

Cost Effectiveness of Screening for Tuberculosis in a General Medical Clinic

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SHOULD PEOPLE HAVE an annual chest X-ray to detect tuberculosis? The answer depends on the population and the incidence of tuberculosis, as well as on the medical care system available.

Before effective treatment for tuberculosis became available, there was little emphasis on detecting new cases except when patients' symptoms alerted a physician. After World War II when effective treatment became available, X-ray screening programs proved valuable in detecting new cases of tuberculosis and in bringing patients to treatment (1-3).

However, as the incidence of tuberculosis steadily declined in the United States, the yield from these screening programs progressively dropped (1,3,4). Many tuberculosis X-ray screening programs have recently been disbanded, and the Public Health Service has recommended that X-ray screening for tuberculosis in the general community be discontinued (5).

The incidence of tuberculosis is known to be higher in certain populations within the United

States—older age groups, lower economic and inner city groups, and patients with chronic disease (6). It is possible that certain groups of people could benefit from routine X-ray screening for tuberculosis. In 1969, a project was begun at Grady Memorial Hospital in Atlanta, Ga., to screen a population of old and poor patients with chronic disease in an attempt to increase tuberculosis detection and bring earlier treatment to these people.

Materials And Methods

Design of the program. Any patient attending the general outpatient clinic at Grady Hospital who had not had a chest X-ray within the previous year was offered this free service. These were patients coming to the clinic seeking medical attention for a chronic disease or for new problems. Many patients had two or three films taken during the 3-year study period (1969-71). X-ray microfilms were taken on a photo roentgen unit. The films were read within 1 to 2 weeks by various radiologists on a per diem contract basis, and any patients whose films suggested tuberculosis were reported to the Fulton County Health Department for followup. Those patients with suspicious films were recalled by the health department for regular chest X-rays, skin testing, and when indicated, sputum culture.

The population surveyed. Grady Hospital is the only hospital offering full services to the indigent of Fulton County (population 590,000), which comprises much of Atlanta and its suburbs. The general outpatient clinic offers the only medical care available to most of the people who attend it. The patients are mainly poor, old, black, and residents of the inner city. A majority of them attend the clinic because of one or more maladies: hypertension, heart disease, diabetes, and chronic lung disorders. Acute minor viral infections account for 10 to 20 percent of visits during the winter months. In essence, the clinic is a primary care facility for adults, accommodating 75,000 patient visits annually, with the average patient attending five times a year.

Analysis of cases. All cases of active tuberculosis discovered by the screening program during 1969, 1970, and 1971 were retrospectively analyzed by reviewing patients' chart records at Grady Hospital and at the Fulton County Health Department. Because the films were made only of patients who had come to the clinic for medical attention, there was a physician's examination record for each person on the day that the chest X-ray had been made. For each patient, it was determined whether tuberculosis had been diagnosed on the basis of symptoms or if the microfilm had

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provided the first evidence of the disease.

The decision in almost every instance was clear-cut: the patient was either admitted with the diagnosis of tuberculosis on the same day he came to the clinic after diagnostic tests were ordered because of symptoms, or he was dismissed with no suspicion of tuberculosis raised by the physician in his notes. Obviously, in analyzing the effectiveness of a screening program, patients diagnosed as having tuberculosis because of their symptoms must be excluded. In this study, patients were excluded who were diagnosed before the microfilm was developed and read (a lag of 1 to 2 weeks).

A patient was considered to be an alcohol abuser if any of the following criteria were met by information in the records:

1. Hospital discharge diagnosis of alcoholism
2. Repeated clinic visits during which the physician noted drunkenness
3. Presence of alcoholic liver disease
4. Statement by a social worker or psychiatrist
5. Patient's statement that he drank excessively

Unfortunately, records were not available to enable the direct computation of the rate of alcoholism among the patients who were microfilmed. To get this information, 760 patients attending the clinic during 1 week were picked at random and their charts reviewed, using the aforementioned criteria. Since there was no evidence that the clinic population had changed over the study period, I believed that this sample would give a good estimate of the rate of alcoholism among all patients who had had microfilms taken.

Results

The active tuberculosis cases found via microfilms are an overstatement of the effectiveness of the screening because more than half (32) were diagnosed on the

Table 1. New active cases of tuberculosis found through X-ray screening, Grady Memorial Hospital, 1969-71

Item	1969	1970	1971	Total
Total microfilms	19,106	13,427	15,545	48,078
Newly discovered cases of active tuberculosis	30	13	11	54
Discovered by investigation of symptoms	18	9	5	32
Disclosed by X-ray screening	12	4	6	22

Table 2. Analysis of 22 cases discovered by X-ray screening, Grady Memorial Hospital, 1969-71

Indicator	1969	1970	1971	Total
Respiratory symptoms	1	0	1	2
History of tuberculosis	0	1	0	1
Alcohol abuser	6	2	2	10
No symptoms, no chronic disease	5	1	2	8

¹ patient had cancer of cervix.

basis of diagnostic tests ordered because of apparent symptoms (table 1).

