

Group Chest X-ray Examinations And the Tuberculosis Death Rate

By PHILIP ENTERLINE, B.B.A.

The rapid increase in the number of group chest X-ray examinations as a case-finding procedure is one of the interesting postwar developments in the field of tuberculosis control. During 1946, about 6 million X-rays were taken in the United States for the detection of chest disease, excluding chest X-ray examinations by the armed forces and the Veterans Administration (1). In 1950, comparable information submitted to the Division of Chronic Disease and Tuberculosis of the Public Health Service indicated that about 15 million X-rays were taken. The geographic distribution of mass chest X-ray activities, and the apparent relationship between the intensity of these activities and the striking decline in the tuberculosis death rate during this period are reported here.

Since July 1947, a semiannual tuberculosis report (PHS 1394 TB) has been requested by the Public Health Service from each State health department and the District of Columbia for the 6-month periods ending in December and June. These reports give the number of individuals examined on mass radiography projects in each State and the District of Columbia. Mass radiography projects are defined as "any group X-ray examinations, including contacts, regardless of the size of films, taken for the purpose of detecting pulmonary pathology, but not for the identification of pathology or deter-

mination of activity." The instructions further state that "medical examinations, including X-rays taken in the offices of private physicians or in clinics for the purpose of final diagnosis of tuberculosis or determination of activity, are not to be included."

Because of reporting difficulties within the States, the information actually reported probably understates the true totals in many instances. The magnitude of this error is impossible to calculate, and the data shown here should, for the most part, be considered as minimum estimates. Crude estimates were made for a few periods for which reports were not received or for which a report indicated that a sizeable area of the State was omitted. In some instances, the necessary estimates were obtained from local publications, while in others they were based on reports for preceding or succeeding periods.

Relative Intensity of X-ray Activities

Figure 1 shows the number of X-ray examinations estimated and reported for the years 1946 through 1950. The 1947 figure is an estimate based on reports received for the last 6 months of that year, while the figures for later years are essentially those actually reported. During the period 1946-49, the number of examinations increased by about 2.5 million each year; from 1949 to 1950 the increment was about a million.

The table summarizes data reported by each State during the 3½-year period ended in December 1950 and, in addition, shows aggregate information for nine geographic regions. The

Mr. Enterline is assistant chief of the program analysis section, Division of Chronic Disease and Tuberculosis, Public Health Service.

total number of X-rays taken in the United States was 44,000,000, with an average of about 12.5 million per year. Column 3 of the table shows the average annual percentages of the population X-rayed in each State and the District of Columbia, and in each of nine regions. For the United States as a whole, an average of 8.6 percent of the population was X-rayed annually, while for individual reporting areas the average ranged from a high of 26.5 percent for the District of Columbia to 1.5 percent for

Idaho. States with a fairly high average annual percentage of their population X-rayed during this period include: Minnesota, 16.8 percent; Florida, 16.5 percent; Colorado, 15.3 percent; and Washington, 25.7 percent.

The figures shown for the percentages of population X-rayed annually may be overstated somewhat because some persons receive more than one X-ray during a single year. However, since it is generally recommended that chest X-ray examinations be made annually, it is un-

Chest X-ray examinations and tuberculosis deaths in the United States, by regions and States, 1947-50

