Collaboration With School Nurses

Improving the Effectiveness of Tuberculosis Screening

Cynthia W. DeLago, MD; Nancy D. Spector, MD; Beth Moughan, MD; Mary M. Moran, MD; Hans Kersten, MD; Laura Smals, MD

Objective: To compare tuberculosis skin test (TST) reading rates between children whose tests were read by school nurses following specific requests by physicians and those who relied on their parents to get their tests read, either at school or at the physician’s office.

Design: A randomized controlled trial.

Setting: An urban hospital-based pediatric practice.

Participants: Healthy low-income Hispanic and African American children aged 5 to 17 years whose physicians ordered TSTs at their routine physical examinations. Subjects attended 1 of 68 public schools. Nurses at these schools were willing to read student TSTs, and received instructions about how to read and report the results back to the physician’s office.

Intervention: Subjects were randomized to a control group (routine TST placement, with no physician–to–school nurse communication) or to an intervention group (routine TST placement, with physician–to–school nurse communication).

Main Outcome Measures: Tuberculosis skin test reading rates between the 2 groups were compared. Impediments to TST reading and reporting were investigated.

Results: One hundred thirty-four children were enrolled, 54 (40%) in the control group and 80 (60%) in the intervention group. More patients in the intervention group had their TSTs read by 72 hours compared with those in the control group (74 [92%] vs 30 [56%]; P < .001). The low reading rate in the control group was best attributed to communication failures.

Conclusion: Systematic collaboration with school nurses can increase TST reading rates.


TUBERCULOSIS (TB) is a serious health problem that disproportionately affects the poor. Eighteen thousand new cases of TB occur annually in the United States, and approximately 15 million people have latent TB infection. According to the Philadelphia Department of Health, the new case rate of TB in Philadelphia in 1996 was 20 cases per 100 000, with 10% of the cases occurring in children.

Our urban residency-based pediatric practice in Philadelphia is located in a high-prevalence area for TB. Many of our patients have additional TB risk factors, such as recent immigration from Latin America, close contact with prison inmates and drug-abusing adults, and homelessness. At the inception of this study, patients were screened for TB every 2 to 3 years. From September 1, 1999, to December 31, 1999, however, only 43% of school-aged patients who had tuberculosis skin tests (TSTs) placed by us had the tests read by a health professional (physician or school nurse) within 72 hours. This problem has been reported by other urban centers.2,3

The best way to screen for TB is with the TST or the Mantoux test. The Committee on Infectious Diseases of the American Academy of Pediatrics recommends targeted screening of high-risk groups.4,5 Before instituting targeted screening, we sought to find a way to improve the reading rate of the test in our population.

Cheng et al2 tested 5 strategies to increase TST reading rates in an urban population. All groups received verbal and written instruction about the TST. The group that only received this intervention demonstrated a reading rate increase of 13 percentage points. Two other strategies, completing school forms contingent on return for test reading and dispatching nurses to children’s homes to read TSTs, further increased reading rates to a
PARTICIPANTS AND METHODS

This study was conducted at an urban hospital-based pediatric practice serving predominately low-income African American and Hispanic children. The institutional review board at the MCP Hahnemann University School of Medicine, Philadelphia, approved the study protocol. We recruited healthy children between the ages of 5 and 17 years whose physicians ordered TSTs as part of their physical examinations. Only the first child encountered from each family was included, and the child had to be accompanied by a parent or guardian. Any child receiving the TST as part of a diagnostic evaluation for an illness was excluded. Children had to be enrolled at 1 of 68 participating public schools, which included 30 elementary, 12 middle, and 6 high schools. Many schools were involved because there are more than 150 public schools within an 8.0-km radius of the clinic. Parochial and private schools were not included. All schools had a nurse on site on Wednesday, Thursday, or Friday to read the TSTs placed Monday, Tuesday, or Wednesday.

Patients were enrolled from January 10, 2000, to May 31, 2000. School nurses from all 68 schools were recruited to participate at 1 of 4 group meetings arranged to explain the study protocol, collect school information, and review the proper TST reading technique. Instruction about the TST reading technique was based on recommendations by the American Thoracic Society, as described in an article by Seibert and Bass and depicted in a Centers for Disease Control and Prevention videotape. Nurses were shown this videotape during the meeting. Of the 68 nurses, 15 did not attend the meeting. They were enrolled individually by telephone. Information and diagrams based on the article by Seibert and Bass were faxed to these nurses.

At the inception of this study, little information existed about where our patients attended school. Initially, the 40 closest schools were enrolled. After several weeks, we realized many students were not being recruited because of school affiliation. Subsequently, 28 more schools with similar demographics and close proximity to the clinic were enrolled.

