In the medical organization of a modern army it is essential that special measures be taken for the control of tuberculosis. Military experience in the past has shown that tuberculosis will be costly in the medical personnel and facilities required, in the loss of trained soldiers, and in ultimate expenditures for disability pension, unless suitable measures are taken to control the disease at the beginning of mobilization.

Tuberculosis is known to have been a serious medical problem in the armies of every war, but the magnitude of the problem first became apparent with the comprehensive records kept in the armies of the first world war. The United States Army recognized the gravity of the problem when mobilization began, for the experience of the French Army had already furnished a valuable index, and measures were taken promptly, by the best methods available, to exclude men with this disease. The most accurate method then available was physical diagnosis, and recruits were examined by teams of experts, who rejected many thousands of cases. However, the procedure of physical examination is not sufficiently accurate to detect most minimal lesions, and a large number of clinically significant cases escaped detection. This failure of discovery was reflected in a subsequent rate of discharge for tuberculosis of approximately six men per thousand strength per year.

When mobilization of the United States Army was ordered in 1940, better methods were at hand, and early consideration was given to their best use. It was recognized that military requirements would impose special difficulties not encountered in the control measures applicable in a civilian population. The first requirement was speed of operation, and the second a system that would not interfere with the training program of a soldier, once he had been accepted for military duty. In conformity with these primary requirements a program of rapid X-ray examination was set up, as a part of the entrance physical examination, and as soon as facilities were available prior to entrance in the Army X-ray examination became universal. In the general medical organization of the Army medical officers were alert to the importance of tuberculosis, chest examinations, including radiography, were made whenever chest disease was suspected, cases discovered were promptly hospitalized for observation and care, and after suitable initial treatment patients with active disease were discharged from the Army, with provision for their further care by the Veterans Administration.

METHODS AND STANDARDS OF THE INDUCTION EXAMINATION

It was the original aim of the Office of The Surgeon General, and urgently recommended by the advisory committee on Tuberculosis of the Division of Medical Sciences of the National Research Council, as well as the National Tuberculosis Association, that every recruit have a chest X-ray examination before acceptance for military service. This objective was not fully realized until April 1942. By that time two million men had enlisted or been inducted under the provisions of the National Selective Service Act, of whom one million had not
been X-rayed. After this date X-ray examination was mandatory and in routine operation throughout the country, and more than eight million men subsequently inducted in the Army were all X-rayed.

Early in the war the system of voluntary enlistment, long in effect, was abrogated, and men were called for military service under the National Selective Service System. An initial physical examination to eliminate men with gross physical defects was made by civilian medical examiners attached to the 6,000 local boards of the Selective Service System, and these boards also excluded hospitalized persons obviously unfit for service, including patients in tuberculosis sanatoria. Men called for service then proceeded to one of ninety-five induction stations operated by the Army and Navy, where a thorough physical examination was given. As indicated above, after a developmental period, when equipment was being made available and suitably trained personnel secured, this examination included an X-ray examination of the chest.

In the early period of operation of the induction stations procedure for roentgenography was not uniform. The examination was made by the method most readily available locally. Standard 14 by 17 inch celluloid films, 14 by 17 inch paper films and 4 by 5 inch miniature films made by phororontgenography were all used. After the short developmental period, however, the last named method, developed by D'Abreu of Rio de Janeiro, and already in active operation in a number of civilian programs in the United States, was established as standard. Every induction station was furnished the necessary equipment for stereoscopic 4 by 5 inch films. The standard procedure was to make 50 stereoscopic films at one minute intervals, followed by a 10 minute rest period. Three hundred examinations a day was considered the optimum number per machine and per radiologist. During periods of unusually active processing of recruits this number was greatly exceeded, however. The individual induction stations varied from a daily load of 100 to 3,000 men a day.

Films were taken, developed, interpreted and reported within a period of two hours. This speed was essential in order to complete the entire physical examination within the few hours generally allowable under the required system of rapid movement of recruits.

