PHOTORADIOGRAPHY IN SEARCH OF TUBERCULOSIS

BY

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FOR MY WIFE

FOREWORD

Twenty years' service writes this book—service that has been devoted to the control of tuberculosis by clinics, surveys and conferences in one of our most forward looking States.

If trouble in organizing and carrying forward mass x-ray surveys is to be avoided, this volume is required reading. Its warnings are clear; its attention to detail encouraging; its desire to make case finding a permanent part of each community most commendable.

Take for instance the statement, "The author prefers a slow, sustained, systematic attack upon the problem of unsuspected pulmonary tuberculosis in the presumably well population." The keynote of the entire essay is to start the job right, push it consistently, and make the locality health conscious.

Then, too, the plan gives the medical profession responsibility, and medical men thrive on responsibility provided it is medical. Take for instance the directions to the examinee found to have a chest abnormality. These specifically state he is to be referred to his physician with all helpful data made immediately available. It is plainly evident that the profession is an integral part of the tuberculosis program, thereby securing essential interest and help.

Then there is the emphasis on the opportunity for research. Attention is called to the opportunity to discover more about pathogenesis of tuberculosis, to learn of the significance of apparently inactive lesions, and to find out how minimal lesions behave in different age groups.

For those about to embark upon a mass x-ray survey the clear attention to organization, and the constant attempt to outline the responsibility of each agency, committee, and individual, make this volume an asset not to be neglected.

Twenty years of service show in its writing.

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PREFACE

The terms "mass chest radiography, mass miniature radiography, photofluorography, and photoradiography," specify a screening technique for mass production of chest roentgenograms. By means of small-sized photographic chest negatives, it is possible to single out persons suspected of having pulmonary tuberculosis or other chest conditions, for further clinical and x-ray investigation.

Two publications have appeared on this subject. Hilleboe and Morgan, in "*Mass Radiography of the Chest*" describe the photofluorograph and its effective use. War-time experience with employees in very large industrial plants has impressed these authors with the ease of screening large numbers of persons at minimum cost. Trail, Trenchard and Kennedy, in their book, "*Mass Miniature Radiography,*" are not so sanguine as to the ability of a given operative team to produce more than a specified number of quality films. These authors rightly emphasize the necessity for efficient organization, experienced personnel, and the desirability for correct diagnosis by the survey unit.

It should be realized that pulmonary tuberculosis case-finding methods must depend in large measure upon the existing system of medical practice. In this respect, the survey procedure in Great Britain varies in important detail from that which can be adopted in the United States. The principal difficulty at present, even in the larger centers of population, is the disparity between the available photoradiographic equipment and other indispensable facilities. In the United States, while x-ray equipment is freely available, chest diagnostic centers and trained personnel are often inadequate to complete the diagnosis of the suspected chest condition and to carry out the necessary follow-up examinations.

The introduction of mass chest radiography to the civilian population is by no means an easy undertaking. It must be done without inducing a possibly false sense of security in the great majority of persons who are found to have normal chests on the initial examination. Two methods are now in use:

1. The x-ray apparatus is brought to assembled employee groups in store, factory, office or educational institution.

2. The citizens of a community are invited to accessible x-ray centers by the use of spectacular publicity, and, if possible, by house to house canvassing. This may be accomplished either by the so-called cam-

paign approach, or by the continuous program method. The high-pressure campaign technique requires multiple x-ray units, adequate technical and professional personnel, and, not least in importance, sufficient financial resources with ability for rapid community organization and high-pressure publicity in order to arouse not only interest in the community generally, but also a willingness to participate personally in the x-ray program. The campaign approach is rapid, spectacular, high-geared, but its contribution to tuberculosis control may be equally fleeting. The author of this monograph prefers the relatively slow, sustained, systematic attack upon the problem of unsuspected pulmonary tuberculosis in the presumably well population. The plan proposed is based upon extensive community organization and adequate chest diagnostic facilities, in addition to the survey procedure. The promotional aspect of the survey program is regarded only as a necessary prelude to a well integrated campaign of tuberculosis control.

