ORIGINAL INVESTIGATION

Tuberculosis Among Immigrants and Refugees

Kathryn DeRiemer, MPH; Daniel P. Chin, MD, MPH; Gisela F. Schecter, MD, MPH; Arthur L. Reingold, MD

Background: Overseas screening of immigrants and refugees applying for a visa to the United States identifies foreign-born individuals who are at high risk for tuberculosis (TB) or who have active TB. The system's effectiveness relies on further medical evaluation and follow-up of foreign-born individuals after their arrival in the United States.

Methods: Retrospective cohort study of 893 immigrants and refugees who arrived in the United States from July 1, 1992, through December 31, 1993, with a destination of San Francisco, Calif, and a referral for further medical evaluation.

Main Outcome Measures: Time to report to the local health department after arrival and the yield of active and preventable cases of TB from follow-up medical evaluations.

Results: Median time from arrival in the United States to seeking care in San Francisco was 9 days (range, 1-920 days). Of 745 immigrants and refugees (83.4%) who sought further medical evaluation, 51 (6.9%) had active TB and 296 (39.7%) were candidates for preventive therapy. Being a refugee was an independent predictor of failure to seek further medical evaluation in the United States. Class B-1 disease status based on overseas TB screening (odds ratio, 3.5; 95% confidence interval, 2.0-6.2) and being from mainland China (odds ratio, 4.4; 95% confidence interval, 1.9-9.9) were independent predictors of TB diagnosed in San Francisco.

Conclusions: Timely, adequate medical evaluation and follow-up care of immigrants and refugees has a relatively high yield and should be a high priority for TB prevention and control programs.

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From the Division of Public Health Biology and Epidemiology, School of Public Health, University of California at Berkeley (Ms DeRiemer and Dr Reingold); Medical Service, San Francisco General Hospital and Department of Medicine, University of California at San Francisco (Drs Chin and Schecter); and the Division of Tuberculosis Control, Department of Public Health, San Francisco, Calif (Dr Schecter).

FOR MORE than a decade, the largest absolute numbers of cases of tuberculosis (TB) among foreign-born individuals in the United States have been reported by the state of California. In California, the number and percentage of reported cases of TB among foreign-born individuals increased from 2046 (58.5% of all cases reported in California) in 1985 to 3086 (66.2% of all cases reported in California) in 1995. Seventy-one percent of these individuals were from 4 countries: Mexico (31.7%), the Philippines (19.9%), Vietnam (14.7%), and China (4.8%). San Francisco, Calif, is the resettlement site of a large, diverse, foreign-born population. The number and proportion of foreign-born individuals with TB in San Francisco have been high for the last 10 years, ranging from 214 cases in 1985 (70.9%) to 171 cases in 1995 (63.3%). One third of these foreign-born individuals were in the United States less than 1 year before TB was diagnosed; they likely had TB when they entered the country or developed it shortly thereafter.

The importance of rapid diagnosis and appropriate treatment for immigrants and refugees as a strategy for controlling TB in the United States has been outlined by the Centers for Disease Control and Prevention (CDC).[1,2] Guidelines for screening foreign-born people for TB in their countries of origin and on arrival in the United States have been in place since 1977, and were revised in 1990.[3,4] Visa applicants aged 15 years and older undergo mandatory screening for TB and testing for other important public health conditions in their country of origin. All immigrants and refugees have a chest radiograph performed. If the chest radiograph shows an abnormality suggestive of active TB, sputum smears are obtained on 3 consecutive days and are examined for the presence of acid-fast bacilli by light microscopy. Based on results of the chest ra-

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METHODS

SCREENING AND MEDICAL EVALUATION

The classification as an immigrant or a refugee was defined by the US Immigration and Naturalization Service in the process of granting a visa. Using records obtained from the Division of Quarantine, National Center for Infectious Diseases, CDC, a cohort of 893 immigrants and refugees who entered the United States from July 1, 1992, through December 31, 1993, with a TB disease classification of class A, class B-1, class B-2, or class B-3 based on initial screening in their country of origin and a stated destination of San Francisco, California was identified. Such records are routinely provided to the local health departments by the CDC to facilitate follow-up of individuals for public health purposes.

