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Delayed tuberculosis diagnosis and costs of contact investigations for hospital exposure: New York City 2010 – 2014

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Abstract

Background—A delayed diagnosis of tuberculosis (TB) in the hospital may lead to nosocomial exposure, placing employees and other patients at risk. A lack of prompt infection control measures for suspected cases at the time of admission may require complicated and expensive contact investigations. The purpose of this study was to estimate the person-hour costs required by infection control staff to investigate a single hospital-based TB exposure.

Methods—Electronic data were extracted from two tertiary hospitals and one community hospital in a large healthcare system in metropolitan New York City to identify pulmonary TB cases unsuspected at admission. All cases were reviewed by infection prevention & control (IPC) staff to identify exposures.

Results—From 2010 – 2014, 34 pulmonary TB cases which necessitated a contact investigation were identified. IPC staff calculated an average of 15–20 hours of work per exposure plus 30 minutes of follow-up for each exposed staff member. For exposures, time from admission to isolation averaged 3.3 days with a mean of 41 staff exposed per patient and an approximate resource usage of 38 person-hours.

Conclusion—Contact investigations are costly to the healthcare system. In a low-prevalence country such as the US, it is still important that healthcare providers are trained to "think TB".

Keywords

Tuberculosis; Disease Outbreak; Delayed Diagnosis; Infection Control

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In New York City (NYC), the incidence of tuberculosis (TB) has been steadily decreasing since a peak in the mid-1990s.[1] One negative consequence of this otherwise positive trend is that healthcare providers have less experience with TB and thus have a lower index of suspicion, which may lead to a delayed or missed diagnosis.[2] Further, not all TB patients present with the classic symptoms of coughing and chest pain, but may present with more generalized symptoms of fever and weight loss.[3] This may also lead to a delay in treatment and placing the patient on airborne isolation.[4] Previous studies have indicated that delayed diagnosis is the principal cause of nosocomial TB transmission.[5–8] With a rate of 7.1 cases per 100,000 persons, NYC continues to be a higher burden region compared to the US national rate of 2.96 per 100,000, requiring clinicians to maintain a high index of suspicion for TB.[1]

The Centers for Disease Control & Prevention (CDC) indicate that a contact investigation should be performed if the presumed index patient was determined to have confirmed or suspected pulmonary, laryngeal, or pleural TB and appropriate isolation precautions were not taken at the time of hospital admission.[9] Necessary infection control measures include placing a surgical mask on the patient prior to their admission into an airborne isolation room with negative pressure and N-95 masking by healthcare professionals.[10] Once TB exposure is presumed, a complicated and resource-intensive contact investigation often ensues.

There is a scarcity of research on the resources required by the healthcare system when a TB exposure is identified. The specific aims of this retrospective study were to identify hospital-based TB exposures documented over a four-year period in an urban hospital system and estimate the person-hours required to conduct a hospital-based contact investigation for each exposure.

METHODS

Study design

To first identify exposures, we conducted a retrospective analysis of adults with culture-confirmed pulmonary TB admitted between January 2010 through December 2014 which were unsuspected at hospital admission.

Identification of TB cases

Electronic data were extracted from two tertiary hospitals and one community hospital in a large healthcare system in Manhattan. All three hospitals were under the same healthcare system and therefore followed the same Infection Prevention & Control (IPC) procedures for exposure management. Two sources of data were utilized to conduct the retrospective review of the medical records. The first was a database of > 500,000 discharges from the healthcare system collected between 2010–2014 as part of a National Institutes of Health-funded study (5R01NR010822). The second source of data were the hospital medical records, including microbiology results, and the IPC Department personnel and exposure records.

Inclusion criteria for first database: persons were classified as “TB-positive with unsuspected diagnosis at hospital admission” if culture-positive for TB and placed on the anti-TB regimen of at least isoniazid and rifampicin more than three days following admission. The CDC recommends that drug therapy should be initiated before smear and culture results when clinical suspicion for TB is high,[11] therefore the absence of anti-tuberculosis treatment within 3 days of admission was used as a possible indicator of delayed diagnosis. Exclusion criteria for first database: extrapulmonary TB, non-mycobacterium TB, or <18 years of age. Extrapulmonary TB and pediatric cases were excluded due to a decreased likelihood of infectivity.[9] Analysis of the first database resulted in 59 cases of “TB-positive with unsuspected diagnosis at hospital admission” which were then compared to the second source of data, the IPC exposure records, to compile the final sample for the study. Inclusion criteria for second database: previous documentation of an exposure work-up by the IPC department. The TB exposure identification process used by the IPC department is provided in the following section. From the second data source, we collected data on time from hospital admission to airborne isolation, time to TB diagnosis, acid fast bacilli (AFB) status, and number of staff exposed per patient and roommates exposed, if available.