After they had served their immediate purpose all films were sent to a large centralized X-ray film file maintained by the Veterans Administration in Washington, D. C. There they are available for any desirable subsequent comparison. Chest X-ray examination is required upon discharge from the Army and all discharge films are filed with the corresponding induction film. Interim chest X-ray films made in Army hospitals are not filed at the Veterans Administration, but the latter sends induction films, on request, to any Army hospital desiring to compare a currently taken film with that made at the time of induction.

The standards set for chest examination were designed to exclude active tuberculosis and potentially active disease likely to break down under the strain of military conditions. They were so drawn as to permit acceptance of men with arrested lesions of both primary and reinfection type, of extent and character affording reasonably strong assurance that they would never break down. These standards, which were published in Army Mobilization Regulations, were based on recommendations made by the previously mentioned Committee on Tuberculosis of the National Research Council, which was made up of experts in the diagnosis and treatment of tuberculosis.

**Results of Induction Examination**

During the five years, from the beginning of mobilization to the fall of 1945, approximately 18 million men were examined, 150,000 of whom were rejected from
the armed forces because of the presence of tuberculous lesions of serious or potentially serious character discovered in chest X-ray films. The majority of these were cases of minimal extent not recognizable by any other means than X-ray examination. In only a relatively small number of cases was the existence of a lesion known to its owner.

Thus the X-ray examination, obligatory for a military purpose, proved a highly effective measure in the general antituberculosis program of the nation. A large number of persons whose disease would have gone undetected until it had reached a considerably more advanced state learned of its existence in time to take appropriate measures for its cure. At the same time those states and other governmental divisions with vigorous public health programs recognized in the induction station examination an opportunity for the discovery of sources of infection and institution of control measures. Army regulations were drawn in conformity with state regulations requiring reporting of all cases of active tuberculosis, and by arrangement with the Selective Service System, which automatically received the chest films of rejected men, the films of men discovered to have tuberculosis were forwarded, when desired, to the appropriate state, county or municipality public health officer.

The degree of success of the chest X-ray examination for its immediate purpose of exclusion of unfit persons from military service is best measured by the number of cases of tuberculosis recognized later in military service. Actually in the five years that have elapsed since the declaration of a national emergency and the beginning of mobilization of an army from the citizens of the country, a not insignificant number of cases of tuberculosis have developed, and subsequent comparison of X-ray films with those taken at the time of induction, has indicated that in a large percentage of cases a lesion existed which should have been detected at the time of the initial physical examination. Several reasons are apparent for the failure to detect certain cases of tuberculosis at the time of the initial physical examination. The chief one was the necessary speed of the examination. Analysis of the records of the different induction stations shows that all made errors, including the stations with the most highly qualified professional personnel. However, the number of mistakes made did vary with the skill of the radiologists reading the films. The Army's need for radiologists in the enormous chain of hospitals established in the United States and overseas proved a severe handicap to the induction stations, which, because of the military exigencies, could not be assigned the most highly qualified personnel, nor assured of the continuing service of those assigned. Large numbers of civilian radiologists were employed on a part time basis. Their duties in the civilian population had been multiplied by the withdrawal of a high percentage of the medical profession for military duty, however, and the service they rendered was given under unusual difficulties.

In spite of these defects the system was effective in excluding the great majority of cases of pulmonary tuberculosis from military service. Whereas the number of persons rejected at the induction physical examination averaged from 1 to 1.5 per cent during the five year period, the subsequent rate of admission of men with definite or suspected tuberculosis to Army hospitals averaged only 1.2 men per thousand strength per year. This rate is almost exactly one-tenth of that prevailing in the first world war. The accompanying graph furnishes a comparison of the hospital admission rates for tuberculosis in the United States armies of the two wars.

