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Controlling Tuberculosis in an Urban Emergency Department: A Rapid Decision Instrument for Patient Isolation

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ABSTRACT

Objectives. This study examined whether data routinely available in emergency departments could be used to improve isolation decisions for tuberculosis patients.

Methods. In a large emergency department in New York City, we compared the exposure histories of tuberculosis culture-positive and culture-negative patients and used these data to develop a rapid decision instrument to predict culture-positive tuberculosis. The screen used only data that are routinely available to emergency physicians.

Results. The method had high sensitivity (.96) and moderate specificity (.54).

Conclusions. The method is easily adaptable for a broad range of settings and illustrates the potential benefits of applying basic epidemiologic methods in a clinical setting. (*Am J Public Health.* 1997;87:1543–1547)

Introduction

This study examined whether routinely available data could be used to improve isolation decisions for tuberculosis patients in an urban emergency department. The resurgence of tuberculosis in the United States has been attributed to many factors, including homelessness, increasing immigration, and the epidemic of human immunodeficiency virus (HIV).[1–9] This resurgence has been most marked in our inner cities,[10–14] where patients at high risk for tuberculosis often use an emergency department as their initial or sole source of health care.[15–18]

Effective and rapid isolation of patients with active tuberculosis in inner-city emergency departments is essential because the presence of infectious patients in this crowded setting could contribute to outbreaks of tuberculosis.[19–27] The emergence of multidrug-resistant strains has made the situation even more hazardous.[28–35] Indeed, exposure in emergency departments has been implicated in institutional transmission of tuberculosis.[36–39] Urban emergency departments are likely to be subject to long waiting times, however, and to have limited respiratory isolation space.[40] The Centers for Disease Control and Prevention (CDC) suggest that emergency departments develop protocols for rapid identification and isolation of possible tuberculosis patients, and that such protocols "be based on the prevalence and characteristics of TB in the population served by the specific facility."[41] An emergency department triage procedure for rapid chest x-ray and respiratory isolation has been published in abstract form, but only four patients in that data set (.4% of those placed into isolation) had positive sputum acid-fast bacillus smears.[42]

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The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Indian Health Service.

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Editor's Note. See related annotation by Schuchat (p 1413) in this issue.

TABLE 1—Demographic Characteristics of Patients in an Urban Emergency Department in New York City Evaluated for Pulmonary Tuberculosis, 1992

Variable	Case Patients (n = 28)	Control Patients (n = 113)	Odds Ratio	95% Confidence Interval
Age, y	36.6 ± 11.0	38.4 ± 13.1	$P < .51$	...
Gender, no. male	20	66	1.78	.72, 4.38
Race				
Asian	0	2	...	...
Black	17	54	1.69	.73, 3.92
Hispanic	10	42	.94	.40, 2.22
White	1	10	.38	.05, 3.11
Unknown	0	5	...	...
National origin				
Dominican Republic	5	16	1.32	.44, 3.97
Puerto Rico	2	9	.89	.18, 4.36
Mainland US	19	73	1.16	.48, 2.79
Other	2	9	.89	.18, 4.36
Unknown	0	6	...	...

With the recommendation of the CDC in mind, this study used data routinely available to emergency department physicians to develop a rapid decision instrument for isolation of tuberculosis patients. The research was conducted in a New York City university hospital located in a neighborhood with a high prevalence of acquired immunodeficiency syndrome (AIDS) and tuberculosis.[43,44] The adult emergency department receives approximately 65 000 visits annually. In studying patients being evaluated for tuberculosis in the emergency department, we compared culture-positive and culture-negative patients with respect to risk factors noted in the chart to determine which factors best predicted a positive culture and to develop a screen to predict positive cultures.

Methods

Study Design

The study used a nested case–control design. The cohort was 547 patients who, as determined by review of Mycobacteriology Division records, had sputum cultures for *Mycobacterium tuberculosis* sent from the emergency department during 1992. Patients could be counted in the cohort only once; in the case of multiple visits, data from the first visit were used. The 28 case patients were 26 patients whose emergency department sputum culture grew *M tuberculosis* by standard laboratory techniques and 2 patients who had a negative emergency department culture but a positive sputum culture at the hospital within 1 month of their emergency department visit. Control patients were unmatched; 117 of 519 eligible control patients (23%) were randomly selected for review. Of these 117 control patients, 3 were not reviewed because of problems with medical records (i.e., the index visit could not be confirmed). One was not reviewed because the culture sample was not sputum. These eliminations left 113 control patients. The 28 case patients made a total of 141 patients (ratio of control to case patients, 4:1) who were fully reviewed.

To determine exposure status, patient charts and the computerized information system were reviewed by the first author with specified criteria used for ratings. Many potential exposures were rated, including tuberculosis history; HIV-related variables; social variables, such as substance abuse and living situation; patient complaints; and objective data, such as physical examination, x-ray, and laboratory results.