People in the study cohort who sought care in San Francisco were evaluated by the clinical staff of the Division of Tuberculosis Control, San Francisco Department of Public Health (SFDPH), or a private health care provider. Standardized procedures were used, including review of the initial screening results from the country of origin, questioning the individual about a history of anti-TB treatment or preventive therapy, and performing a medical examination.[2,3,7] A diagnostic evaluation for *M tuberculosis*, which included a tuberculin skin test and a current chest radiograph, was also performed. Comparisons of the current chest radiograph with any available prior radiographs were made. For individuals with a positive skin test result and an abnormality on the chest radiograph, 3 sputum specimens were obtained on consecutive days for acid-fast bacilli staining and culture. The isolates of cultures that were positive for *M tuberculosis* had drug susceptibility testing performed for the 5 first-line anti-TB drugs used in the United States (isoniazid, rifampin, pyrazinamide, ethambutol hydrochloride, and streptomycin sulfate). Isolates with resistance were submitted to the state reference laboratory for further susceptibility testing.

Treatment with a standardized regimen of 4 anti-TB drugs (2 months of isoniazid, rifampin, pyrazinamide, and ethambutol followed by 4 months of isoniazid and rifampin) was initiated for people suspected of having TB and was used until the diagnosis was clarified. Individuals who were infected and at high risk of TB were offered preventive therapy, once active TB was ruled out.

Local staff actively sought to find those individuals who failed to report to the health department within 30 days of their arrival, using the stated address, agency sponsor information, telephone number, and other data provided on their medical documents to staff of the CDC at the port of entry.

CASE DEFINITIONS

Tuberculosis was defined, based on the CDC case definition, by either the confirmed culture of *M tuberculosis* from a clinical specimen, or a clinical case definition based on a positive tuberculin skin test reaction and clinical and/or radiographic improvement while taking anti-TB drugs. Standard TB staging classifications (ie, class 0- 5) were used.[8,9] Individuals with a positive tuberculin skin test reaction but no evidence of active TB were considered candidates for preventive therapy if they had an abnormality on a chest radiograph with evidence of old, healed disease and no prior anti-TB treatment. Individuals with a positive tuberculin skin test reaction and normal chest radiograph results were also candidates for preventive therapy if they were younger than 35 years. Preventive therapy consisted of 6 to 12 months of isoniazid or, if infection with a drug-resistant strain was suspected, rifampin or isoniazid and rifampin. Standardized guidelines were followed to define treatment and preventive therapy regimens.[7]

The number and proportion of immigrants and refugees with TB and the number and proportion eligible for

diograph and the sputum smear examination, visa applicants are categorized as class A (active, smear-positive TB), class B-1 (active, smear-negative TB), class B-2 (inactive TB), class B-3 (inactive, old, or healed TB), or normal (no TB). Antituberculosis treatment is initiated for those who are categorized as class A, their visa application is not processed, and they are restricted from traveling to the United States until their sputum specimens are no longer positive for acid-fast bacilli. Those with class B-1, class B-2, or class B-3 classifications are able to travel to the United States but are told to report to the local health department for further medical evaluation within 30 days of their arrival. The spirit and purpose of the referral is to ensure that immigrants and refugees receive adequate treatment if they are ill, and to reduce the likelihood of transmission of TB to other people in the community.[2]

Several studies[5,6] based on the previous guidelines or specific populations, such as Southeast Asian refugees, suggest that it is worthwhile to provide further screening and medical evaluation of foreign-born individuals shortly after their arrival in the United States. We conducted a retrospective cohort study to examine the likelihood that immigrants and refugees who were screened in their country of origin and were determined to be at high risk of TB actually sought further medical evaluation for TB. We assessed the efforts of the local public health department to provide timely, adequate medical evaluations and health care to immigrants and refugees after their arrival in the United States. Finally, we determined the yield of active and preventable cases of TB from medical evaluations in the United States and estimated the amount of disease transmission of *Mycobacterium tuberculosis* from immigrants and refugees to the local community.

