THE ECONOMICS OF MASS EXAMINATION FOR TUBERCULOSIS[1]

H. R. EDWARDS, M.D.;[2] E. ROCKS; AND A. V. BIORKLUND[3]

DURING the past few years, there has been an increasing interest in case finding as a fundamental step in the control of tuberculosis. The tuberculosis problem has been of such extensive proportions for so many years in most communities that every available method has been utilized to reduce its spread, and if the costs of these efforts are measured against the estimated monetary losses caused by the disease, the expenditures seem very small indeed. Until recently, very little attention has been paid to the cost of a given procedure, and its yield in significant new cases.

There are only occasional references to costs in case finding in the literature and such as do exist are usually not accompanied by the basic items upon which they were computed. Thus, they are not comparable one with the other, and give no basis for the estimation of costs by others desirous of launching a program. As the majority of these programs are financed through tax funds, and as the amount of such funds available is limited, it is well that some basic data be set up that will serve as a guide.

Some workers ignore such items as rent, heat, light, or the salaries of personnel if they were not actually paid for in the specific survey. If the survey is conducted in a public building for which no rent is paid no charge is made. If the tuberculin tests are done by a staff paid for other services, or the radiographs interpreted in a like manner, no charge is made. While these differences represented by the non-expenditure of funds for specific items may in a sense be

[1] Read before the New England Health Institute, Boston, Mass. April 2, 1941.

[2] Director, Bureau of Tuberculosis, New York City Department of Health.

[3] Statistical Assistants, WPA Project No. 665-97-3-48-WP4.

legitimate in estimating costs, they must, nevertheless, be considered if an accurate comparison is to be made between the programs operated under differing auspices.

The mass survey of apparently healthy adults in New York City has been fully outlined in a supplement to the *American Review of Tuberculosis* in June, 1940. It was therefore felt that the analysis of costs of this work for a specific period might help to lay a sound foundation for cost accounting in mass surveys.

This report will therefore deal with as complete a cost analysis as can be made of the mass surveys conducted by the Department of Health in New York City for the period from January 1 to June 30, 1940. During this period 24,136 individuals were radiographed in our surveys, representing individuals from twenty-nine different sources.

The studies in New York City have been done with a certain amount of assistance from the Work Projects Administration. During the period of this study, the contribution from Federal funds is represented entirely in clerical or statistical personnel. A total of twenty-five individuals were assigned to the surveys by Work Projects Administration. The Department of Health provided all the professional staff such as physicians, nurses, and also x-ray technicians, and some supervisory clerical assistance. The costs for materials and supplies (survey x-rays, cut films, tuberculin, stationery, etc.) are indirectly borne by the City of New York as they are taken from funds regularly alloted to WPA by the City to cover similar costs in all WPA Projects.

The rapid paper x-ray method was used on a contract basis. The vendor supplied the x-ray unit, the technicians to operate it, the paper film in rolls, and the technical services required in processing and its delivery to the Department ready for interpretation.

The cost of the radiographs on this plan were based on a sliding scale ranging from 75 cents each where 500 or more were done in a single day to $1.00 where 200 or less were done in the same time.

Occasionally more than one unit was in operation on a given day, however, the above rates held.

The original survey radiographs were usually made in the quar-

Table 1. Cost of x-ray surveys of 24,136 individuals for the six-months period, January 1 to June 30, 1940.

Type of Expenditure			Amount	Per Cent
ORIGINAL MASS SURVEY USING ROLL PAPER.....			$19,251.75	45.45
Contract with vendor includes:				
Films	Typist			
Apparatus	Processing			
Technicians	Viewing Device			
PERSONNEL AND OTHER COSTS REQUIRED TO COMPLETE SURVEYS.....			23,102.15	54.55
Personnel:				
Medical and Technical.....		$8,102.06		
Supervision	1,144.96			
Phy. 600 Sessions	3,000.00			
Nurses	2,876.34			
Technicians Service	574.66			
Laboratory Sputum				
1,446 Sputum Examinations	506.10			
Clerical.....		12,033.34		
Supervision	850.50			
14 Clerks	7,077.18			
1 Stenographer	400.65			
2 Typists	945.61			
5 Research Editors	2,759.40			
Supplies:				
Medical.....		947.03		
1,794 X-ray Films	773.21			
Chemicals	53.82			
Drugs and Sundries	120.00			
Clerical.....		125.00		
General	125.00			
Other Expenses.....		1,894.72		
Rental	1,350.00			
Telephone	90.00			
Electric Service	180.00			
Depreciation of Equipment	274.72			
TOTAL			$42,353.90	100.00

ters of the agency cooperating in the survey. No charges have been made for the use of this space nor the time of the agency personnel in organizing their membership to appear before the machine for a radiograph.

