Self-assessment of Tuberculosis Infection Risk by Urban Adolescents

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Objective: To examine self-reported risks for tuberculosis (TB) infection relative to recalled receipt of TB risk assessments and skin testing in a cohort of urban adolescents.

Design, Setting, and Participants: Survey of ninth graders and their parents from 3 inner-city public high schools. Students and parents were asked about TB infection risk factors, frequency of routine health maintenance visits, TB risk assessments, and TB skin testing. Students were surveyed in schools and asked to take home surveys for their parents to complete.

Results: Of 578 students (95.4% response rate), 436 (75.4%) claimed at least 1 TB infection risk factor. Although 468 (81.0%) of the students reported having a regular checkup within the past year, only 128 (22.1%) recalled undergoing TB risk assessment questions and only 231 (40.0%) recalled undergoing skin testing during the previous year. Parent response rates were low (n=207; 34.2% response rate), and parents of students attending bilingual classes were overrepresented among responders. There were no significant relationships between self-indicating a risk for TB infection and self-recollection of having undergone TB screening, having had a tuberculin skin test placed, or having had a regular checkup, with the exception that students who responded that they lived with a tuberculin skin test–positive person were 38% less likely to recall having had a tuberculin skin test themselves (n=21; 95% confidence interval, 24%-50%). The level of agreement between student and parent responses in the 207 survey pairs available for analysis ranged from poor to good (κ=0.07-0.61) on individual questions.

Conclusions: These observations suggest that most at-risk adolescents in this city are not being adequately screened for TB infection. Programs to improve health care provider acceptance of targeted testing principles or to reengage in school-based screening of students with certain risk factors seem necessary.

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In the early 1990s, the American Academy of Pediatrics (AAP)1,2 and the Centers for Disease Control and Prevention3 revised recommendations on screening for tuberculosis (TB) in children in an effort to improve the predictive value of testing for TB in a low-risk population. Universal screening in public schools was abandoned in favor of a more selective approach of tuberculin skin testing (TST) of only children deemed to be at higher risk for TB infection. Children at high risk include contacts of persons with active TB, immigrants from regions of the world with a high prevalence of TB, and those at risk for progression from infection to disease, such as children infected with the human immunodeficiency virus or those with chronic conditions such as diabetes mellitus, renal failure, malnutrition, or other immunodeficiencies. Cost-benefit analyses supported this targeted screening of high-risk schoolchildren as “much less costly than mass screening” and “more efficient in prevention of tuberculosis.”

The predicted success of this targeted testing approach depended on assumptions that routine health care evaluations would (1) regularly occur for all children, (2) consistently include assessment of risk of exposure to TB, and (3) be performed by practitioners knowledgeable about the local epidemiological characteristics of TB.1,2,4 However, at least 2 lines of evidence questions these assumptions. In a recent survey4 of 762 responding community-based physicians located in the mid-Atlantic region of the United States, 75% were aware of the 1994 AAP recommendations on TB screening in children, but only 22% adhered to recommendations regarding frequency, testing method, and reading the test reaction. In a sample of 199 urban adolescents (age range, 12-18 years) recruited from pub-
Know Your TB Risk Factors!

This VOLUNTARY and ANONYMOUS questionnaire will help you find out if you are at ANY risk for tuberculosis (TB). You do not have to complete any part of this form if you do not want to. Your answers will not affect your school involvement or performance. However, your answers will help Boston's TB Control Program find out how cases of tuberculosis are diagnosed. The letter-number combination in the right hand corner of this survey only matches your answers to your parent's answers on a similar survey. Nothing links your or your parent’s answers to your names.

TB is caused by a germ that is spread from one person to another person through the air. If you come into contact with the TB germ, you are at risk for becoming ill from TB. However, finding the infection early and treating it with medications can stop the disease before you get sick.

Please mark only one box per question.

- Do you spend time with anyone who is sick with TB?
- Does anyone living with you have a “positive” TB skin test (PPD)?
- Does anyone living with you come to the US from another country?
- Did you ever travel outside of the US?
- Do you spend time with people...
  - who live in a hospital, nursing home, halfway house, or prison? OR
  - who are homeless or living on the street? OR
  - who inject or use street drugs? (contact with these people increases your risk of TB)
  - who have AIDS or are HIV infected? OR
  - who have never received TB screening?
- Were you asked questions like these in the past year?
- Have you seen a doctor or nurse for a regular checkup in the past year?
- Have you had a TB skin test (PPD) placed in the past year?
- Do you live with people...
  - who have a family member who has TB?
  - who are homeless or living on the street?