Of those patients whose cases were discovered via microfilm evidence and not diagnosed by the physician at the time of the clinic visit, 10 were alcoholics (table 2). Only three patients had respiratory symptoms which might have provided a clue to the diagnosis. One patient had old treated tuberculosis which was discovered to have reactivated, although he had no symptoms. The rest were asymptomatic in terms of respiratory disease and had no chronic disease.

For the 3 years as a whole, 48,098 films were taken and 22 new cases of active tuberculosis were brought under medical care that otherwise would not have been discovered. The chart review of a random sample of the clinic population revealed that 37 of 760 patients (5 percent) were alcoholics. Thus, using the 5 percent rate of alcoholism in our clinic population, the screening program discovered approximately 1 case of tuberculosis for every 240 alcoholics X-rayed, a rate of about 4 per 1,000. However, for the remainder of the clinic population, approximately 3,806 films were made for each new case

Table 3. Analysis of case rates, assuming a 5 percent alcoholism rate in clinic population, Grady Memorial Hospital, 1969-71

Item	1969	1970	1971	Total
Total microfilms	19,106	13,427	15,545	48,078
Estimated population:				
Alcoholics	955	671	777	2,403
Nonalcoholics	18,151	12,756	14,768	45,675
Cases of tuberculosis:				
Among alcoholics	6	2	2	10
Among nonalcoholics	6	2	4	12
Ratio of cases found to films taken:				
Among alcoholics	1:159	1:336	1:388	1:240
Among nonalcoholics	1:3,025	1:6,378	1:3,692	1:3,806
Case rate per 1,000:				
Among alcoholics	6.28	2.98	2.58	4.17
Among nonalcoholics	0.34	0.16	0.27	0.26

detected, a rate of 0.26 per 1,000 (table 3). In addition, 2,237 regular size chest X-ray films were made because of suspicious microfilms, a ratio of 102 large films for every case of active tuberculosis discovered.

No difference was found in the extent of tuberculosis between alcoholic and nonalcoholic patients. The distribution of minimal and advanced (cavitary and noncavitary) cases was proportionally the same for both groups, as indicated in the following tabulation:

Status of tuberculosis	Alcoholic patients	Nonalcoholic patients
Minimal	3	2
Noncavitary:		
Moderately advanced	4	6
Far advanced	0	1
Cavitary:		
Moderately advanced	0	1
Far advanced	2	2
Unknown	1	0

The \$30,000 annual cost of the program was derived by adding known expenses for personnel and 70-mm X-ray film to estimated expenses for space in the hospital and a regular size chest X-ray. The yearly expenses were as follows:

Item	Yearly cost ¹
Personnel:	
1 clerk and 1 X-ray technician	\$15,500
Per diem payment to radiologists	8,400
Materials:	
70-mm film	600
Use of hospital space (estimate)	2,000
Large X-ray films (estimated at \$5 per film)	3,500
Total	\$30,000

¹Many indirect expenses not included.

However, the considerable costs of services provided as part of the regular health department or Grady Hospital programs were not taken into account, primarily because a good method of estimating them was lacking. These costs included purchase and operation of the X-ray unit itself, expenses of recalling patients, doing skin tests and sputum cultures,

physicians' time in evaluating recalled patients, housekeeping expenses, and office supplies. Thus, the minimum cost over the 3 years comes to almost \$2 per film for 48,000 persons screened. Multiplying by the number of films required yields an approximate cost of \$8,000 per case of active tuberculosis found among the general clinic population, compared with \$500 for each case identified in the alcoholic subgroup.

Discussion

In this study, the yield of active cases of tuberculosis in a general clinic screening program was extremely small. Other researchers have documented decreasing yields from mass chest X-ray surveys with fairly low yields in recent years. In New York State in 1952, 2.3 new cases of tuberculosis were found per 1,000 chest films taken at hospital admission, but by 1959, this yield had dropped to 0.5 per 1,000. For community surveys the casefinding rate was 1.1 per 1,000 in 1953, but only 0.3 per 1,000 by 1956 (4). Fleck and co-workers (1) showed a steady decline in casefinding in New York State between 1952 and 1958 whether the survey was of the general population, school groups, hospital admissions, or hospital employees. The cost per active case discovered rose reciprocally from \$492 to \$1,441. The Worcester, Mass., 1952, massive chest X-ray survey (7) of an entire population yielded only 55 new active tuberculosis cases out of 158,279 films taken, or a rate of 0.3 per 1,000.

In Denver, a 1949 mass survey yielded 1 new case per 1,000 screening films. By 1962-64, only 0.2 new cases were found per 1,000 screened, and between 1965 and 1970, the yield dropped to 0.1 per 1,000. The cost per new active case discovered during the period 1965-70 amounted to as much as \$8,115, depending on the area surveyed (3).