RESULTS

SEEKING MEDICAL EVALUATION AND CARE

According to the CDC, there were 11 400 immigrants and refugees who entered the United States from July 1, 1992, through December 31, 1993, with a disease classification of class A, class B-1, class B-2, or class B-3 and were referred for further medical evaluation in California. They were from 51 different countries, and 75% stated they were coming to 1 of 6 of the 58 counties in California (Los Angeles, Orange, Santa Clara,

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preventive therapy were determined. Contact investigations were performed by the local staff to identify and evaluate any individuals who were likely to have been infected by people with TB among the immigrants and refugees.

RESTRICTION FRAGMENT LENGTH POLYMORPHISM (RFLP) ANALYSIS

To determine whether any of the detected active cases of TB among immigrants and refugees in the cohort were linked to other cases of TB subsequently reported in San Francisco, IS6110-based RFLP analysis was performed using previously described standard methods on isolates available from the cases of TB with positive cultures.[10-12] This type of RFLP testing is routinely performed for all patients reported to the SFDPH since 1991 as part of a population-based study of the molecular epidemiological features of TB.[13] Comparisons were made using the data available from all cases of TB in San Francisco that were culture positive for *M tuberculosis* and had RFLP typing performed through June 1996.

Isolates were grouped as having either identical or unique DNA fingerprints. A case was considered to be linked to another case in San Francisco if the RFLP band patterns matched based on IS6110 and, when indicated, polymorphic G-C rich sequence typing. Such linkages were used to infer recent transmission of *M tuberculosis* and rapid progression to disease.[13] Cases with positive cultures that were reported but which were later determined to be the result of laboratory contamination were excluded from the analyses.

MATCHING RECORDS

The computerized records of immigrants and refugees provided by the CDC for individuals in the study cohort were matched by date of birth, name, date of arrival, and sex to the records of immigrants and refugees reporting to the SFDPH from July 1, 1992, through December 31, 1995. Individuals who reported to a different health care provider in San Francisco were also captured in the match if that health care provider reported the outcome of the medical evaluation to the SFDPH, or to the CDC, as they are requested to do.

Information on demographic data; the medical examination performed in the country of origin; the results of the medical evaluation in San Francisco, including the tuberculin skin test results, clinical presentation, bacteriological examinations, and drug susceptibility test results; clinical response to therapy; and the results of contact investigations were obtained from reviews of medical records and computerized data available from the SFDPH.

STATISTICAL ANALYSIS

Data entry and management were performed using computing software (Microsoft FoxPro, Microsoft Corporation, Redmond, Wash) and analyses were performed using SAS and STATA statistical software.[14,15] The Mantel-Haenszel χ^2 test and the 2-tailed Fisher exact test were used to test the associations between categorical predictor variables and the outcomes of interest. The Student *t* test for comparisons of means and the nonparametric Wilcoxon 2-sample rank sum test were used to compare means and medians, respectively. In both instances, the null hypothesis was rejected at $P<.05$. Univariate analysis was performed to identify factors significantly associated with the outcomes of interest. Multivariate logistic regression analysis was used to determine which of these factors were independently associated with the outcome of interest. A stepwise forward regression model was constructed by comparison of log likelihood ratios. The crude and adjusted odds ratio (OR) and 95% confidence intervals (CIs) were calculated.[16,17]