A chest x-ray for each person to whom x-ray service is offered is the immediate objective in mass chest radiography. In order to bring about individual acceptance of the examination, education regarding pulmonary tuberculosis is necessary. Facts about the disease and the need and value of periodic chest x-rays should be stressed. The educational program must be continuous and purposeful in order to influence people in large or in small numbers.

The ultimate aim in the demonstrative chest x-ray surveys as opposed to the short term objective is the establishment of chest x-ray service which will be available on a permanent basis to all persons either through private physicians, health departments, or cooperating community health agencies.

The attainment of these objectives will depend in large measure upon education, not only education of the people themselves but also education of official and voluntary health agency leaders.

More than twenty years experience with mass tuberculin testing and x-ray examinations conducted by the Department of Public Health in the schools and colleges of Massachusetts has convinced the author that in a comprehensive program of mass chest radiography only time, persistence, and quality work will bring the desired results. There was resistance at first in Massachusetts to the tuberculosis school program by school officials and parents alike. Only when the tuberculous 'teen age children resumed their studies after successful treatment, did the practical value of the school program become evident. Resistance then gave way to enthusiastic acceptance.

Mass chest radiography should be planned with thought to furthering

tuberculosis research. The data incidental to the Massachusetts School Program was used later in extensive epidemiological study. Ten years of painstaking follow-up of pulmonary tuberculosis in youth contributed knowledge to the pathogenesis, treatment, and prognosis of the disease. Much has been learned of the behavior of pulmonary tuberculosis in the past twenty-five years by serial x-ray study. Gaps, however, still exist in the available knowledge of the disease. Careful study in the future of serial x-ray films which will accumulate rapidly in mass chest radiography, may possibly solve some of the remaining problems in the pathogenesis and course of pulmonary tuberculosis in the adult. For a solution of these problems, accurate records will be necessary. The questions awaiting adequate answers are:

1. How often does adult pulmonary tuberculosis heal spontaneously with or without x-ray residuals?
2. How often is the subacute chronic subapical tuberculosis infiltrate preceded by a slight apical focus? What is the x-ray pattern of the apical focus?
3. What is the relationship of the calcified primary complex, acquired in childhood, to progressive phthisis in the third and later decade of life?
4. Does primary pulmonary tuberculosis in the adult behave differently from that in childhood?
5. Is phthisis of the aged always preceded by indurative apical foci?
6. What is the x-ray characteristic of apical foci which seldom lead to progressive phthisis?
7. Is it possible to establish x-ray criteria for accurate differentiation of active from inactive pulmonary tuberculosis, without recourse to troublesome, repetitious, laboratory procedures; which may not be acceptable to persons who feel well, and which may not be psychologically desirable?

The author is deeply grateful to Miss Katharine M. Riordan for help in the preparation of the material, to Miss Grace M. Carroll, Public Health Nurse, for demonstrating the feasibility of successful follow-up where the local board of health has adequate diagnostic facilities as well as an interested and efficient nursing staff; and to Miss Beryl Roberts, Educational Secretary of the Massachusetts Tuberculosis League, Inc., for her ideas on preliminary community and company organization for health education described in Chapter III.

The author is appreciative of the assistance of his son, Sumner Zacks, without whose skill and industry in the many days and nights spent in the darkroom preparing the photographic reproductions, it would have been impossible to present the illustrations in the Atlas.

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Chapter 1

INTRODUCTION

The present photoradiograph, when properly used, is a fairly efficient tool for finding unsuspected pulmonary tuberculosis as well as other chest conditions. The extent of hidden pulmonary tuberculosis, which previously could only be inferred, has now been made visible by the application of mass chest radiography to unselected population groups.