PATIENT RECRUITMENT PROCESS

The investigators (C.W.D., N.D.S., B.M., M.M.M., H.K., and L.S.) obtained written consent and interviewed parents or guardians about demographics from scripted questionnaires in either English or Spanish, with the aid of an interpreter. Eligible patients were randomly assigned to the control or intervention group by an allocation system using sealed opaque envelopes containing the group assignment. We anticipated an effect size of only 15 to 20 percentage points, necessitating a sample size of about 175 patients per group. Therefore, 350 envelopes were prepared, shuffled, numbered, and drawn in order, as each new patient presented.

After group assignment was made, instruction was given as follows: All parents were educated about the purpose of the TST and the importance of getting it read in a timely fashion. Parents were asked to bring the child back to the clinic area to review the proper TST reading technique. Instruction about the TST reading technique was based on recommendations by the American Thoracic Society, as described in an article by Seibert and Bass and depicted in a Centers for Disease Control and Prevention videotape.

After group assignment was made, instruction was given as follows: All parents were educated about the purpose of the TST and the importance of getting it read in a timely fashion. Parents were asked to bring the child back to the clinic area to review the proper TST reading technique. Instruction about the TST reading technique was based on recommendations by the American Thoracic Society, as described in an article by Seibert and Bass and depicted in a Centers for Disease Control and Prevention videotape.

RESULTS

SAMPLE GROUP DIFFERENCES

When we first began recruiting patients, we were bound to draw envelopes in numerical order as dictated by the randomization process described. After several months, it became apparent that the effect size was actually 30 percentage points. Statistically, only 35 patients are required in each group to demonstrate an effect of 30 percentage points above the anticipated baseline reading rate of 55%. Therefore, we made the decision to complete the study at the end of the school year, because we attained an adequate sample size in each group. At that point, the distribution of randomly assigned patients was unequal. If we continued to recruit all 350 patients, we would have finished with equal numbers in each group.

PARTICIPANT DEMOGRAPHICS

Six hundred thirty-four school-aged children presented to the clinic and had TSTs placed during the study period. Of these children, 157 (25%) were eligible for the study and 143 (23%) were recruited. Four parents refused to participate. Five patients were dropped from the study: 2 were enrolled erroneously, and 3 control group school nurses were accidentally sent facsimiles. Final enrollment was 134 children (21%), with 54 (40%) in the control group and 80 (60%) in the intervention group. Patients were excluded from the study for various reasons (Figure 1). Many patients were ineligible because of school affiliation. Although we tried to involve enough schools, we quickly learned that our patients hailed from a wide geographic area involving many schools. In retrospect, we needed to enroll twice as many schools to capture most patients.

Fourteen eligible patients were missed. Three parents left before consent could be obtained. Eleven patients were not recognized as attending eligible schools. In 3 cases, the parent could not pronounce or spell the school name. Eight others were missed because of staff oversight.

The children’s ages ranged from 5 to 17 years. Participants in each group did not differ for age, sex, race, insurance status, household member with a previously...
positive TST result, mode of transportation to the clinic, single-parent status, or employment status of the primary caretaker (Table).

TST READING RATES

The TST reading rate for school-aged children during the 4 months preceding patient enrollment was 43%. During the study period, the reading rate increased to 56% in the control group, and to 93% in the intervention group. This difference was statistically significant ($P<.001$) (Figure 2).

Of the 28 control group parents whose children did not have documented TST results, 27 were contacted. Four tests were later verified as being read by the school nurse. Parents or guardians gave us permission to notify the nurse about test placement by facsimile or telephone and to request test reading in 48 to 72 hours. Nurses were instructed to report the results directly to us on the day the test was read. Any child noted to have an indurated TST result was told to return to our office after school for an official reading by a physician. Nurses were asked to report the degree of induration in millimeters. Negative test results were reported as 0 mm.

Parents or guardians of children who did not have their tests read were called within 1 week of test placement. A scripted interview was used for this call. School nurses were also called if the parent could not explain why the test was not read.

**ANALYSIS**

We assumed a 43% return rate (based on the return reading rate 3 months before the study commenced) and a Hawthorne effect between 10 and 13 percentage points when calculating the sample size. The Hawthorne effect estimate was based on the increase in the TST reading rate observed by other investigators when education was introduced as a strategy for a similar population. We estimated our control group reading rate would increase to about 55% once the study commenced because the enrollment process might influence behavior. Initially, we determined we would need to enroll 162 patients per group to give us 80% power to detect an effect size of 15 percentage points. Four months into the study, we recognized that the effect size was closer to 30 percentage points. We recalculated the number of subjects needed to give us 80% power to detect an effect size of 30 percentage points (increasing the return reading rate from 55% to 85%) for a 2-tailed test, $\alpha=.05$, using the $z$ statistic to compare proportions of dichotomous values; this number was about 35 per group.