If you answered yes to ANY CIRCLED question, you may be at risk for TB infection. We strongly recommend that you go to the school nurse, school health center, or your health care provider to get more information.

Do you have questions for us? Call the TB Information Line at 534-4875 on weekdays between 9 am and 5 pm to speak to a nurse or doctor with Boston's TB Control Program.

Get screened! Get tested! Fight TB!

Student questionnaire used for the identification of ninth graders at increased risk of acquiring tuberculosis. HIV indicates human immunodeficiency virus; US, United States.

lic middle and high schools, only 70% of students even reported having seen a physician in the past year.7

Risk assessment questionnaires to identify children at higher risk for TB infection have recently been validated.8-10 In Rochester, NY, which had a low TB case rate (4.4 per 100000 population), similar to that of Boston in 2001 (4.3 per 100000 population),11 a self-administered survey extrapolated from AAP recommendations had a sensitivity of 100%, a specificity of 34.8%, a positive predictive value of 2.0%, and a negative predictive value of 100% compared with TST, when administered to the parents of 401 children (aged 1-18 years) during annual health maintenance visits. To our knowledge, a pediatric study has yet to examine the validity of administering TB infection risk assessment questionnaires directly to adolescent patients.

The identification of 2 cases of active TB within the Boston Public Health system in 1999 prompted the Boston Public Health Commission to take a closer look at the diagnosis and management of TB infection in the era of selective screening. It was ultimately determined that both patients had undergone appropriate TST but developed active disease because of incomplete therapy for latent TB infection (LTBI); however, more relevant to our study, a contact investigation of the 2 patients revealed poorly documented TB risk assessments in many fellow students. The purpose of this study was, therefore, to describe TB risk assessments and health care use in Boston ninth graders through the use of self-administered TB infection risk assessment questionnaires. Ninth graders were selected for participation because this is a grade level in which health education is taught within Boston public high schools, and a secondary goal of this study was to educate high school students about TB and disseminate information about the Boston Public Health Commission’s TB Control Program. We hypothesized that many adolescents at highest risk for TB might not be screened for risk of TB infection because this same population might have poor access to primary care providers mandated to perform the screening.

METHODS

STUDY DESIGN

We performed a multisite survey of Boston public high school ninth graders and their parents in March 2000. Approximately 1 week before survey administration, consent forms for study participation were disseminated by school administrators to all ninth graders at 3 Boston high schools and to their parent or guardians. Students had a choice of English, Spanish, Portuguese, Haitian Creole, Vietnamese, and Chinese consent forms (reflective of the ethnicities in this population), and were directed to carry these forms home. Parents or guardians were asked to sign and return these forms to the school administration if they chose not to participate or have their child not participate in the TB exposure risk survey. Following 1 week, the same study investigator (K.H.) surveyed all individual ninth-grade classes by visiting each class in turn, reading the standardized survey form (or having the bilingual teacher read the appropriate language survey if applicable), and collecting surveys after they were completed by the students. All ninth-grade students then were asked to take home an appropriate language survey for their parent or guardian to complete and return to each classroom drop box within 1 week. The student surveys were linked with the corresponding parent surveys using a paired numbering system, without the use of personal identifiers. All participating ninth graders in classrooms with the highest parent survey return rates at each school were given $10 gift certificates to a record store as an incentive. This study was approved by the Institutional Review Board of Boston University Medical Center. The involved school administrations also approved all forms used for the study.

STUDY SITES

Three Boston public high schools were selected for participation in the study because each of these 3 sites had an on-site school-based health clinic actively engaged in student health education and were, therefore, amenable to participation in this study. Also, these sites were selected because they covered a spectrum of school enrollment sizes. Each site served grades 9 through 12. Of the 3 sites, 2 included bilingual education programs for Spanish-, Portuguese-, and Haitian Creole-speaking students.