San Diego, San Francisco, and Alameda). There were 20 154 immigrants and refugees who entered the United States during 1993 with a visa, a prior medical examination in their country of origin, and a stated destination of San Francisco.[18] Based on these data, we estimate there were 32 054 immigrants and refugees with these same criteria during the 18-month period from July 1, 1992, through December 31, 1993. Of these, 893 (2.8%) had a TB disease classification of class B-1, class B-2, or class B-3 based on their initial medical examination and TB screening status in their country of origin and were told to report to the local health department within 30 days of arrival for further medical evaluation in the United States. This cohort differs slightly from the immigrants and refugees going to other counties in California by having a smaller proportion of Indochinese refugees (2.8% among immigrants and refugees going to San Francisco vs 14.4% among those going to other counties in California), a smaller proportion of people from Vietnam (97% among immigrants and refugees going to San Francisco vs 32.1% among those going to other counties in California), a larger proportion of individuals from mainland China (12.8% among immigrants and refugees going to San Francisco vs 1.7% among those going to other counties in California) and the Russian Federation (7.3% among immigrants and refugees going to San Francisco vs 3.3% among those going to other counties in California), more individuals 65 years or older (30.8% among immigrants and refugees going to San Francisco vs 25.4% among those going to other counties in California), and more individuals entering the United States via the port of San Francisco (82.3% among immigrants and refugees going to San Francisco vs 39.1% among those going to another county in California). However, the individuals in this cohort are similar to the other immigrants and refugees in their initial TB classification and sex. There were no class A immigrants and refugees in the study cohort.

Seven hundred forty-five (83%) of the 893 immigrants and refugees were confirmed to have sought further medical evaluation and follow-up care from a health care provider in San Francisco, according to the records of the SFDPH. Of those who sought care, 80.4% did so within 30 days of arrival, as they were instructed to do. The median number of days from arrival to seeking care in San Francisco was 9 days (range, 1-920 days). Indi-

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Table 1. Univariate Analysis of the Characteristics of Immigrants and Refugees Who Sought Further Medical Evaluation and Follow-up Care at the Local Health Department vs Those Who Did Not, San Francisco, Calif, July 1, 1992-December 31, 1993*

Characteristic	No. (%) Did Not Seek Care (n = 148)	No. (%) Sought Care (n = 745)	Odds Ratio	95% Confidence Interval	*P*
Sex					
Male	77 (52.0)	387 (52.0)	1.00	0.71-1.43	.99
Female	71 (48.0)	358 (48.1)	Reference	. . .	
Age at arrival, y					
Median	58.2	56.9	. . .	. . .	.003
<25	15 (10.3)	46 (6.2)	0.54	0.21-1.31	.14
25-34	7 (4.8)	56 (7.5)	0.57	0.29-1.11	.08
35-44	14 (9.7)	106 (14.2)	0.84	0.48-1.45	.50
45-54	26 (17.9)	133 (17.8)	0.72	0.43-1.21	.19
55-64	26 (19.6)	182 (25.4)	1.40	0.69-2.82	.32
≥65	42 (31.6)	228 (31.8)	Reference	. . .	. . .
Country of origin					<.001
Russian Federation	37 (25.5)	67 (9.0)	1.38	0.59-3.25	.42
Hong Kong	29 (20.0)	248 (33.2)	0.29	0.13-0.68	.001
Vietnam	29 (20.0)	58 (7.8)	1.25	0.52-3.02	.73
The Philippines	25 (17.2)	247 (33.0)	0.35	0.11-0.60	<.001
Mainland China	13 (9.0)	98 (13.1)	0.33	0.13-0.88	.01
Other countries	4 (3.0)	23 (3.2)	Reference	. . .	. . .
Alien status					
Refugee	36 (26.7)	70 (9.6)	3.43	2.12-5.53	<.001
Immigrant	99 (73.3)	660 (90.4)	Reference	. . .	
Medical evaluation in country of origin					<.08
Class B-1	7 (4.8)	183 (24.5)	0.4	0.2-0.9	.01
Class B-2	56 (38.6)	555 (74.2)	Reference	. . .	. . .
Class B†	82 (56.6)	8 (1.10)	101.6	44.7-240.0	<.001
Days between medical examination overseas and arrival in United States					
Mean ± SD	155.13 ± 108.3	144.3 ± 830.9	. . .	. . .	<.001
Range	2-344	12-363	. . .	. . .	. . .
Median	162	83	. . .	. . .	.03
Port of entry					
San Francisco	89 (61.4)	646 (86.4)	3.99	2.64-6.02	<.001
Other	56 (38.6)	102 (13.6)	Reference	. . .	
Other medical condition present					
Yes	23 (15.9)	229 (30.6)	0.43	0.26-0.70	<.001
No	122 (84.1)	519 (69.4)	Reference	. . .	