Clinically, the TB identification process at the study site involves taking three sputum samples a minimum of eight hours apart, with at least one in the early morning. Sputum samples are sent for AFB smear and culture. Smear results return in one day and culture results can take up to six weeks. Positive AFB smear are automatically sent for nucleic acid amplification test (NAAT) using the Cepheid Xpert MTB/Rif, as well as negative smears with a high index of suspicion from the clinician. NAAT results are also available in <24 hours. For the purposes of this study, the day of positive TB identification comes from either the NAAT or culture results.

Identification of TB exposures

Hospital-based TB exposures are discovered retrospectively. Once a patient who was not suspected to have TB at admission is diagnosed TB-positive by culture or NAAT, IPC staff review medical charts to determine if the case qualifies for a TB exposure. TB exposure is defined as a patient with (1) high infectivity who was not placed on airborne isolation precautions within an hour, or (2) low infectivity who was placed on precautions within eight hours. The NYC Department of Health (DOH) considers an exposure to be eight hours or greater without appropriate airborne precautions, but the study institution has a more conservative approach for exposure management by accounting for possible exposure in less than eight hours among highly infective patients.[12] The IPC Department defines high infectivity as individuals who have an AFB-positive smear and/or cavitary disease and low infectivity as individuals who are AFB-negative and have no indication of cavitary disease. Additional considerations of degree of infectivity include symptomology of patient (i.e., active coughing) and whether or not staff came in close contact with the patient. Close contact was defined as any activity that required direct care of patients. The CDC lists healthcare workers with unprotected exposure to a patient with TB disease before the identification and correct airborne precautions of the patient as high risk for exposure.[9] These considerations enable the IPC department to determine which staff to include in

exposure work-ups. Once a TB exposure is confirmed by an IPC practitioner, an extensive review of the index case medical records and microbiology reports are completed. Exposures are followed three months back to determine if the patient had a past admission within the healthcare system. The exposure management approach is discussed with the hospital epidemiologist, and the case is reported to the NYC DOH, with serious cases reported to the State.

Person-hour costs of exposure

The IPC staff manage investigations of all suspected TB cases and possible staff exposures using a multidisciplinary approach. The infection preventionist completes an extensive chart review to extract names of staff contacts documented in the electronic medical records. Once complete, the names are forwarded to occupational health and the patient care director of the unit. The director is asked to identify those staff members who may have been exposed but did not chart in the electronic medical record. Once the list is completed and exposure is confirmed, IPC personnel e-mail to all exposed staff members a document explaining the exposure management process and a date for their post-exposure management visit. At this time, IPC staff often field questions from concerned staff members. The IPC staff also identify roommates, visitors, and any other potentially exposed patients and provide this information to the DOH for follow-up after hospital discharge.

Once the initial correspondence with exposed staff has occurred, the occupational health team takes over, logs approximately 30 minutes of time per assumed staff exposure, and conducts TB testing within the window period of 8–10 weeks after the last date of the exposure. The follow-up includes placement and reading of the purified protein derivative (PPD) TB skin test. Staff members with a history of being PPD-positive require an occupational health visit and an 8–10 weeks post-exposure visit to determine whether the staff member is symptomatic for TB.

There was a lack of literature on previous methods to calculate the person-hours required to investigate a single hospital-based TB exposure. To estimate the person-hours for this study, IPC staff individually wrote a list of activities required during a typical exposure investigation along with the approximate time for each task. Lists of activities and time were compared and discussion ensued until agreement was reached.

RESULTS

Over a four-year period, we identified 59 cases of pulmonary TB meeting our inclusion criteria. Of these, 34 had been recorded as exposures in the IPC data (Table 1). The remaining 25 cases were those that had not started anti-TB treatment >3 days after admission, but had been placed on airborne isolation <8 hours after admission, therefore they did not meet the definition for an exposure. On average, it was 3.3 days (range: 0 – 25 days) between date of admission and placement on airborne isolation across the three facilities. The number of hospital staff exposed ranged from 2 – 197, with an average of 41 staff members requiring follow-up per TB patient. In most cases, no hospital roommates were exposed, but this ranged from 0 – 9 roommates per TB patient. Average time from admission to diagnosis of TB was 5.1 days.

Diagnoses among patients admitted with unrecognized TB

The admitting diagnosis documented by the physician varied among the 34 cases, with a lung mass or lesion as the most common diagnosis (5, 14.7%). This was followed by pneumonia (4, 11.8%) and non-descript symptoms such as fever (4, 11.8%) or chest or abdominal pain (4, 11.8%). In three cases, TB was the admitting diagnosis at the hospital, but these were still included in the final analysis because they required exposure work-ups. Two cases were due to a missed TB diagnosis at a prior admission within the same healthcare system in the past three months and the third case was placed on droplet isolation precaution instead of airborne isolation precaution at the time of admission. Of the 32 cases from whom we had the AFB results, 14 (43.8%) cases were AFB smear-negative, culture-positive.