QUESTIONNAIRE

The questionnaire was designed to identify children at increased risk of acquiring TB, based on risk factors delineated by the AAP.2 Specifically, separate anonymous 1-page surveys were designed for administration to ninth graders (Figure) and...
their parents or guardians. The Flesch-Kincaid reading level of the survey was grade 5.6 for the students and grade 6.4 for the parents or guardians. Questionnaires were translated into Spanish, Portuguese, Haitian Creole, Vietnamese, and Chinese. At the top of the forms, the voluntary and anonymous nature of the questionnaire was reemphasized, and some information about TB transmission and the effectiveness of treating LTBI was provided. The first 3 questions on each survey were designed to identify risk factors for TB infection. The last 3 questions assessed recall of having been asked these questions, having been seen for a regular checkup, and having undergone a TST within the year before the survey. At the bottom of each form, information was given to study subjects about what to do if they answered affirmatively to having been at risk for TB exposure. This information included a telephone number for the Boston TB Control Program Information Line.

STATISTICAL ANALYSIS

Data from the 3 schools were analyzed in aggregate. Frequencies, χ² statistics, and κ statistics (to evaluate interrater reliability in each parent-child dyad) were calculated using SAS statistical software, version 6.12 (SAS Institute Inc, Cary, NC).

RESULTS

SURVEY POPULATION

During the spring semester of 2000, no active cases of TB were reported in the Boston public high school system. Nine hundred sixty-nine ninth graders were enrolled in the participating high schools. Eleven negative consents were returned by parents or guardians. Only 606 (62.5%) of the students attended class on the days their classrooms were surveyed. In total, 578 (95.4% of the students attending) student and 207 (34.2%) of parents attending) parent surveys were completed and collected by the study investigator (K.H.). Although no specific demographic markers were used in the study questionnaire, certain markers were known for the ninth graders enrolled in the participating high schools (Research Department, Boston School Department). The demographic characteristics at the 3 participating high schools reflected a higher concentration of black and Hispanic students, a lower concentration of white and Asian students, and more students enrolled in bilingual classes, compared with students enrolled in the Boston public high school system at large in the spring of 2000 (Table 1).

SURVEY RESPONSES

Survey answers to TB infection risk factors and health maintenance are indicated in Table 2. Of student respondents, 73.4% (436/578) claimed at least 1 TB infection risk factor (any yes answer to questions 1-5); of students who answered affirmatively to having at least 1 TB infection risk factor, 40.1% (175/436) recalled undergoing skin testing the previous year. Overall, only 22.1% of all student participants recalled being asked TB risk assessment questions, and only 40.0% of all student participants recalled undergoing skin testing during the previous year, despite 81.0% of all student participants recalling an annual checkup. Of the 468 students who recalled an annual checkup, 111 (23.7%) remembered being asked TB infection risk questions.

An analysis of parent responses to TB infection risk factor and health maintenance questions was not completed because of biases inherent in poor parent survey return rates and disproportionately increased return rates from parents of students enrolled in bilingual education classes (60 [29.0%] of 207 parent surveys and 113 [19.6%] of 578 student surveys were from bilingual classes, which was significantly different [P < .005, χ² statistic]). However, we did examine student and corresponding parent responses for level of agreement, which ranged from poor to good, for different questions (Table 2). When analyzed for agreement on whether the student was positive for any TB infection risk factor, students were in fair agreement with their parents (κ = 0.58).

STATISTICAL ANALYSIS

Individual affirmative or negative replies to TB infection risk questions (questions 1-5) were not significantly associated with either increased or decreased recall of health maintenance variables (questions 6-8). The one exception was if student survey respondents replied yes to living with a TST–positive person (n = 21), they were 38% (95% confidence interval, 24%-50%) less likely to recall having had a TST themselves in the previous year.

COMMENT

Although targeted screening for LTBI in pediatric populations remains the current recommendation by the Centers for Disease Control and Prevention and the AAP, it is

Table 1. Characteristics of Boston, Mass, Public High School Ninth Graders*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Participating Schools (n = 969 Enrolled)†</th>
<th>Boston Public High Schools Overall (n = 5310 Enrolled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex</td>
<td>481 (49.6 [46.5-52.8])</td>
<td>2701 (50.9)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>551 (56.9 [53.7-60.0])</td>
<td>2642 (49.8)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>308 (31.9 [28.9-34.8])</td>
<td>1312 (24.7)</td>
</tr>
<tr>
<td>White</td>
<td>69 (7.1 [5.7-8.9])</td>
<td>886 (16.3)</td>
</tr>
<tr>
<td>Asian</td>
<td>37 (3.8 [2.8-5.2])</td>
<td>464 (8.7)</td>
</tr>
<tr>
<td>American Indian</td>
<td>4 (0.4 [0.2-1.1])</td>
<td>24 (0.5)</td>
</tr>
<tr>
<td>Enrolled in a bilingual class</td>
<td>194 (20.0 [17.6-22.7])</td>
<td>668 (12.6)</td>
</tr>
<tr>
<td>Returned negative consent</td>
<td>11 (1.1)</td>
<td>NA</td>
</tr>
<tr>
<td>Attended the day of the survey</td>
<td>606 (62.5)</td>
<td>NA</td>
</tr>
<tr>
<td>Student participants</td>
<td>578 (95.4‡)</td>
<td>NA</td>
</tr>
<tr>
<td>Parent or guardian participants</td>
<td>207 (34.2‡)</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviation: NA, not applicable.