**Numbers do not add up to total because of missing data. Ellipses indicate not applicable.*
†Unknown whether class B-1 or B-2.

viduals who did not seek care in San Francisco were more likely to be refugees than immigrants; have a disease classification other than class B-1 based on the medical examination in their country of origin; have a longer time interval between the date of the medical examination in their country of origin and their arrival in the United States (median, 164 days vs 83 days); and have entered the United States by a port other than San Francisco (**Table 1**). In the multivariate analysis, the only independent predictor of failure to seek further medical evaluation for TB in San Francisco was being a refugee rather than an immigrant (OR, 6.7; 95% CI, 3.1-14.8).

Those who sought medical evaluation but who did so more than 30 days after their arrival in the United States had characteristics that were similar to those who failed to seek further medical evaluation altogether. Those who sought medical evaluation more than 30 days after their arrival were more likely to be refugees rather than immigrants (OR, 7.5; 95% CI, 4.5-12.7), be from the Russian Federation (OR, 3.1; 95% CI, 1.2-4.8), have a longer time interval between the medical examination in their country of origin and their arrival in the United States (118 days vs 80 days), have entered the United States by a port other than San Francisco (OR, 5.6; 95% CI, 3.6-8.3), and were sponsored in the immigration process by an agency rather than by individuals or family members (OR, 2.0; 95% CI, 1.4-3.0).

RESULTS OF MEDICAL EVALUATION IN SAN FRANCISCO

The results of medical evaluations of 745 immigrants and refugees in San Francisco are shown in **Table 2**. The number and proportion of individuals classified as class 2, class 3, or class 4 varied according to the country of origin; individuals from mainland China were most likely to be infected and diseased. The results of the medical evaluation in San Francisco of 32 individuals could not

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Table 2. Comparison of the Results of a Medical Evaluation in the Country of Origin and in San Francisco, Calif, July 1, 1992-December 31, 1993*

	Medical Evaluation in the United States, No. (%)					
Medical Evaluation in the Country of Origin	Active TB (Class 3)	Healed TB With Abnormality on Chest Radiograph (Class 4)	Infected Without Active Disease (Class 2)	Not Infected (Class 0)	Unknown	Total
Active TB, sputum smear negative (class B-1)	27 (14.8)	134 (73.3)	5 (2.7)	13 (7.1)	3 (1.6)	**182**
Healed TB with abnormality on chest radiograph (class B-2)	24 (4.3)	301 (54.5)	77 (13.9)	124 (22.5)	21 (3.8)	**547**
Class B, not stated whether B-1 or B-2	0 (0.0)	3 (30.0)	3 (30.0)	2 (20.0)	2 (20.0)	**10**
Total	**51** (6.9)	**438** (59.0)	**85** (11.4)	**139** (18.7)	**26** (3.5)	**739 (100)**

*TB indicates tuberculosis.

be determined, including the results from some individuals who were evaluated by a private physician rather than the health department.

Fifty-one (6.9%) of 745 immigrants and refugees who underwent further medical evaluation in San Francisco were found to have active TB (**Table 3**). In a multivariate logistic regression model adjusting for age on arrival in the United States, the factors independently associated with a diagnosis of TB were a disease classification of class B-1 based on the medical examination in the country of origin (OR, 3.5; 95% CI, 2.0-6.2) and being from mainland China (OR, 4.4; 95% CI, 1.9-9.9). In most cases, the medical evaluation in the country of origin was based solely on a chest radiograph and lacked information about tuberculin skin testing, sputum smear examinations, and any culture results. Twelve (23.5%) of the 51 individuals with TB had already been diagnosed as having TB in their countries of origin and had initiated treatment for TB before they entered the United States, but required additional follow-up care in San Francisco. They were not counted or reported as new incident cases in the TB surveillance system maintained by the SFDPH, the California Department of Health Services, or the CDC. The median time between arrival in the United States and seeking further medical evaluation was 9 days for individuals with active TB (range, 2-892 days). There was no statistically significant difference in the number of days between arrival and reporting to the local health department among immigrants and refugees who were found to have active disease vs those who did have such a diagnosis (P=.78).