From experience in mass chest x-ray surveys, the pulmonary tuberculosis problem may now be stated as follows: of 1000 adult white persons, 13 exhibit x-ray evidence of active or inactive pulmonary tuberculosis. The incidence is directly related to age; the rate rises consistently from 2 in 1000 for the age group 15 to 19, to 37 in 1000 for the age group 60 years and over. The rate is consistently higher in males. There is a preponderance of advanced disease in the age groups 40 years and over for both sexes, but to a lesser extent in females. The extent of recognizable tuberculous lung pathology is 80 per cent minimal, 15 per cent moderately advanced, 5 per cent advanced, according to classification of this disease by the National Tuberculosis Association. The relative frequency of significant pulmonary tuberculosis varies inversely with age; the older the person at the time of examination, the greater is the proportion of inactive pulmonary tuberculosis, as compared with active disease. It is significant that 88 per cent of advanced pulmonary tuberculosis discovered in persons able to work was unsuspected before the chest x-ray examination. The reported incidence of pulmonary tuberculosis discovered by x-ray during the war years in the general population was fairly uniform throughout the United States, Canada, and Great Britain.

Valuable as chest x-ray examinations of industrial groups are in measuring the extent of the pulmonary tuberculosis problem in presumably healthy people, this approach in itself cannot be considered the complete answer to the eradication of the disease. There are many weaknesses in confining pulmonary tuberculosis case-finding to assembled groups in industry. Photoradiographic chest examinations in small scattered factories are uneconomical because of the limited number of persons that can be examined in a day. In the relatively few large industries with full time medical personnel, it is exceptional for the medical department to be willing or able to adopt a permanent inplant tuberculosis control program following the survey examination.

TABLE 1

INCIDENCE OF PULMONARY TUBERCULOSIS IN CHEST X-RAY SURVEYS OF CIVILIAN EMPLOYEES IN MASSACHUSETTS INDUSTRIES, 1943–1945, BY AGE, SEX, AND SIGNIFICANCE OF LESION

MALE		RATE PER 1000			FEMALE		RATE PER 1000			COMBINED		RATE PER 1000		
Age Group	Number X-rayed	All Pulmonary	Pulmonary Active	Pulmonary Inactive	Age Group	Number X-rayed	All Pulmonary	Pulmonary Active	Pulmonary Inactive	Age Group	Number X-rayed	All Pulmonary	Pulmonary Active	Pulmonary Inactive
15–19	2424	2.0	1.6	0.4	15–19	5625	2.1	1.6	0.5	15–19	8049	2.1	1.6	0.5
20–24	2134	5.1	1.9	3.2	20–24	9429	3.6	2.9	0.7	20–24	11563	3.9	2.7	1.2
25–29	4996	6.0	3.0	3.0	25–29	6462	6.0	3.2	2.8	25–29	11458	6.0	3.1	2.9
30–34	7167	8.7	3.1	5.6	30–34	4904	8.0	4.3	3.7	30–34	12071	8.4	3.6	4.8
35–39	7058	12.1	3.8	8.3	35–39	4456	11.9	4.9	7.0	35–39	11514	11.9	4.2	7.7
40–59	22445	20.4	6.9	13.5	40–59	10783	16.0	7.0	9.0	40–59	33228	19.1	7.0	12.1
60+	5253	39.9	15.4	24.5	60+	736	19.0	6.8	12.2	60+	5989	37.4	14.4	23.0
15–39	23779	8.1	3.0	5.1	15–39	30876	5.7	3.2	2.5	15–39	54655	6.7	3.1	3.6
40–60+	27698	24.2	8.5	15.7	40–60+	11519	16.2	7.0	9.2	40–60+	39217	21.9	8.1	13.8
15–60+	51477	16.8	6.0	10.8	15–60+	42395	8.6	4.3	4.3	15–60+	93872	13.1	5.2	7.9

As the publicity which usually accompanies the chest survey must be directed intramurally, the community at large is not always aware of this important campaign. A serious handicap is the lack of a comprehensive employment policy for persons having pulmonary tuberculosis. The employees are, therefore, fearful lest an unsuspected chest abnormality jeopardize their jobs. Because of this insecurity, workers usually will not accept examination unless the chest findings, if any, are confidential. The preservation of this confidence necessitates a circuitous follow-up procedure. For these reasons, a sounder approach to pulmonary tuberculosis case-finding is mass chest radiography on a community basis.