The discharge rate for tuberculosis is much smaller than the admission rate, however, as the latter includes all cases admitted to an Army hospital with a diagnosis of tuberculosis, irrespective of the severity or clinical significance of the latter. It will be recalled from the description of standards employed that
persons with scarred lesions considered quite stable were accepted for service. In many of these cases subsequent suspicion was raised when the lesion was rediscovered on radiological examination. In the majority of these, however, clinical study confirmed the belief of the original examiners in the stability of the lesion. The discharge rate, which is essentially equivalent to the incidence rate of active tuberculosis in the Army, has averaged approximately 0.6 per thousand strength per year, or one-tenth of that prevailing in the other world war.

Certain features of the chart require explanation. In each an initial rise in the admission rate is evident. This represents, in large measure, discovery of cases missed in the period when mistakes in acceptance were most frequent. Whether the method of exclusion was based on physical diagnosis (World War I) or X-ray examination (World War II) it is evident that mistakes were much more frequent during the developmental period than later. A large proportion of the cases represented by the curve for World War II belonged to the group of one million men who did not have an entrance X-ray examination.

The second rise in the curve represents cases discovered at the time of physical examination on discharge. Whereas the height of the curve in the intervening space represents cases discovered on the basis of symptoms or accidental observation, the rise at the end of the curve, represents the results of deliberate search for new cases by examination of all men discharged. It will be noted that a rise is commencing in 1945. A temporary continuation of the rise is expected as demobilization continues.

**Disposition of Cases of Tuberculosis**

A system for the care of clinically significant cases of tuberculosis is in operation which makes use of the Army hospitals of different types and the extensive chain of hospitals for the care of tuberculosis maintained by the Veterans Administra-
Cases of tuberculosis discovered in the Army in this country are usually found on an Army post, to each of which a "station hospital" is attached, and therefore receive initial care at that type of hospital. Except in the case of very small posts these hospitals are empowered to discharge disabled persons from the Army, and, during the five years since mobilization began, a considerable number of men with obviously active tuberculosis have been discharged from the Army by station hospitals for continued care in tuberculosis hospitals of the Veterans Administration. Here they may remain as long as is necessary to complete their treatment.

When a case is not clearly one in which discharge to the Veterans Administration is immediately desirable, and particularly in those cases where further Army observation and care is necessary for establishment of diagnosis and determination of prognosis, patients are transferred to any one of the large number of general hospitals maintained by the Army. Two of these general hospitals have been designated as special centers for the treatment of tuberculosis. These are Fitzsimons and Bruns General Hospitals, situated respectively in Denver, Colorado, and Santa Fe, New Mexico. The latter of these two hospitals has been used chiefly for the care of patients evacuated to the United States after discovery of their disease in the Army overseas. At these hospitals they receive standard treatment for tuberculosis, for a period which is limited, but sufficient to initiate proper measures for arrest of the disease, and to indoctrinate patients on the principles of the treatment of tuberculosis and necessity for continuing care. These two hospitals are excellently equipped and staffed by specialists.

Treatment in Army hospitals in general is based on standard measures, the chief of which are rest, expert nursing care, adequate diet and collapse therapy. Chemotherapy is looked upon as still in the investigational phase, and this type of therapy has, up to the present time, been used in the Army on a small scale only. Certain important investigations are, however, in progress.

The Veterans Administration maintains nineteen tuberculosis hospitals and has additional beds for tuberculosis cases in a number of general hospitals. The hospitals are distributed in different sections of the country in such a way as to allow for the selection, by a tuberculous veteran, of an institution near his home, where he may be readily visited by relatives. Pensions are paid to patients with tuberculosis, which are subject to annual review.

**Tuberculosis in the Army Overseas**

The Army has maintained separate accurate records on the hospital admission rate for tuberculosis in the United States and overseas. Although environmental conditions and the physical strains of combat may tend to favor breakdown from small latent foci of infection, and the opportunities for exposure may be considerably greater, the incidence of discovered tuberculosis has been consistently lower in troops overseas than in the United States. Up to the present time this fact has held for all theaters, including tropical regions, which are considered by many tuberculosis specialists as prone to reduce resistance to tuberculosis. In general the rates from the different theaters have averaged approximately 0.9 per thousand strength per year, or about three-fourths of the prevalent rate in the Army in the United States.