The preliminary planning and organization of a given survey represents almost entirely an effort on the part of the cooperating agency. It has been our custom to outline the plan to the agency and leave the further details to them. The time utilized by the Department staff has been accounted for in the percentage of services devoted to the survey.

The interpretation of the survey film, the subsequent follow-up of the suspicious or definite cases to the point that a final diagnosis and recommendation could be made, and the tabulation and analysis of data were done in the Central Chest Clinic of the Department of Health. A summary of the costs involved from the beginning of the survey to the above-mentioned point is shown in Table 1.

Type of Expenditures

The original x-ray by the roll paper method accounted for 45.5 per cent of the total cost. On the basis of the expenditure for this item the average cost per film was 79.7 cents. This was due to the fact that it was impossible to x-ray a minimum of 500 individuals per working day. This is a real problem in mass survey work that must always be taken into consideration. Prior to the period included in this study, tentative plans had been made to x-ray a minimum of 50,000 individuals. These plans failed to materialize because in some surveys actually done a larger number of individuals was anticipated from estimates of the organization involved than actually were x-rayed, consequently the equipment was scheduled for a longer period than was necessary. In addition, the promises of a stated number per day did not materialize. There were also some surveys planned for the period that had to be cancelled due to change in plans or circumstances beyond our control.

Personnel and Other Costs

Personnel and other costs constituted 54.5 per cent of the total. In computing these costs the material has been divided into certain groupings for clarity in analysis.

Under medical and technical supervision is included personnel and sputum examination. The item referring to supervision represents on a pro-rata basis the time devoted to the surveys by the Director of the Bureau and his supervisory staff. The physicians' time in interpreting survey films, examination, and final diagnosis of cases is indicated as 600 physicians' sessions which are compensated for at the rate of $5.00 per session. The item for nurses' and technicians' services is pro-rated on the basis of their time actually spent on the surveys. It is to be remembered that the Central Chest Clinic where this work is done is also responsible for other services.

The Bureau of Laboratories estimate the cost of a sputum examination on the basis of personnel, materials, and a reasonable overhead for administration and capital investment. On this basis, which seems to be reasonable, the cost per examination at 35 cents is not excessive. All sputa examinations in the laboratory are done by the concentration method.

Clerical. The clerical costs represent full time of WPA personnel, which included an item for supervision inherent in WPA organization but which did not contribute to the actual work of the survey.

Supplies. X-ray films constitute the chief item in the cost of supplies. The cost of 14 x 17 celluloid films to the City of New York is 43.1 cents each as the entire supply for all city services is purchased on an annual contract. Each case requiring follow-up is radiographed on celluloid, using one or more as the individual case demands. The item for chemicals is estimated on the basis of three cents per film. This figure is derived on experience estimates of 25 films per gallon of chemicals at a net cost of 75 cents.

Under drugs and sundries are included tuberculin, syringes, alcohol, cotton, lipidol, etc. In the surveys reported in this study 1,927

high-school pupils were tuberculin tested prior to x-ray examination.

General clerical supplies represent items such as record forms, stationery, postage, and the like.

Other Expenses. The quarters used for the follow-through of the survey work are in a city-owned building for which no actual rent is paid. However, a charge has been made on the basis of rental values for equivalent space in this district of the City. Electric service is based on the actual cost for another location of similar size in which bills were available. The charge for telephone is the actual cost of equipment in this location, as it is an unlimited service no deductions were made for use in other activities.

The depreciation of equipment has been based on acceptable standards for such calculation including x-ray items, typewriters, calculators, adding machines, and miscellaneous equipment.

Unit Costs of Surveys

A clinically significant case has been considered as the basic unit for estimating the cost of case finding. Such a case may be defined as one with radiographic evidence of a lesion characteristic of the reinfection type of pulmonary tuberculosis, varying from the obviously active, with associated constitutional symptoms and physical findings, to those without associated findings, but in which the stability of the lesion cannot be determined without further supervision. A distribution of these costs is shown in Table 2.

On the basis of costs charged against these surveys, the average cost for each individual examined was $1.75. The unit cost for each case of chronic pulmonary tuberculosis (active and arrested) was $58.99, and the cost for each clinically significant case was $146.55.

The variations in unit costs bear a general relationship to the average age of the population studied. Thus the costs among high-school students, with an average age of 16.5 years, was over ten times as great as among the homeless, with an average age of 50.8 years.