Data Analysis

We sought to devise a decision instrument that yielded a high sensitivity (so as not to miss any infectious patients) for culture-positive tuberculosis, while reducing the number of patients being isolated. We also wanted the instrument to be simple to administer; this ruled out the use of such procedures as CART (Salford Systems, San Diego, Calif) analysis. Analysis began with a careful review of bivariate data.[45] Logistic regression was used to examine the potential contribution of each variable to predicting culture-positive tuberculosis. Logistic models were built manually, with the use of a forward strategy. Tests of significance for a variable's coefficient in an equation were based on the change in log likelihood. Potential confounders were evaluated by means of the change-in-estimate approach.[46–50] Candidate screens were selected on the basis of the results of the logistic regression analysis, ease of use, and rapidity of administration.

Results

Demographic data are presented in Table 1, and clinical data in Table 2.

All 28 case patients had *M tuberculosis* sensitivities available. Cultures were reported as positive after a mean of 25.0 ± 13.2 days. All isolates were tested for sensitivity to isoniazid, rifampin, ethambutol, and streptomycin. Four were resistant to isoniazid, five to rifampin, one to streptomycin, and none to ethambutol. Six isolates were resistant to at least one agent and three were multidrug resistant. Twenty-seven case patients had sputum acid-fast bacillus stain reported; 12 were positive. Eighty-five control patients had sputum acid-fast bacillus reported; none were positive. As specified in emergency department protocol, all patients were placed in respiratory isolation by their treating physicians.

The rapid decision instrument with the best combination of high sensitivity, at least moderate specificity, and ease of administration consisted of a simple 0-through-4 scale of 1 point each for abnormal chest x-ray, temperature greater than 101°F, current homeless shelter dweller, and tuberculosis history (history of either positive skin test, active tuberculosis, or tuberculosis exposure). A score of 2 or greater on this scale was used to predict culture-positivity. The performance of this screen, including sensitivity and specificity, is presented in Figure 1.

Discussion

This study found that a simple four-variable decision instrument had high sensitivity and moderate specificity for infectious pulmonary tuberculosis in a cohort of urban emergency department patients being evaluated for pulmonary tuberculosis. Had the emergency department used this screen to make isolation decisions in these patients, 54% of the culture-negative patients might not have been isolated. This could represent a

TABLE 2—Clinical Characteristics[a] of Patients in an Urban Emergency Department in New York City Evaluated for Pulmonary Tuberculosis, 1992

Variable	Case Patients (n = 28) Yes	Case Patients (n = 28) No	Control Patients (n = 113) Yes	Control Patients (n = 113) No	Odds Ratio	95% Confidence Interval
History of active tuberculosis	9	19	17	96	2.67	1.04, 6.89
Skin test positive	12	16	33	80	1.82	.78, 4.26
History of tuberculosis exposure	6	22	14	99	1.93	.67, 5.58
HIV positive	10	18	41	72	.98	.41, 2.31
AIDS diagnosis	5	23	24	89	.81	.28, 2.34
Ethanol use, current or former, any amount	16	12	55	58	1.41	.61, 3.24
Illegal drug use, any, current or former	16	12	63	50	1.06	.46, 2.44
Shelter dweller, current	6	22	8	105	3.58	1.13, 11.35
Cough, any	27	1	91	22	6.53	.84, 50.68
Cough, chronic, > 1 week	22	6	48	65	4.97	1.87, 13.19
Hemoptysis, any amount or duration	4	24	23	90	.65	.21, 2.07
Shortness of breath	12	16	39	74	1.42	.61, 3.31
Fever, any duration	22	6	63	50	2.91	1.10, 7.72
Night sweats, any duration	13	15	29	84	2.51	1.07, 5.90
Anorexia, any duration	11	17	11	102	6.00	2.25, 16.00
Weight loss, any amount or time	18	10	31	82	4.76	1.98, 11.44
Temperature > 101°F	17	11	31	82	4.09	1.72, 9.70
Lung examination abnormal	18	10	45	68	2.72	1.15, 6.43
Chest x-ray, any abnormality	27	1	70	43	16.59	2.17, 126.50
Chest x-ray, upper lobe lesions	18	10	22	91	7.45	3.02, 18.36

Note. HIV = human immunodeficiency virus; AIDS = acquired immunodeficiency syndrome.
[a]Missing data were filled in by assuming that if an exposure rating was missing from the chart, then the risk factor was not present. Running the screen using other missing data assumptions did not produce substantially different results, suggesting that exposure suspicion bias did not appreciably influence the outcome.

major saving of emergency department resources.

One culture-positive patient would not have been isolated. She was a 33-year-old White woman with a history of recent active tuberculosis who presented with a chronic productive cough. She was an intravenous drug user, but was known to be HIV negative. She was not a homeless shelter dweller, was afebrile, had a normal chest x-ray, and had sputum negative for acid-fast bacillus. She was, however, appropriately isolated by her treating physicians on the basis of her recent history and symptoms. This case underscores that variables not included in the instrument will sometimes be important.