Geographic region ¹ and State	Total X-ray examinations July 1947-Dec. 1950 ²	Average annual number of X-ray examinations, column (1) ÷ 3½	Average annual percent of population examined, column (2) as percent of July 1, 1949, population ³	Tuberculosis death rate, 1947 ⁴	Tuberculosis death rate, 1950 ⁵	Percentage decline in tuberculosis death rate
	(1)	(2)	(3)	(4)	(5)	(6)
Grand total	44, 365, 799	12, 675, 944	8. 6	33. 5	22. 2	33. 7
New England	3, 017, 057	862, 016	9. 3	29. 7	18. 6	37. 4
Maine.....	166, 989	47, 711	5. 3	-----	-----	-----
New Hampshire.....	93, 921	26, 835	5. 2	-----	-----	-----
Vermont.....	80, 596	23, 027	6. 3	-----	-----	-----
Massachusetts.....	1, 842, 081	526, 309	11. 1	-----	-----	-----
Rhode Island.....	272, 297	77, 799	10. 0	-----	-----	-----
Connecticut.....	561, 173	160, 335	8. 0	-----	-----	-----
Middle Atlantic	3, 877, 520	1, 107, 863	3. 7	35. 2	24. 3	31. 0
New York.....	2, 701, 225	771, 779	5. 2	-----	-----	-----
New Jersey.....	605, 379	172, 965	3. 6	-----	-----	-----
Pennsylvania.....	570, 916	163, 119	1. 6	-----	-----	-----
East North Central	8, 338, 086	2, 382, 311	7. 9	29. 3	19. 8	32. 4
Ohio.....	2, 698, 972	771, 135	9. 7	-----	-----	-----
Indiana.....	1, 095, 660	313, 046	8. 0	-----	-----	-----
Illinois.....	2, 186, 134	624, 610	7. 3	-----	-----	-----
Michigan.....	1, 368, 487	390, 996	6. 2	-----	-----	-----
Wisconsin.....	988, 833	282, 524	8. 5	-----	-----	-----
West North Central	4, 261, 621	1, 217, 606	8. 9	21. 5	13. 7	36. 3
Minnesota.....	1, 718, 592	491, 026	16. 8	-----	-----	-----
Iowa.....	506, 256	144, 645	5. 7	-----	-----	-----
Missouri.....	656, 312	187, 518	4. 8	-----	-----	-----
North Dakota.....	252, 611	72, 175	12. 4	-----	-----	-----
South Dakota.....	243, 856	69, 673	11. 3	-----	-----	-----
Nebraska.....	380, 591	108, 740	8. 5	-----	-----	-----
Kansas.....	503, 403	143, 829	7. 8	-----	-----	-----
South Atlantic	7, 264, 888	2, 075, 684	10. 2	37. 6	23. 9	36. 4
Delaware.....	84, 018	24, 005	7. 5	-----	-----	-----
Maryland.....	750, 536	214, 439	9. 3	-----	-----	-----
District of Columbia.....	751, 543	214, 727	26. 5	-----	-----	-----
Virginia.....	1, 266, 019	361, 720	11. 3	-----	-----	-----
West Virginia.....	377, 922	107, 978	5. 6	-----	-----	-----
North Carolina.....	891, 663	254, 761	6. 6	-----	-----	-----
South Carolina.....	553, 795	158, 227	8. 0	-----	-----	-----
Georgia.....	1, 068, 048	305, 157	9. 2	-----	-----	-----
Florida.....	1, 521, 344	434, 670	16. 5	-----	-----	-----

See bottom of table for footnotes.

Continued ►

Chest X-ray examinations and tuberculosis deaths in the United States, by regions and States, 1947-50—Continued

Geographic region ¹ and State	Total X-ray examinations July 1947- Dec. 1950 ²	Average annual number of X-ray examinations, column (1) ÷ 3½	Average annual percent of population examined, column (2) as percent of July 1, 1949, population ³	Tuberculosis death rate, 1947 ⁴	Tuberculosis death rate, 1950 ⁵	Percentage decline in tuberculosis death rate
	(1)	(2)	(3)	(4)	(5)	(6)
East South Central	3,900,172	1,114,334	10.0	45.3	30.3	33.1
Kentucky.....	704,740	201,354	7.1	-----	-----	-----
Tennessee.....	1,696,238	484,639	14.9	-----	-----	-----
Alabama.....	707,924	202,264	6.8	-----	-----	-----
Mississippi.....	791,270	226,077	10.9	-----	-----	-----
West South Central	4,071,175	1,163,193	8.2	38.1	26.4	30.7
Arkansas.....	699,964	199,990	11.0	-----	-----	-----
Louisiana.....	819,207	234,059	8.9	-----	-----	-----
Oklahoma.....	851,615	243,319	11.5	-----	-----	-----
Texas.....	1,700,389	485,825	6.4	-----	-----	-----
Mountain	1,800,955	514,558	10.7	39.4	25.2	36.0
Montana.....	251,040	71,726	12.9	-----	-----	-----
Idaho.....	29,296	8,370	1.5	-----	-----	-----
Wyoming.....	75,940	21,697	8.0	-----	-----	-----
Colorado.....	661,508	189,002	15.3	-----	-----	-----
New Mexico.....	166,521	47,577	7.7	-----	-----	-----
Arizona.....	293,408	83,831	11.7	-----	-----	-----
Utah.....	300,120	85,749	12.7	-----	-----	-----
Nevada.....	23,122	6,606	4.2	-----	-----	-----
Pacific	7,834,325	2,238,379	15.8	31.8	19.1	39.9
Washington.....	2,080,319	594,377	25.7	-----	-----	-----
Oregon.....	698,697	199,628	13.4	-----	-----	-----
California.....	5,055,309	1,444,374	14.0	-----	-----	-----

¹ Groupings by the U. S. Bureau of the Census.