It should be realized that a mass chest x-ray survey, no matter how painstaking and thorough, is but the first important step and in itself can offer only a partial solution to the complex pulmonary tuberculosis problem. Identification of the case is not enough. There are many related problems; problems of isolation, treatment, supervision, socio-economics and psychology; which must be considered seriously in planning a total pulmonary tuberculosis campaign. Otherwise, a critical appraiser of the mass chest x-ray method (particularly if he is not well-disposed toward the procedure) will regard the failure to solve these related problems as evidence of inadequacy of the survey method and its promoters. The time seems favorable to undertake a complete solution of the tuberculosis problem. The population is x-ray conscious as a result of the large scale chest x-ray examinations carried out by the military and by the United States Public Health Service in industry.

Experience with industrial examinations shows the chest x-ray examination has considerable popular appeal. Seventy per cent of employees respond to the usual introductory publicity. A greater effort is needed, through personal appeal, to raise this response to 90 per cent. A total response in industrial groups can be expected only where ideal relationship exists between management and labor. For a successful chest x-ray survey, an enthusiastic and cooperative full-time medical staff in the plant is essential.

The reactions of individuals to suggestive chest findings varies. The majority will not become alarmed. If left to themselves, most persons would ignore the notice requesting them to consult the family physicians as long as they are able to work. The indifferent individual must be tactfully warned of the danger to his health. The few persons who become over-anxious must be re-assured to avoid, if possible, tuberculophobia. The tradition that tuberculosis is a stigma is so old and so generally accepted that intensive and widespread popular education is required to overcome the false notion. In the disposition of persons

with important chest x-ray findings, one of three methods may be used:

PLAN I. A chest x-ray survey is ideal when it permits a correct diagnosis. The patient is then referred to his personal physician for treatment or observation. A correct diagnosis is possible only when an efficient chest diagnostic clinic is part of the x-ray survey procedure.

PLAN II. The next best arrangement is to take a 14 x 17 inch film and a clinical history if the small chest film reveals an abnormality. From this information, a tentative diagnosis or differential diagnosis should be made. The patient is then advised to consult his physician who is notified of the x-ray findings.

PLAN III. The least desirable method of mass chest radiography is when a question of a specific chest condition is raised on the small film and a second person or facility must be depended upon to complete the diagnosis. Even with the best organization, this poor approach may be necessary occasionally where a chest condition is suspected in the miniature film and the individual concerned refuses further examination by the x-ray survey unit.

Plan II is commonly used throughout the United States at the present time. The personal physician receives a report of suspicious chest findings, tuberculous or otherwise, noted on the miniature film and confirmed by a retake 14 x 17 inch celluloid film. The usual procedure, it should be noted, is reversed in that the chest physician sends an unsolicited report to the general practitioner. The x-ray report, however, should be regarded by the general practitioner as a tentative diagnosis only. The making of the correct diagnosis becomes the duty of the personal physician and the roentgenologist or chest consultant for the person who can afford private service. If the individual cannot afford the necessary additional x-ray and other study, the doctor should refer his patient to the nearest free chest clinic. There is no question here of so-called socialized medicine. Mass chest x-ray examination is an ethical attempt to get at the root of tuberculosis control. It is incidental that other important chest conditions are discovered which cannot be ignored. The personal physician, however, has a reciprocal duty to report his findings to the x-ray survey unit physician. In this manner, the patient is placed under proper treatment or supervision and the x-ray survey unit doctor becomes more proficient in the correct interpretation of chest conditions. Compulsory reporting of tuberculosis and the "See Your Doctor" approach to the problem of tuberculosis control in the past fifty years has not proven wholly satisfactory because it is now clear that pulmonary tuberculosis usually develops silently and slowly. Better results may be expected from a

comprehensive tuberculosis control program based upon routine chest x-ray examinations and sustained popular education.

This book is an attempt to record the experience of the author in the planning and execution of mass chest x-ray surveys. It deals with organization, personnel, and operation of mobile units. The problems of viewing and interpreting small chest x-ray films are considered as well as follow-through, follow-up, and disposition of persons with suggestive x-ray abnormalities in the chest. The role of the general practitioner and the industrial physician in the chest x-ray survey procedure is discussed. Suggestions are made for standards in the management of persons with chest abnormalities by chest x-ray clinics. Health education is stressed in attaining communal cooperation and individual consent. A frank discussion of some of the unsolved problems of tuberculosis case-finding, it is hoped, may result in a sympathetic understanding by the medical profession, the voluntary health associations, and official health departments. Without co-ordinated team work, chest x-ray surveys cannot attain their great purpose, the eradication of pulmonary tuberculosis.