*Data are given as number (percentage) of those enrolled unless otherwise indicated.
†Data in brackets are 95% confidence intervals for the percentages.
‡Data are given as number (percentage) of those who attended the day of the survey.
The preference in the design of the survey was to err on the side of overcalling those who might be at risk for TB infection so that more students were instructed (at the bottom of the survey) to go to a health care provider to obtain additional information.

Our hypothesis, that adolescents at risk for TB might not be screened for risk of TB infection because this same population might have poor access to health care, seems to have been disproved by our study. Most students involved in this study did recall going for a regular checkup. Lack of skin testing was likely not due to the students having been lost to the health care system. Rather, the health care system might not have screened the student appropriately; of the 468 students who recalled seeing a physician or a nurse for a regular checkup, only 23.7% recalled being asked TB infection risk screening questions. This finding is in agreement with what was previously known about physician adherence to the 1994 AAP recommendations regarding TB screening in children.6

Recall bias could have affected our findings, because adolescents may have forgotten about TST or TB screening questions asked in the previous year. However, adolescents have been shown to be reliable self-reporters about receipt of preventive services, although reporting on items such as immunizations decreased from a sensitivity of 94% and a specificity of 86% within 2 to 4 weeks of the queried visit to a sensitivity of 68% and a specificity of 86% between 5 and 7 months postvisit.13 To confirm our results, it would be reasonable to review records of teenagers’ primary care visits or survey patients in waiting rooms immediately following their primary care appointments, thereby minimizing recall bias.

Differences in survey methods likely accounted for a much lower parent response rate. Students were surveyed in class settings during school hours. Despite verbal and written emphasis on the voluntary and non–school-related nature of survey participation, students probably completed the survey when they saw peers doing it during class. Although an incentive was offered to classes with the highest return rates on parent surveys, the incentive offered and the spirit of competition were insufficient to

### Table 2. Survey Responses

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Yes</th>
<th>No</th>
<th>Do Not Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spent time with someone sick with TB</td>
<td>15 (2.8)</td>
<td>353 (61.1)</td>
<td>207 (35.8)</td>
</tr>
<tr>
<td>Lived with someone PPD positive</td>
<td>21 (3.6)</td>
<td>408 (70.6)</td>
<td>143 (24.7)</td>
</tr>
<tr>
<td>Lived with someone from another country</td>
<td>291 (50.3)</td>
<td>262 (45.3)</td>
<td>20 (3.5)</td>
</tr>
<tr>
<td>Traveled outside of the United States</td>
<td>267 (49.7)</td>
<td>276 (47.8)</td>
<td>7 (1.2)</td>
</tr>
<tr>
<td>Spent time with someone at high risk for TB exposure†</td>
<td>151 (26.1)</td>
<td>375 (65.0)</td>
<td>28 (4.8)</td>
</tr>
<tr>
<td>Yes to any TB exposure risk factor</td>
<td>436 (75.4)</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>In the past year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asked questions like these</td>
<td>128 (22.1)</td>
<td>405 (70.1)</td>
<td>31 (5.4)</td>
</tr>
<tr>
<td>Saw MD or RN for regular checkup</td>
<td>468 (81.0)</td>
<td>70 (12.1)</td>
<td>24 (4.2)</td>
</tr>
<tr>
<td>PPD placed</td>
<td>231 (40.0)</td>
<td>165 (28.6)</td>
<td>167 (29.0)</td>
</tr>
</tbody>
</table>

Abbreviations: MD, doctor of medicine; PPD, purified protein derivative (tuberculin); RN, registered nurse; TB, tuberculosis.

†Someone who lived in a hospital, nursing home, halfway house, or prison; someone who was homeless or lived on the street; someone infected with AIDS or the human immunodeficiency virus; or someone who injected or used street drugs.