² From semiannual tuberculosis reports (PHS 1394 TB).

³ Civilian population estimated as of July 1, 1949, from current population reports, population estimates, series P-25, No. 47, U. S. Bureau of the Census.

⁴ Death rates, tuberculosis (all forms) from Vital Statistics of the United States, part I, 1947.

⁵ Bulletin of the National Tuberculosis Association, September 1951. (A 10-percent sample of the death certificates by the National Office of Vital Statistics yielded the same rate for the United States (22.2) for 1950.)

likely that the number of repeat X-rays is very great in any one year. Moreover, the extent to which the percentages are overstated is probably about the same from one State to another, so that direct comparisons would seem valid.

X-ray Activities and Death Rate Decline

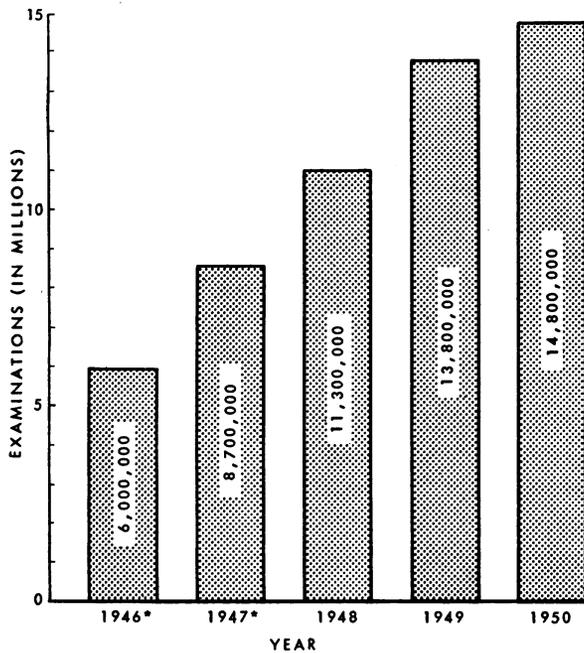
From 1947 to 1950, the tuberculosis death rate (all forms) dropped from 33.5 to 22.2—a decline of 34 percent. This is the largest percentage drop recorded for the United States during any 3-year period since 1921. The only greater percentage drop ever recorded was for the years 1918-21 when the tuberculosis death rate (all forms) dropped from 149.9 to 98.6—a decline

of 35 percent. The 1918 rate was abnormally high, however, and the 1947-50 drop is probably the more significant one.

It would be difficult indeed to isolate any single factor responsible for this favorable experience. Historically, fluctuations in the decline in the tuberculosis death rate have shown little association with the development and application of any new public health techniques and therapeutic measures. Certainly, improvements in housing and general living conditions have been of major importance and may be largely responsible for the postwar decline in tuberculosis deaths. Improvements in case finding, resulting in earlier discovery of the disease, as well as advances in therapy, also have no

doubt contributed to the decline in the death rate as evidenced by the steady decrease since World War II in the percentage of persons discharged from tuberculosis sanatoriums because of death (2-4).

There appears to be some relationship between the intensity of case-finding activities in each of the nine geographic regions tabulated and the decline in the death rate in those regions. This relationship is shown graphically in figure 2. Where the average annual percentage of the population examined was greatest, the percentage decrease in the death rates tends to be greatest as well. (The simple correlation coefficient is 0.800. This is statistically significant at the 1-percent level.) Conversely, where the average percentage is smallest, the decrease tends to be smallest. Although this might appear to suggest that the decline in death rates is attributable to X-ray activities, this is not necessarily true. Both may, in fact, be a result



* Estimated

Figure 1. Chest X-ray examinations in the United States, 1946-50.

of treatment facilities, standard of living, or over-all health department activities.

When the relationship between the number of X-rays taken and the decline in death rate is studied by States rather than by regions,

some of this association disappears. This is largely because in such a comparison the less populous States receive the same weighting as