CHAPTER 2

ORGANIZATION

Mass chest radiography, to attain its aim, should be planned methodically to include the total population rather than assembled groups exclusively chosen for accessibility or a willingness to participate. At its maximum, a photofluorograph with two operating teams can x-ray 800 persons daily on a ten-hour exposure schedule, if such a number can be assembled, and if trained personnel, including x-ray "interpreters" are available.

There is, however, a practical limit to the number of exposures that can be made by the x-ray tube and by a workable x-ray survey field staff. The criteria should be, not how many small films can be theoretically exposed in a day, but how many persons can be assembled at a given place in a given time and handled with comfort by the operating team. The number that can, or should, be "screened" in a day by the examining physician must also be considered. A reasonable number of yearly examinations for one x-ray field unit is fifty to sixty thousand persons with 4x5 inch film and eighty thousand persons with 70 mm. roll film.

The organizational problem may then be stated in terms of x-ray units which are needed to survey and resurvey the population within a reasonable time. A suggested plan is to begin with the larger population centers. One x-ray field unit should be assigned to each 100,000 of the population. While the educational campaign is in progress, assembled groups such as high schools and larger factories may be x-rayed first. It is usually feasible to x-ray one-half of a community of 100,000 during the first year of the survey, the remaining half during the second year. In the third year, the community group first surveyed should be resurveyed. While yearly chest x-ray surveys may be desirable, such repetition is neither practical nor possible at the present time. The re-examination of the community should be rotated as stated for six or ten years, depending upon subsequent results. At the end of the survey period, the x-ray field unit should be installed permanently in a health center which should be developed in the meanwhile as an integral part of the mass chest x-ray procedure. If health education which accompanies the mass chest x-ray survey has been effective, the citizens will then either come to the established chest x-ray clinic voluntarily, or may be recalled for examination.

It should be realized that considerable time and effort are necessary to elaborate a community-wide program. All interested groups should be brought into the program in the planning stage. It is important, however, to demarcate clearly at the beginning, the scope and duties of each participating agency; that each may know its share in this co-operative venture and be prepared with equipment and personnel to meet its full share of responsibility. An effective mass chest x-ray program will result only from joint effort of the State Department of Public Health, local Boards of Health, medical practitioners, the voluntary health and tuberculosis association and other sponsoring groups.

The Voluntary Health and Tuberculosis Association

When mass chest x-ray examinations were accepted as good tuberculosis case-finding procedure, the voluntary health and tuberculosis associations in the United States became interested in this program. In Massachusetts, for example, the Massachusetts Tuberculosis League, Inc., presented a mobile x-ray unit to the State Department of Public Health. This unit was the only one in operation until funds were made available by the United States Public Health Service when two additional x-ray field units were purchased by the Massachusetts Department of Public Health. The three x-ray field units are now in constant use in industry and community-wide chest x-ray surveys which are co-sponsored by the local official and voluntary health agencies.

If the main objective of tuberculosis control is to become a reality, the local official health departments and the voluntary tuberculosis associations must learn to work together, since neither can successfully conduct community chest x-ray surveys without the help of the other. At best, the planning for a community-wide program is a difficult undertaking. Both health agencies must willingly pool their resources. When a harmonious relationship exists between the official and the voluntary health agencies, it then makes little difference which of these agencies takes the initiative in the program. Should the local board of health point the way, the local tuberculosis association must willingly cooperate. Should the local tuberculosis association take the initiative, then the local board of health must freely contribute its full share. Sharing of program activities, in which the educational phase is conducted by the voluntary health association, will usually bring both health agencies together, enabling each to know the other better and to appreciate the value of cooperative effort in a common endeavor. This collaboration, if freely given, will be an educational experience for both. The tendency of the local voluntary health association is to