Almost half (42.0%) of the individuals with active cases reported a history of TB and had received treatment in their country of origin more than 1 year previously. Sputum smears and cultures were obtained in San Francisco for 46 of the 51 individuals with active cases of TB. Of these 46, 3 patients (6.5%) had a positive smear and positive culture for TB, 27 (58.7%) had a negative smear and positive culture for TB, and 16 (34.8%) had a negative smear and negative culture for TB. Drug susceptibility testing was performed in all 30 individuals with positive cultures for TB. Nine (30%) were resistant to 1 or more of the 5 first-line anti-TB drugs that are used in the United States. One immigrant who was identified as having class B-2 TB in China was found to have TB with organisms that were resistant to 4 anti-TB drugs, including isoniazid and rifampin.

Forty (78%) of the 51 individuals with TB completed an adequate regimen of anti-TB therapy in San Francisco. However, 11 individuals (22%) with active cases moved to another county before completing therapy and were referred to another health jurisdiction for follow-up care.

TB TRANSMISSION

There were a mean of 3 (range, 0-14) contacts identified for each of the 51 cases and a total of 173 contacts. Nine (17.6%) of the 51 individuals reported no contacts. On screening for TB infection and disease, 83 (48%) of the contacts were infected with *M tuberculosis*, one secondary case of TB was detected among the contacts, and 73 individuals (42%) were started on a regimen of preventive therapy. Nineteen (11%) of the contacts were named by an individual with an active case resistant to 1 or more first-line anti-TB drugs; 11 (58%) of them were infected and were started on a regimen of preventive therapy. Historical tuberculin skin test results were not available for the contacts.

The results of RFLP testing to produce DNA fingerprints were available for 21 (70%) of 30 individuals with positive cultures for active TB detected in the study cohort. Their DNA fingerprints were compared with the DNA fingerprints of all other individuals with positive cultures for TB identified in San Francisco from January 1992 through June 1996. Twenty immigrants and refugees had unique DNA fingerprints. One immigrant who entered the United States in April 1993 had a fingerprint with a band pattern that matched that of 1 US-born individual whose diagnosis was established in January 1995. No epidemiological link between the immigrant and the US-born individual could be ascertained. Even if the matching RFLP patterns for these 2 cases represent transmission, there were few secondary cases of TB in the local community in San Francisco by June 1996 that could be attributed to the immigrants and refugees in the study cohort.

PREVENTABLE CASES

An additional 296 (39.7%) immigrants and refugees who sought further medical evaluation and follow-up care in

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Table 3. Univariate Analysis of the Characteristics of Individuals Who Had a Diagnosis of Active Tuberculosis (TB) in the United States, Among Immigrants and Refugees Who Sought Care at the Local Health Department, San Francisco, Calif, July 1, 1992-December 31, 1993*