Our screen was more sensitive than the sputum acid-fast bacillus smear for identifying culture-positive cases. The smear was positive in only 12 of 27 cases (44%) who had smear results available, as compared with our screen's sensitivity of 96%. When sputum acid-fast bacillus smear was used as the outcome of interest, the screen's sensitivity was 1.0, and its specificity .43. Although our screen performs well in identifying patients with positive acid-fast bacillus smears, we believe that in the crowded emergency department setting it is more appropriate to attempt to identify all patients with culture-positive sputum, not only those with positive acid-fast bacillus smears.

The performance of screens developed for use in other settings will vary according to the local prevalence of tuberculosis. Consequently, the cutoff for predicting positive sputum must be set according to local needs. The neighborhood of the medical center in this study has a high age-adjusted rate of tuberculosis: the 1992 case rate was 60.9 per 100 000 population, nearly six times the national rate of 10.5 per 100 000.[44]

In this study, the case and control groups were both drawn from patients being evaluated for pulmonary tuberculosis. These may be the patients for whom the decision instrument is most appropriate. Clinicians could initially exclude patients with no possibility of tuberculosis and then apply the screen to improve isolation decisions for the remaining patients. Of course, we cannot determine whether the decision instrument would be equally effective if applied to all emergency room patients.

The present study demonstrates that it is feasible to develop a screen for more effective isolation of tuberculosis patients using data easily available in any emergency department. In all likelihood, the same approach could be used to develop screens for use in other settings as well. While the most effective screen will differ across populations and settings, the method

Decision instrument's performance in cases and controls

Predicted	ACTUAL Case	ACTUAL Control	Total
Positive (Score ≥ 2)	27	52	79
Negative (Score < 2)	1	61	62
Total	28	113	141

Decision instrument's performance if assumed to apply to the entire cohort

Predicted	ACTUAL Case	ACTUAL Control	Total
Positive (Score ≥ 2)	27	239	266
Negative (Score < 2)	1	280	281
Total	28	519	547

Note. Score 1 point each for abnormal chest x-ray; temperature > 101°F; current homeless shelter dweller; tuberculosis history (history of positive skin test, active tuberculosis, or tuberculosis exposure). Positive is defined as a score of 2 or more. Sensitivity = .96; specificity = .54; positive predictive value = .10; negative predictive value = 1.0.

FIGURE 1—Characteristics of the decision instrument used to evaluate patients for pulmonary tuberculosis in an urban emergency department in New York City, 1992.

used to develop the screen is simple and widely applicable. More broadly, this work illustrates that basic epidemiologic methods can be applied at very low cost and can have significant implications for health care delivery. □

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Shigellosis on Indian Reserves in Manitoba, Canada: Its Relationship to Crowded Housing, Lack of Running Water, and Inadequate Sewage Disposal

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ABSTRACT

Objectives. This study compares incidence and hospitalization rates for shigellosis between Indians and the rest of the population in Manitoba, Canada. It examines the relationship between shigellosis and environmental conditions on reserves.

Methods. Rates were calculated with surveillance data and a survey of environmental infrastructure was done.

Results. Indians had shigellosis incidence and hospitalization rates that were 29 and 12 times as high, respectively, as those of the rest of the population. Household crowding, lack of piped water, and inadequate sewage disposal were significantly associated with an increased incidence of shigellosis on reserves.

Conclusions. Many cases of shigellosis may be prevented by improving living conditions on Indian reserves. (*Am J Public Health.* 1997;87:1547–1551)

Introduction

Shigellosis is a highly infectious diarrheal disease[1] that can lead to explosive common-source[2–6] and prolonged propagated[7] epidemics. With improvements in standards of sanitation and hygiene in developed countries, the incidence of shigellosis has steadily declined and the epidemiology of this disease has changed. The age of persons with reported cases has increased[8] and the majority of cases in Canada and the United States now occur in high-risk groups (members of closed religious communities,[9] travelers returning from areas in which shigellosis is endemic,[10,11] and homosexuals[12]) and settings (jails and camps,[12] nursing homes,[13] and child day care centers[14]).

Improvement in standards of sanitation and hygiene has not been universal in North America, resulting in prolonged communitywide epidemics.[7,15] This report describes the epidemiology of shigellosis during a 2-year epidemic cycle in the Canadian province of Manitoba. It examines the relationship between disease rates and water delivery, sanitation, and household density on Indian reserves.

Methods

This study includes all cases of shigellosis reported to the Manitoba health department during the 2 years of an epidemic cycle that began when monthly case rates doubled in September 1992 and ended in August 1994, after which the case rates returned to endemic levels (Figure 1). Reporting of shigellosis in Manitoba is mandatory under the Public Health Act, and information about cases is entered into a computerized surveillance database. A case is defined by a stool culture positive for shigella. Data on antibiotic susceptibility was abstracted from laboratory reports. All case patients were checked against a population file for a treaty number, which is given to aboriginal persons who are considered registered Indians under the Federal Indian Act. Data on hospitalizations and deaths from shigellosis during this period were obtained from the computerized provincial hospital discharge file and vital statistics registry, respectively, using *International Classification of Diseases,* ninth revision, Clinical Modification (ICD-9 CM) code 004.[16] Population figures from December 1993 were used to calculate and compare the rates of Indians and members of the general population.

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