The unit cost for all chronic tuberculosis is less than the unit cost for clinically significant cases, also with the increase in average age the ratio of significant to all chronic lesions becomes less.

The unit cost of significant tuberculosis was highest in students in evening high schools and those examined at settlement houses. A classification of racial stock, other than white and colored, was not made in these studies. However, from the areas from which they were drawn it is fair to assume that a high percentage were Jews among whom the tuberculosis rates are low. Further suggestive evidence of this general racial background is to be seen in the higher ratio of arrested tuberculosis.

The college students reported in the study were the positive reactors to tuberculin at Queens College. A total of 1,651 were tested by the College and 462, or 28.4 per cent, reacted and were x-rayed by us. The selection for x-ray by the tuberculin test reduced the cost by

Table 2. Classification of 24,136 individuals surveyed showing total cost per group and unit costs according to diagnosis.

Classification	Number X-Rayed	Average Age	Number Diagnosis Chronic Pulmonary Tuberculosis		Total and Unit Costs		
					Total at $1.7548 per Person	Chronic Pulmonary Tuberculosis	
			Active[1]	Active[1] & Arrested		Active[1]	Active[1] & Arrested
Day High Schools	8,929	16.5	31	36	$15,668.61	$505.44	$435.24
Colleges	462	19.3	4	4	810.72	202.68	202.68
Evening High School	925	29.1	3	12	1,623.19	541.06	135.27
Settlement Houses	3,945	31.1	13	93	6,922.69	532.51	74.44
Civil Service Applicants	596	32.2	0	9	1,045.86	—	116.21
Union Members	3,912	35.1	36	137	6,864.78	190.69	50.11
Prisoners	3,260	38.1	123	222	5,720.65	46.51	25.77
Homeless	2,107	50.8	79	205	3,697.36	46.80	18.04

[1] Active = Clinically significant.

the difference between the cost of x-rays for the total and cost for the reactors. This saving is estimated roughly at $891.75.

This difference is further illustrated in considering the students in high schools included in this study. Only a few were preselected with the tuberculin test, the majority being routinely x-rayed. The two groups are not exactly comparable in all respects. Students in Queens College are, by and large, residents of the Borough of Queens where the death rate from tuberculosis is very low when compared to the general areas of the City from which the high-school students were drawn. Thus, the percentage of reactors in Queens College of 28.4 per cent is considerably lower than other tuberculin studies among high schools similar to the above which average nearer 50 per cent.

A routine x-ray, regardless of reaction to tuberculin, has many advantages in survey work. It is much easier to secure cooperation for an x-ray than for a tuberculin test, and not infrequently non-tuberculous conditions are discovered in non-reactors that need attention. If the purpose of the survey is to secure information on epidemiological factors then the tuberculin test is essential; if the purpose is to discover manifest lesions then the x-ray is necessary. However, in case finding among the younger age groups with equipment now available an appreciable amount may be saved by preselecting the material on the basis of a positive reaction to tuberculin.

For several years a routine x-ray has been required of applicants for appointment to civil service positions in the Departments of Health and Education and the Fire Department. The 596 reported here were those examined during the first half of 1940. It has been noted that since the start of this program the percentage of disease has steadily decreased. This is due to the fact that an increasing number of these individuals are being x-rayed before applying for positions and thus significant cases are automatically eliminated before they come to Civil Service.

The percentage of significant tuberculosis in the members of unions examined in this study was 0.9 which compares favorably with other surveys of union workers involving 33,303 individuals, and in whom the prevalence of tuberculosis was 0.7 per hundred. In our experience in survey work, persons employed, such as members of unions, have a much lower percentage of tuberculosis than those on relief and the unemployed.

Conclusion

An attempt has been made to set up indices of cost that would be fairly constant for specified operations on the basis of this study, but it is not believed that the data thus far can be evaluated in that manner. It would be important to have such indices so that the cost of a survey of a given population could be fairly estimated in advance. Cost analyses such as the foregoing are being made for the year 1940, which will include 98,448 examinations, and it may be that a reasonable average will be obtained.

This study is presented as a preliminary report on cost accounting in mass surveys with the hope that it will stimulate others to report on other methods of survey, such, for example, as fluoroscopy and the fluorographic method using the 4 x 5 or 35 mm film, and surveys using standard sized celluloid or paper in stationary or portable apparatus.

If cost accounting is to be of any value, the analysis must include comparable items of expense regardless of whether or not they represent monies actually expended, or the equivalent of such costs as personnel, rent, and overhead items that have a monetary value.