (27 [75%] complex neuromuscular conditions, 6 [17%] immunocompromise or sickle-cell disease, and 2 [8%] bronchiectasis). Eighteen (27%) of the remaining 66 patients had normal chest radiographs, leaving a comparison group of 48 patients. For this group the median duration of fever was 6 days (IQR, 3 days; range, 1–14 days) and of cough 7 days (IQR, 3 days; range, 1–84 days) (Table 2 and Supplementary Table 2). One patient (2%) had fever for >10 days and 4 (9%) had cough for >14 days.

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**Table 1. Demographics, Clinical Features, and Results of Investigations of Patients Presenting to the Emergency Department With Undiagnosed Infectious Tuberculosis**

| Characteristic                  | Patients, No. (%) | Symptom Duration Recorded, No. | Median Duration (Range) | Duration ≥2 Weeks, No. |
|--------------------------------|-------------------|-------------------------------|-------------------------|------------------------|
| **Presenting symptoms**        |                   |                               |                         |                        |
| Cough                          | 10 (100)          | 9*                            | 3 wk (2–17 wk)          | 9                      |
| Fever                          | 7 (70)            | 5                             | 3 wk (1–13 wk)          | 6                      |
| Chest pain                     | 7 (70)            | 5                             | 3 wk (2–10 wk)          | 5                      |
| Weight loss                    | 6 (60)            | 6                             | 10.5 wk (1–17 wk)       | 6                      |
| Hemoptysis                     | 3 (30)            | 3                             | 2 d (1–4 d)             | 0                      |
| Night sweats                   | 9 (90)            | 3                             | 3 wk (2–3 wk)           | 3                      |
| **Tuberculosis risk factors**  |                   |                               |                         |                        |
| Birth abroad                   | 9 (90)            |                               |                         |                        |
| Parents born abroad            | 10 (100)          |                               |                         |                        |
| **Radiographic findings**      |                   |                               |                         |                        |
| Upper lobe disease             | 7 (70)            |                               |                         |                        |
| Consolidation                  | 8 (80)            |                               |                         |                        |
| Pleural effusion               | 4 (40)            |                               |                         |                        |
| Intrathoracic adenopathy       | 1 (10)            |                               |                         |                        |
| Cavitary lesions               | 1 (10)            |                               |                         |                        |
| **Microbiology results**       |                   |                               |                         |                        |
| Positive smear                 | 7 (70)            |                               |                         |                        |
| Positive culture               | 10 (100)          |                               |                         |                        |

*One patient with unrecorded cough duration had fever duration >2 weeks.*

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Radiologically, 9 of 48 patients with pneumonia (19%) had upper lobe airspace disease. None had cavitary disease.

The effects of different criteria for isolation during 2019 are shown in Supplementary Table 2. The presence of fever for 10 days or more would lead to isolation of 1 (2%) pneumonia patient and of cough for 14 days or more to the isolation of 4 (8%) pneumonia patients. Upper lobe airspace disease occurred in 9 pneumonia patients (18%), 1 of whom had >10 days of cough. Three TB patients in the study would not be isolated if upper lobe disease was the sole criterion used.

**DISCUSSION**

We identified 10 cases of infectious pulmonary TB presenting to a busy pediatric ED in a low-TB-burden setting over a 14-year period. Although a rare event, airborne isolation was not instituted in approximately 60% of SickKids ED visits, resulting in exposures of staff and patients. Delayed diagnosis also may have contributed to community spread.

Nine of 10 patients were born in a high-TB-burden setting and all had a foreign-born parent. During clinical evaluation these epidemiologic risk factors should heighten suspicion for TB.

Symptom duration differentiated TB patients from pneumonia patients with excellent sensitivity and specificity. The median duration of most symptoms in TB patients prior to the ED visit was 3 weeks; all had a symptom duration of 2 weeks or longer. Only 1 of the comparison group of ED patients with pneumonia had fever for >10 days and 4 had cough for >14 days. Those who presented with hemoptysis were appropriately isolated, but this represented only 30% of patients.

Physical signs were not discriminating. Tuberculosis is associated with lower BMI [9]; however, most had an average BMI, and 3 were overweight. Many patients had crepitations or reduced air entry, signs found in bacterial pneumonia.

Upper lobe involvement on chest radiograph has helped differentiate community-acquired pneumonia from TB in adults [10] and was found in 7 of our patients (70%), 6 of whom had smear-positive disease, the most infectious form of pulmonary TB. In contrast, 9 of 48 (19%) patients with pneumonia had upper lobe involvement.

Most patients had smear-positive sputum, when obtained. Obtaining sputum either in the ED or soon after the visit would have expedited diagnosis [11].

Triage protocols for isolation and TB evaluation of adolescents based on symptom duration would help reduce TB exposure and aid diagnosis: given the rarity of TB in low-TB-burden settings, implementation in a busy ED requires further evaluation. A greater availability of airborne isolation rooms in EDs would assist with TB and other airborne pathogen containment, which may then allow for sputum samples to be safely obtained to accelerate diagnosis.

This study has several limitations. It is retrospective and not all symptoms were recorded in the ED record. The number of cases with TB is small. The comparison convenience sample of patients with pneumonia attended the ED over a single year in the pre–COVID-19 era: this may not be representative of other years. The diagnosis of pneumonia was clinical, and we do not have confirmatory culture results, follow-up, or epidemiologic data for these patients. The study occurred in a large tertiary ED in a low-TB-burden setting, limiting its generalizability. Our findings do not apply to younger children who may have nonspecific symptoms and paucibacillary intrathoracic disease. However, our data may be useful for pediatric emergency physicians who are not used to manifestations of TB in adolescents and adults.

Prolonged symptoms and the presence of upper lobe airspace disease should heighten suspicion of TB in adolescents. Based on our findings, we believe that adolescent patients with suspected pneumonia who have cough for >13 days or fever for >10 days should be isolated and evaluated for TB disease, as should those with upper lobe changes and a prolonged cough. Both interventions would not place large burdens on isolation

### Table 2. Comparison of Patients With Undiagnosed Tuberculosis and Those With Pneumonia Attending the Emergency Department

| Symptom                           | Tuberculosis (n = 10) | Pneumonia (n = 48) | OR (95% CI) | P Value |
|-----------------------------------|-----------------------|--------------------|-------------|---------|
| Fever                             | Cases with duration recorded 7 (70%) 44 (93%) ... | ... |
|                                  | Duration, d, median (range) 21 (7–91) 6 (1–14) ... < .0001 | ... |
| Cough                             | Duration ≥14 d 7 (86%) 1 (2%) ... < .0001 | ... |
| Radiological findings             | Upper lobe air space disease 7 (70%) 9 (19%) 10.1 (2.1–46) < .003 |

Data are presented as No. (%) unless otherwise indicated.

Abbreviations: CI, confidence interval; OR, odds ratio.
facilities. While these algorithms should be prospectively evaluated, their development would likely improve patient and health care worker safety and lead to earlier diagnosis of adolescents with infectious TB.

Supplementary Data
Supplementary materials are available at Open Forum Infectious Diseases online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes
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