Calculating person-hour cost of average exposure

Using the staff estimates, each suspected exposure required approximately 15–20 person-hours over a 1–2 week period by the IPC staff (Table 2). An average exposure required approximately 17.5 hours from the IPC staff, followed by 30 minutes per staff member by occupational health. Using an average of 41 staff per exposure, the time required by occupational health was 20.5 hours, and combined with the 17.5 hours per exposure conducted by the IPC staff, an average total of 38 person-hours was required for a single TB exposure.

DISCUSSION

With an additional workload of almost 40 hours for an average TB exposure case, we have demonstrated the potential burden to a healthcare system when TB is missed as a possible diagnosis. Among our sample, very few additional patients were considered at risk for transmission from the exposures, but in hospitals with multi-bed units, such patient exposures would certainly be higher. On the other hand, high numbers of staff were at risk. Although we did not identify staff exposures by discipline, others have demonstrated that among healthcare workers, nurses have been shown to have the highest rates of latent and active TB infection following exposure.[13,14] This is unlikely due to the discipline of staff members, but rather the level of contact with the patient.

Our findings suggest that clinicians should still consider a TB diagnosis even with smear-negative AFB results. Although considered less of an exposure risk, previous studies have confirmed the potential for transmission from smear-negative index cases.[6,9,15] Our results also support previous studies indicating that TB may be present even when more generalized symptoms such as fever and localized pain are the only symptoms present.[3]

Our finding of an average of 3.3 days from admission to isolation was shorter than other studies that had documented hospital-based TB exposures.[6] This was likely due to the more conservative definition of exposure used in our hospital system.

A limitation of this study is the inclusion of a single healthcare system in a large metropolitan area; results may not be generalizable to smaller facilities or those in rural areas, but the hours required for investigation of a single exposure are likely to be

representative. In this acute care system, policies err on the side of caution by including in the exposure workup any staff member who may have had only minimal contact with the index patient, but still expresses concern. Further, person-hours were retrospective estimations from staff and, as such, provided a subjective measurement with a risk for recall bias. Every attempt was made to confirm the date of TB diagnosis and airborne isolation, but in 7 cases, one of these variables was missing. This may have led to over-or under-reporting of the number of staff or roommates exposed. But for the sake of this analysis, we only needed to know the number of staff who were followed as part of the contact investigation to calculate person-hours. Finally, estimates in this study included only those resources and time requirements incurred by investigation of staff contacts; potential exposures among other patients were not included.

In summary, it is beneficial for clinicians to have a suspicion of TB, even in low-prevalence regions.

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Table 1

Exposures in chronological order

Exposure No	Admitting Hospital Diagnosis	Days from Admit to Isolation	Days from Admit to TB Diagnosis	AFB Status	Roommates Exposed	Staff Exposed
2010						
1	Pneumonia	4	10	+	0	39
2	HIV/Pneumonia	1	1	+	0	5
3	Pulmonary emboli	2	0	−	N/A	101 *
4	Chest pain	4	3	+	0	13
5	Cancer work-up	N/A	5	−	3	24
2011						
6	Lung nodule	0	0	+	0	38
7	TB †	1	0	−	N/A	53 *
8	Dysuria	9	8	+	0	69
2012						
9	Cough	1	1	+	0	6
10	Lung cancer	0	N/A	−	N/A	74 *
11	Atypical chest pain	3	5	−	0	59
12	Epigastric pain	N/A	0	+	0	65
13	Nausea	25	13	+	8	197
14	Altered mental status	3	5	−	2	75
15	Respiratory distress	0	1	+	0	9
16	Caustic ingestion	2	2	−	1	20
2013						
17	Cavitary lung lesion	0	0	+	1	9
18	Neutropenic fever	1	4	+	N/A	53
19	Headache	N/A	21	N/A	9	24
20	Fever	N/A	16	−	0	93

Exposure No	Admitting Hospital Diagnosis	Days from Admit to Isolation	Days from Admit to TB Diagnosis	AFB Status	Roommates Exposed	Staff Exposed
21	Aortic stenosis	4	10	+	1	66
22	Pneumonia	1	1	−	0	15
23	TB[†]	0	N/A	N/A	0	6[*]
24	Lung mass	N/A	0	−	0	5
25	Fever	4	5	+	0	39
26	Ascites	17	21	−	3	85
2014						
27	TB[§]	1	0	+	0	15
28	Pneumonia	1	4	−	0	19
29	Altered mental status	1	2	−	0	17
30	Lung mass	0	1	+	0	18
31	Abdominal pain	4	N/A	+	0	20
32	Aortic aneurysm	4	9	−	0	17
33	Lung nodule	0	3	+	0	2
34	Fever	4	6	+	0	31

N/A=data not available

[*] Includes staff exposed from prior admission within same healthcare system in past 3 months

[†] Exposure work-up from prior admission in same healthcare system

[§] Was incorrectly placed on droplet isolation instead of airborne isolation

Table 2

Estimated person-hours for each suspected TB exposure

Infection prevention & control activity	Approximate time allotted per index case
Extensive chart review	8–10 hours
Compile exposure list	4–6 hours
Staff notifications	3–4 hours
Total estimated hours per exposure	**15–20 hours**