Most surveys have been conducted among the general population, although it is well known that the incidence of tuberculosis is

much higher in the lower socioeconomic and older age groups. Theoretically, screening this higher risk population should yield more new active tuberculosis cases than a mass survey of the general population. Swallow and Sbarbaro (3) showed that the cost to find one new active case of tuberculosis by X-ray screening in two small poverty clinics was \$3,249, and in the county jail, only \$1,448. The discrepancy between this report and the Denver findings probably lies in the fact that patients whose disease could have been discovered by the presenting symptoms were not excluded.

Admittedly, the patients X-rayed in the Grady study form a very biased sample. Only adult patients in the general clinic were surveyed, and self selection by patients in accepting the offer of a free X-ray further biased the sample. Thus, the casefinding rate reported in this paper is only a reflection of the true incidence of tuberculosis in the patient population that the clinic serves. However, the actual casefinding rate is the important figure in terms of deciding the value of a screening program, since the purpose of health screening is to discover disease and not necessarily to determine true incidence rates.

The value of any program must be decided on the basis of its cost and results. However, the results must be carefully analyzed. In this study, if the gross figure of 54 cases of active tuberculosis for 48,000 films (1 case per 888 films) had been accepted blindly and only the specific costs of taking X-rays used, the cost effectiveness figure would have been \$1,800 per case of tuberculosis discovered. And this figure probably would have been accepted as justifying continued screening. However, those patients whose disease was discovered without the aid of the screening obviously should be excluded from analysis of the benefits of screening.

Detailed analysis revealed that for the nonalcoholic clinic population, the casefinding rate for active

tuberculosis was only 26 per 100,000—less than the rate for the general population of Fulton County (32 per 100,000 for 1971). This result is at first surprising, since one would expect to find more tuberculosis in the clinic population, which is composed of poor, old, chronically ill, and mainly black residents of slum areas of the city. The answer to this superficial paradox probably lies in the fact that most people with active tuberculosis are symptomatic and seek medical attention. Their disease can be discovered because of its symptoms. Thus, the small proportion of asymptomatic cases leaves few cases to be discovered by X-ray screening programs.

When uncalculated indirect costs are added to direct costs, one must conclude that X-ray screening to detect tuberculosis—even for an older and chronically ill population—is not justified on sound financial grounds. Because of this analysis the X-ray screening program for tuberculosis at Grady was discontinued in 1973.

On the other hand, a subgroup within the clinic population has been identified that has a high incidence of undetected tuberculosis and for whom screening would be highly desirable—the alcoholics. Since 60 percent of the tuberculosis cases at Grady and 50 percent for Fulton County as a whole in 1972 were among alcoholics (unpublished data, A. Feingold), screening this subgroup should prove fruitful in discovering un-

diagnosed active tuberculosis. Indeed, Chaves and co-workers (8) reported a finding of 16 cases of active tuberculosis per 1,000 men screened in a casefinding program among skid row men in New York City.

If the X-ray screening in this study had been used only for alcoholics, then the cost per discovered case would have been much higher than \$2 per film. If the estimated 2,400 alcoholics in the population had been screened with regular large chest films in the hospital radiology department, the cost (at \$15 per film) would have amounted to \$3,600 per case discovered. This sum might be an acceptable figure for justifying yearly chest X-rays for alcoholics attending Grady Hospital clinics. The best alternative would be to have a small scale microfilm screening program which could accomplish the task at a total cost of \$3 to \$5 per film. The success of such screening would depend on the cost efficiency with which X-rays could be taken.

Since alcoholics are less likely than others to seek early medical attention for their problems, it is relatively more important to discover tuberculosis among their ranks to prevent contact cases as well as to initiate treatment before the disease becomes far advanced. However, screening for tuberculosis among alcoholics does not appear to be an accepted practice.

Screening of the general population is now considered unjustified,

and this study reinforces that position, even for an elderly, chronically ill population. Evidence produced by this study shows that X-ray screening of alcoholics could be fruitful and justified, and might be an important adjunct to controlling tuberculosis in many cities. More such programs need to be initiated and their cost effectiveness carefully analyzed.

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SYNOPSIS

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Over a 3-year period, only 22 new active cases of tuberculosis were discovered as a result of taking 48,000

70-mm X-ray films of generally elderly and chronically ill patients. The cases were among the patients of the general medical outpatient clinic of Grady Memorial Hospital in Atlanta, Ga. Costs for the X-ray screening program exceeded \$90,000.

Ten of the 22 patients with new cases were alcohol abusers. Further analysis

of the program revealed a yield of 1 new active case per 240 alcoholics screened, but only 1 new active case per 3,806 nonalcoholic patients screened. It is argued that screening of alcoholics for tuberculosis should be widely practiced, but routine yearly X-rays for detection of tuberculosis—even in a chronically ill population—is unwarranted.