Characteristic	Active TB, No. (%) (n = 51)	Without Active TB, No. (%) (n = 694)	Odds Ratio	95% Confidence Interval	*P*
Sex					
Male	33 (64.7)	354 (51.1)	1.76	0.98-3.16	.07
Female	16 (35.6)	332 (40.3)	Reference	. . .	. . .
Age at arrival, y					
Median	54.2	58.1	. . .	. . .	.15
<25	6 (11.8)	38 (5.5)	2.62	0.97-7.12	.06
25-34	5 (9.8)	49 (7.1)	1.70	0.60-4.80	.33
35-44	4 (7.8)	98 (14.1)	0.68	0.23-2.03	.50
45-54	12 (22.2)	117 (16.9)	1.70	0.77-3.79	.19
55-64	11 (21.6)	176 (25.4)	1.04	0.46-2.33	.93
≥65	13 (25.5)	216 (31.1)	Reference	. . .	. . .
Country of origin					.003
The Philippines	19 (37.3)	227 (32.7)	1.99	0.92-4.30	.08
Mainland China	15 (29.4)	82 (11.8)	4.35	1.92-9.89	<.001
Hong Kong	10 (19.6)	238 (34.3)	Reference	. . .	. . .
Vietnam	2 (4.4)	46 (6.8)	1.03	Undefined, 4.37	>.99
Russian Federation	2 (3.9)	56 (8.1)	0.85	Undefined, 3.57	>.99
Other countries	3 (5.9)	24 (3.5)	2.98	0.83-10.82	.12
Medical evaluation in country of origin					
Class B-1	26 (51.0)	157 (22.6)	3.49	1.97-6.18	<.001
Class B-2	25 (49.0)	527 (75.9)	Reference	. . .	. . .
Class B†	0 (0.0)	8 (1.2)	Undefined	. . .	. . .
Alien status					
Immigrant	49 (98.0)	609 (90.0)	5.41	0.74-40.3	.06
Refugee	1 (2.0)	68 (10.0)	Reference	. . .	
Median No. of days from medical examination overseas to arrival in United States	54	86	. . .	. . .	<.001
Median No. of days from arrival in United States to seeking care at local health department	9	11	. . .	. . .	.78
PPD skin test results					
≥10 mm	41 (90.1)	367 (80.7)	2.46	0.89-6.75	.11
Negative	4 (8.9)	88 (19.3)	Reference	. . .	. . .
Other medical condition present					
Yes	9 (20.0)	213 (31.7)	1.85	0.88-3.91	.10
No	36 (80.0)	460 (68.4)	Reference	. . .	. . .

*Numbers do not add up to total because of missing data. Ellipses indicate not applicable; PPD, purified protein derivative.
†Unknown whether class B-1 or B-2.

San Francisco were candidates for preventive therapy. Twenty-eight individuals (3.8%) younger than 35 years were infected with *M tuberculosis* (class 2). There were also 268 individuals (36%) who had evidence of old, healed TB (class 4) without adequate prior treatment, and were considered at risk of reactivation.

Of 296 immigrants and refugees who were eligible for preventive therapy, 241 (81.4%) initiated preventive therapy and 55 (18.6%) did not. Of the 241 individuals who initiated preventive therapy, 178 (73.9%) completed an adequate regimen and 63 (26.1%) did not. Of 63 individuals who initiated preventive therapy but failed to complete an adequate regimen, 6 discontinued it on a physician's advice because of adverse reactions, 14 decided themselves to stop preventive therapy, 17 moved to another county and were referred to another health department to complete preventive therapy, and 26 were unavailable for follow-up.

COMMENT

Our study demonstrates the importance of providing timely, adequate follow-up, medical evaluations, and care for immigrants and refugees determined to be at high risk of TB. Evaluation of immigrants and refugees referred to the local health department shortly after arrival in the United States yields a high number of cases of TB (6.9%) and a high number of candidates for preventive therapy (39.7%). A recent study[6] of TB among immigrants and refugees in Hawaii, based on a less diverse study population, reported similar results. In addition, our study found that a class B-1 disease status and a short median number of days between the time of the medical examination overseas and arrival in the United States were the strongest predictors of active TB among immigrants and refugees. However, only 30 (58.8%) of the 51 active cases in our study were confirmed by culture, suggesting a di-

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agnostic bias by physicians examining individuals from countries with a high prevalence of TB. Physicians may also be likely to have available, use, and compare chest radiographs made before and after immigration to diagnose TB based on clinical and radiographic changes. Infection with *M tuberculosis* is likely the leading cause of radiographic abnormalities in susceptible populations in areas with high incidence and prevalence of TB.[19] In our study, immigrants and refugees with an abnormality on the initial chest radiograph from the country of origin were 3.5 times more likely to subsequently be diagnosed as having active TB than were immigrants and refugees with old, inactive healed disease or those with no radiographic abnormality.

We report a 48.2% positive tuberculin skin test rate among contacts of active cases, consistent with a high rate of transmission, but few secondary cases. In the absence of historical tuberculin skin test results for the contacts, it was not possible to determine whether a positive tuberculin skin test reaction in a contact represented an old, prior infection or a recent infection and a tuberculin skin test conversion. Analyses of DNA fingerprinting patterns did not reveal significant clustering and no epidemiological links could be established between the patients with matching strains. The fact that no further matching strains were identified between the cases of TB diagnosed among immigrants and refugees and other cases of TB in San Francisco through June 1996 suggests that the immigrants and refugees probably did not acquire their infections locally. Our data indicate that few secondary cases of TB in the community are attributable to immigrants and refugees if they and their contacts receive timely, appropriate health care services.