Demographic characteristics were compared by calculating the means and medians of the children’s ages or by calculating the frequency distribution and $\chi^2$ of the characteristics listed in the Table using computer software (Epi Info 6; Centers for Disease Control and Prevention, Atlanta, Ga). Comparison of the TST reading rates between the control and the intervention groups was analyzed using the $\chi^2$ test. Telephone call responses were examined to identify common reasons for failing to have tests read.

COMMENT

Tuberculosis screening of high-risk populations is considered one of the essential components of a successful TB control program. Unfortunately, TB screening efforts in urban areas are plagued with low turnouts for TST reading. Health care professionals working in high-risk areas are encouraged to collaborate with local TB control programs and each other to enhance TB screening efforts.

During the enrollment process, almost all of the control group parents wanted the school nurse to read the TSTs. Their behavior supported this preference, because only 3 of 34 control group patients returned to the clinic for test reading. Parent–school nurse communication failures were primarily responsible for lack of TST reading or reporting. Our efforts to streamline communication between physicians and school nurses greatly...
improved TST reading rates in the intervention group. Other benefits of this intervention included the following: (1) increased education of school nurses about TB; (2) improved school nurse awareness of proper test reading and reporting; (3) more accountability for reporting (including days when school nurses could read the tests); and (4) better planning to read TSTs, because we did not test the school nurses in this intervention were different from those imposed because the circumstances for TST reading by school nurses (control group) were referred back to us within 24 hours. Nurses had a tendency to overread induration. This contradicts the findings of Kendig et al,12 possibly because the circumstances for TST reading by school nurses in this intervention were different from those imposed by their study.

Several biases were present in the study design. Two of these potentially increased the intervention group reading rate. First, the study was not blinded. School nurses received facsimiles to read TSTs knew these were intervention patients and may have been more conscientious about reading and reporting results. This does not seem to be the case, however, because control group parents relied heavily on school nurses to read their children’s tests. When this was effectively communicated to the nurse and the child was not absent, the tests were read in all cases but 1 in the control group and 2 in the intervention group.

A second bias was introduced by contacting intervention group nurses after sending them their first facsimile. While this helped ensure the functionality of facsimile machines, it was potentially an extra reminder. Eighty patients were enrolled in the intervention group from 35 different schools; therefore, 45 intervention group nurses did not receive a telephone call in addition to the facsimile. Of this group, 40 patients (89%) had their TSTs read on time. Thus, the additional telephone call did not influence the intervention group results enough to alter our conclusions.

### Table: Distribution of Characteristics of the 134 Children and Their Families by Group Assignment

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control Group (n = 54)</th>
<th>Intervention Group (n = 80)</th>
<th>Total (N = 134)</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>8.7 (2.6)</td>
<td>9.4 (2.8)</td>
<td>9.1 (2.7)</td>
<td>.14‡</td>
</tr>
<tr>
<td></td>
<td>8.5</td>
<td>9.0</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>25 (46)</td>
<td>44 (55)</td>
<td>69 (51.5)</td>
<td>.42</td>
</tr>
<tr>
<td>Female</td>
<td>29 (54)</td>
<td>36 (45)</td>
<td>65 (48.5)</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>16 (30)</td>
<td>28 (35)</td>
<td>44 (32.8)</td>
<td>.55§</td>
</tr>
<tr>
<td>Hispanic</td>
<td>36 (67)</td>
<td>51 (64)</td>
<td>87 (64.9)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2 (4)</td>
<td>1 (1)</td>
<td>3 (2.2)</td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government subsidized HMO or Medicaid</td>
<td>49 (91)</td>
<td>75 (94)</td>
<td>124 (92.5)</td>
<td>.52‖</td>
</tr>
<tr>
<td>Private</td>
<td>5 (9)</td>
<td>5 (6)</td>
<td>10 (7.5)</td>
<td></td>
</tr>
<tr>
<td>Lives with a person with a positive TST result</td>
<td>6 (11)</td>
<td>9 (11)</td>
<td>15 (11.2)</td>
<td>.80</td>
</tr>
<tr>
<td>Transportation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>34 (63)</td>
<td>48 (60)</td>
<td>82 (61.2)</td>
<td>.56§</td>
</tr>
<tr>
<td>Bus</td>
<td>11 (20)</td>
<td>13 (16)</td>
<td>24 (17.9)</td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>0</td>
<td>2 (2)</td>
<td>2 (1.5)</td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>9 (17)</td>
<td>17 (21)</td>
<td>26 (19.4)</td>
<td></td>
</tr>
<tr>
<td>Single parent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>34 (63)</td>
<td>51 (64)</td>
<td>85 (63.4)</td>
<td>.93</td>
</tr>
<tr>
<td>No</td>
<td>20 (37)</td>
<td>29 (36)</td>
<td>49 (36.6)</td>
<td></td>
</tr>
<tr>
<td>Parent employed or a student</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>28 (52)</td>
<td>41 (51)</td>
<td>69 (51.5)</td>
<td>.91</td>
</tr>
<tr>
<td>No</td>
<td>26 (48)</td>
<td>39 (49)</td>
<td>65 (48.5)</td>
<td></td>
</tr>
</tbody>
</table>