### Table 3. Interrater Reliability for 207 Parent-Child Dyads

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>κ Statistic*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spent time with someone sick with TB</td>
<td>0.25</td>
</tr>
<tr>
<td>Lived with someone PPD positive</td>
<td>0.22</td>
</tr>
<tr>
<td>Lived with someone from another country</td>
<td>0.47</td>
</tr>
<tr>
<td>Traveled outside of the United States</td>
<td>0.61</td>
</tr>
<tr>
<td>Spent time with someone at high risk for TB exposure†</td>
<td>0.32</td>
</tr>
<tr>
<td>Yes to any TB exposure risk factor</td>
<td>0.58</td>
</tr>
<tr>
<td>In the past year</td>
<td></td>
</tr>
<tr>
<td>Asked questions like these</td>
<td>0.15</td>
</tr>
<tr>
<td>Saw MD or RN for regular checkup</td>
<td>0.07</td>
</tr>
<tr>
<td>PPD placed</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Abbreviations: Explained in the first footnote to Table 2.

*κ: Less than or equal to 0, no agreement; κ: between 0.01 and 0.20, poor agreement; κ: between 0.21 and 0.40, slight agreement; κ: between 0.41 and 0.60, fair agreement; κ: between 0.61 and 0.80, good agreement; κ: between 0.81 and 0.92, very good agreement; κ: between 0.93 and 1.00, excellent agreement.

†Someone at high risk is defined in the third footnote to Table 2.
Identification of TB infection among adolescents seems to have declined in high-risk communities since universal TB skin testing was replaced by screening questions designed for health care provider use to determine risk. The proportion of this decline due to an appropriate decrease in false-positive test results vs an inappropriate loss of high-risk populations to screening remains unknown.

In our study of urban youth, we found a mismatch in which (1) ninth-grade students self-identified as being at risk for TB infection, yet did not recall undergoing a mandated annual TST; and (2) ninth graders and their parents were in varying levels of agreement on exposure to TB infection risk factors. Because most students surveyed claimed that they had undergone an annual checkup, lack of access to primary care was not likely to be the cause of low rates of TST. To improve identification of adolescents at risk for TB infection, programs to increase health care provider acceptance of targeted TST principles should be considered. Whether ninth graders or their parents are more reliable reporters of TB infection risk factors remains a question for further study.

Although respondent bias left us unwilling to analyze parent survey data for proportions of parents who believed their ninth graders to be at risk for TB infection or who recalled receipt of preventive health maintenance by their children, we were able to determine levels of agreement between responding parents and corresponding children. We suspect ninth graders might more accurately report TB infection risk factors such as spending time with individuals at higher risk for TB exposure, because parents might be unaware of all individuals their children interact with. However, our study was not designed to determine whether the parent or the student is the more reliable reporter of either TB infection risk factors or receipt of preventive health measures.

Finally, our sample population of 3 schools likely had more minority groups, compared with the Boston public high school system population at large. Of the 3 surveyed schools, 2 also had bilingual education classes. In those 2 schools, the bilingual classes had the highest return rates on parent surveys. Although school might be an excellent way to reach this population of high-risk adolescents, responses to the parent or guardian surveys were skewed by more participating bilingual families. Overall, the high percentages of minority students, students living with foreign-born household members, and students who travel outside of the United States make it difficult to generalize our study results to the Boston public school system, much less to nonurban less multicultural populations. However, in urban areas with many highly mobile or immigrant populations, an argument can be made for a return to universal TST of adolescents, using negative selection to exclude low-risk children.

It is easy to become complacent about an illness characterized by a latent stage of months to years following primary infection. Because reporting in the United States is only based on active disease, it is difficult to ascertain the true burden of LTBI, which would represent the reservoir from which future cases of TB arise. Our study suggests some pessimism, because it indicates that high-risk students may be lost to screening now that universal screening is no longer in practice. Public health measures need to focus on identification of, without discrimination against, local high-risk populations. Targeting at-risk populations improves the specificity of TST, but in practice, health care providers need to accept responsibility for performing risk assessments and then applying and reading TST results appropriately.

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We thank the many enthusiastic and supportive Boston, Mass, public high school administrators and teachers; the Boston Public Health Commission’s school-based health center providers involved in this study; and Stephen Pelton, MD, for his critical review of the study proposal and manuscript.

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REFERENCES