The evaluation of immigrants and refugees who enter the United States and are referred to the local health department for further medical evaluation is an existing, relatively easy, efficient way of identifying both cases of TB and candidates for preventive therapy. Given these results, it should be accorded a high priority by public health departments. It is possible to identify specific characteristics that are associated with failure to seek further medical care and delays in seeking care in a local health jurisdiction. Strategies to find and evaluate those who do not seek further medical care should be devised and aggressively pursued. Our study showed that the yield of cases of TB (6.9%) found by screening immigrants and refugees with a class B-1 and class B-2 classification was 10 times higher than the yield from contact investigations (700 per 100 000 individuals evaluated or 0.7%, CDC Program Management Reports, unpublished data, 1990-1992).[20] In health jurisdictions with a large number of foreign-born individuals, follow-up of immigrants and refugees who were referred with a class A, class B-1, class B-2, or class B-3 disease classification should be an indicator of program performance. Given the relatively high risk of those without disease who are candidates for preventive therapy, the prevalence of drug-resistant strains among active cases from the same countries, and the significant proportion of individuals who move to another county within a year of arrival in the United States, timely follow-up to provide medical evaluations and adequate care is important and requires improved coordination between local health department jurisdictions.

MOST IMMIGRANTS and refugees who enter the United States with prior screening in their country of origin and a referral to the local health department come from a limited number of countries and settle in a limited number of counties or geographical areas in the United States.[21,22] For example, many individuals from mainland China resettle in San Francisco and Alameda counties in northern California. Culturally appropriate strategies and efforts to find, evaluate, and provide services can be emphasized in those counties and health jurisdictions that receive large numbers of immigrants and refugees. In California, the efforts and resources to find, evaluate, and treat foreign-born immigrants and refugees could be targeted to the 6 counties that receive three quarters of them.[23]

We report that 17% of the immigrants and refugees who were referred to the SFDPH were unavailable for follow-up. Communities of foreign-born individuals may have limited access to health care services if there are cultural and linguistic barriers.[2] Regulations, legislation, and other attempts to limit the access to care for undocumented and illegal aliens will limit the effectiveness of follow-up screening and health care for foreign-born individuals, such as immigrants and refugees, if such restrictions are implemented, misconstrued, misinterpreted, or incorrectly applied.[24]

Our study did not evaluate TB in all foreign-born populations. Many cases of TB among foreign-born individuals in California since 1992 occurred among individuals who did not receive a medical examination in their country of origin and who were not referred to the local health department. In San Francisco, 29.2% of the cases in foreign-born individuals with TB were among individuals from Mexico and other parts of Latin America, from which a visa is seldom sought and is rarely obtained. Although reliable estimates of the number, age distribution, and other characteristics of individuals who enter California without a visa are not available, TB is prevalent in many countries of Latin America, and many individuals arriving from that region are also likely candidates for anti-TB preventive therapy. Undocumented workers, illegal aliens, and foreign-born individuals with a temporary visa status such as students, businessmen, and tourists who come from a setting of high prevalence of TB are also at high risk of TB, and they might have different resettlement patterns. It would be unwise to restrict health care services to any foreign-born individuals at risk of developing TB.

Tuberculosis prevention and control is one of the most cost-effective disease control strategies available.[25,26] Improving the local TB prevention and control programs in other countries will reduce the number and proportion of immigrants and refugees who have TB when they enter the United States.[27] Collaborative efforts to effectively reduce TB morbidity and mortality in other countries will have a direct impact on TB prevention and control efforts in the United States and worldwide.

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Corresponding author: Arthur L. Reingold, MD, Division of Public Health Biology and Epidemiology, School of Public Health, 140 Warren Hall, University of California at Berkeley, Berkeley, CA 94720-7360 (e-mail: reingold@uclink3.berkeley.edu).

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