*Data are given as number (percentage) of children unless otherwise indicated. Percentages may not total 100 because of rounding. HMO indicates health maintenance organization; TST, tuberculosis skin test.
†All χ2 and P values were Yates corrected unless otherwise indicated.
‡An analysis of variance was used to calculate the P value for normally distributed data.
§The χ2 and P values were uncorrected.
‖The 2-tailed Fisher exact test was used.

**Figure 1.** Patient enrollment process. TST indicates tuberculosis skin test.

**Figure 2.** Tuberculosis skin test (TST) reading results: systematic collaboration with school nurses (intervention group) vs no collaboration with school nurses (control group). The difference between the 2 groups was significant (P < .001).
What This Study Adds

Screening patients with risk factors for TB with the TST or the Mantoux test is recommended; however, the effectiveness of the TST is of no value if it is not read. Our experience and the experience of others working in urban practices where many patients have risk factors is that only half of the TSTs placed are read. Interventions to improve reading rates have been minimally successful.

This study provides clinicians with another way to improve TST reading rates. We found that school nurses are reliable resources for reading TSTs once their roles are clearly assigned and communication is streamlined.

Last, was bias introduced by limiting patient enrollment to specific schools? Parochial, private, charter, and home schools were excluded. Parents sending their children to these schools might respond differently to the charge of getting TSTs read on time. The reading rate of the 43 patients attending these schools was 42%; exclusion of this group did not seem to introduce bias.

Limiting recruitment to children attending schools closest to our clinic may have introduced bias if transportation or convenience influenced the test-reading rate. Selective student enrollment from schools closest to the clinic might skew the control group reading rate to be higher than average. The converse would be a lower than average reading rate among ineligible patients. Indeed, the return rate for patients who were ineligible for the study because they attended nonparticipating public schools during the study period was 40%, slightly lower than the baseline of 43% observed before the study commenced.

One of the strengths of this program is its real-life applicability. Many urban outpatient clinics already rely on school nurses to help read TSTs (Harriet Weinstein, RN, oral communication, March 9, 2000). Nurse recruitment is not difficult if group meetings can be arranged. A designated telephone line for nurses to report results also improves the communication process. Despite the lack of year-round school nurse availability, this intervention is worthwhile for inner-city youth of low socioeconomic status, and can be expanded to preschool-aged children attending programs in which nurses or other health care professionals can be instructed to identify children with indurated TST results. This intervention is adaptable to e-mail, if patient confidentiality can be assured.

Collaboration with health care professionals with access to children successfully “bridges the gap” to improve TST reading rates. A physician’s ability to determine whom to screen is preserved; reading is more convenient for parents or guardians; and verification, management, and treatment of positive test results reverts back to the primary physician.

Accepted for publication June 21, 2001.

Presented (as a final requirement for a Primary Care Faculty Development Fellowship) at the Michigan State Primary Care Research and Development Conference, East Lansing, June 8, 2000; and as a poster at the Societies for Pediatric Research/Ambulatory Pediatric Association Spring Meeting, Baltimore, Md, April 30, 2001.

We thank the Michigan State Primary Care Faculty Development Fellowship Program’s faculty for their critical appraisal and expertise.

Corresponding author and reprints: Cynthia W. DeLago, MD, Section of General Pediatrics, St Christopher’s Hospital for Children and MCP Hahnemann University School of Medicine, Erie Avenue at Front Street, Philadelphia, PA 19134-1095 (e-mail: Cynthia.W.DeLago@drexel.edu).

REFERENCES

8. Screening for TB: Administering and Reading the Mantoux Test [videotape]. Atlanta, Ga: Centers for Disease Control and Prevention; 1990.