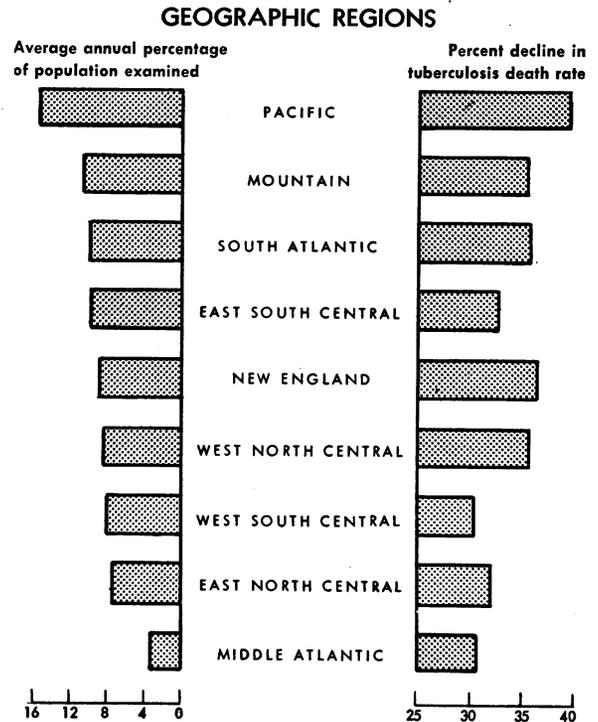


Figure 2. Average annual percentage of population examined and percentage decline in tuberculosis death rate, by geographic regions, 1947-50.

the larger States, and because an unusually great number of these smaller States either had a small percentage of the population examined and a large drop in mortality, or a large percentage of the population examined and a small drop in mortality. More homogenous areas than States are therefore needed for analysis—hence, the use of regions in this report.

Summary

1. The number of chest X-ray examinations in the United States increased from about 6 million in 1946 to 15 million in 1950.
2. On the average, about 8.5 percent of the population of the United States was examined by X-ray during each of the years 1947 through 1950.
3. When data are studied by geographic region, there appears to be a positive relationship

between the emphasis placed on chest X-ray activities and the decline in the tuberculosis mortality rate.

* * *

Reports thus far received for 1951 show a considerable decline in the number of chest X-ray examinations. Probably only about 13 million were made—a decrease of 2 million as compared with 1950. This decrease was greatly accelerated during the last 6 months of 1951, with the total number of examinations for that period nearly 1.5 million below the total for the corresponding 6-month period in 1950.

REFERENCES

- (1) National Tuberculosis Association: Report of the executive office. *In* Transactions of the forty-fourth annual meeting, June 15–18, 1948. New York, N. Y., 1949, pp. 19–60.
- (2) New York State Department of Health, Division of Tuberculosis Control: Annual report, 1950. Albany, N. Y., 1951.
- (3) Drolet, Godias, J.: Tuberculosis—Year 1950. Tuberculosis hospital facilities, New York City. Changing forms of treatment in pulmonary tuberculosis. A report to the Tuberculosis Sanatorium Conference of Metropolitan New York, February 20, 1951. New York, N. Y., New York Tuberculosis and Health Association, 1951, 12 pp.
- (4) Barnwell, John B.: Care of the tuberculous veteran. *J. A. M. A.* 146: 1372–1376 (1951).

Prevalence of Tuberculosis in the United States

Current estimates place the number of active tuberculosis cases in the United States at 400,000. Of this number 150,000 are undiscovered.

These figures replace the half-million estimate, widely used during the past decade, which was based on tuberculosis mortality data. The new estimate is based upon the findings of chest X-ray programs throughout the country, plus an inventory of tuberculosis cases registered with local health departments. A joint committee of the National Tuberculosis Association and the Division of Chronic Disease and Tuberculosis of the Public Health Service prepared the new estimate.

Recent chest X-ray surveys of adult populations (15 years of age and over) have revealed approximately one active case for every 1,000 examinations. Since there are approximately 110 million adults in the United States, the committee believed that there were probably at least 110,000 undiscovered active cases of tuberculosis. The upward adjustment of this 110,000 estimate to 150,000 was based upon the belief that estimates from surveys tend to understate

the true prevalence of undiscovered tuberculosis and to compensate for the omission of the active cases in the population under 15 years of age.

Information available from health department case registers in all parts of the country—operated under widely varying conditions and representing about one-fourth of the population of the United States—indicates that for the country as a whole there are records for about 250,000 active tuberculosis cases. This figure, when added to the estimated 150,000 undiscovered active cases, yields the 400,000 figure.

In addition, the committee estimated that there are 800,000 important inactive cases of tuberculosis in the country, 550,000 of them currently undiscovered. This estimate was also based upon the findings of chest X-ray programs and an inventory of tuberculosis cases registered in the United States.

The current estimates released by the committee are summarized as follows:

	<i>Total</i>	<i>Known</i>	<i>Undiscovered</i>
Total -----	1,200,000	500,000	700,000
Active -----	400,000	250,000	150,000
Inactive -----	800,000	250,000	550,000