The apparently more favorable trend in troops overseas is explained on the basis of the training and care to which men are submitted prior to embarkation for foreign service. The circumstances of dispatch overseas in the period of combat did not permit a complete reexamination of soldiers comparable to the induction physical examination. X-ray examination was required only where some indication for its need was evident. However, the months of training to which
each soldier was subjected prior to dispatch overseas furnished an abundant opportunity for the discovery of existing cases. Medical attention is constantly available to all soldiers, and symptomatic tuberculosis is therefore likely to be discovered. Cases so detected add to the rate for continental United States and not the overseas rate, which, therefore, is smaller. In addition to the discovery of cases on a symptomatic basis, many are detected through routine examination in the United States, as for officer candidate school and special services such as flying and paratrooper duty.

How much tuberculosis has developed from new infection in the Army overseas is as yet undetermined. The answer to this question may be furnished when the immediate objectives of demobilization are attained and opportunity is at hand for the prolonged comparative study of induction and discharge films necessary for the determination. Up to the present time there has been no indication of a serious increase in the tuberculosis rate from exogenous sources. However, judgment is reserved on this question, for it is recognized that evidence of infection may not become apparent for many months.

The development of tuberculosis in the forces overseas introduced the special problems involved in evacuation through a chain of mobile hospitals and further evacuation to the United States. A considerable number of the cases discovered were diagnosed in advanced positions in combat areas. Remarkably accurate diagnosis was often made in field hospitals housed in tents, with limited laboratory and X-ray facilities. Motor transport was ordinarily available for transfer of such cases to more extensively equipped hospitals in rear areas. In certain areas small sections of general hospitals were reserved for cases of tuberculosis. As a rule, however, general hospitals were used, according to convenience, and probably all of the many general hospitals gave temporary care to a few patients.

Unless there was special indication for it, such as hemoptysis or rapid progression of the disease, prolonged definitive care was not given overseas. Every effort was made to send cases as promptly as possible to the United States. Three means were available, hospital ships, troop transports and airplanes. The first of these was recognized as most suitable. The number of hospital ships available in the early months and at later periods when combat casualties were high, was limited, however, and not a few cases had to be returned by troop transports. All transports had certain hospital facilities, so that no serious inadequacy in care occurred. In the later months of the war air transportation was used to a considerable extent. It was considered ideal for early cases without positive sputum and with good prognosis, and suitable for more advanced cases which could be grouped and sent back in full plane loads with appropriate medical attention en route.

On arrival in the United States, patients with tuberculosis were rapidly transferred from debarkation hospitals to the two centers specially designated for tuberculosis, after which their case and disposition was as described above.

**RESEARCH ON TUBERCULOSIS IN THE ARMY**

In addition to research on methods of exclusion of tuberculosis from service and other features of tuberculosis as a military problem, two investigations are in progress which, it is hoped, will be of general significance for tuberculosis control. These are determination of the prognosis of minimal lesions under the great variety of conditions imposed by Army service, and the value of certain of the newly discovered agents analogous to penicillin.

The latter investigation is in too early a stage to permit any indication of results, but the former has progressed to the point where its value is evident. The course of minimal tuberculosis under widely varying environmental conditions
and in men of quite different physique and temperament, has been studied extensively. It is clear that exposure to the elements and physical strain is important, although remarkable instances of stability of a lesion that might be considered on radiological grounds as potentially active, have been observed. The rôle of nutrition and constitutional character is still under close scrutiny, and conclusions with respect to the importance of these factors have not yet been drawn. A finding of great importance is that the temperament of the infected individual has a tendency to affect the course of his disease. Certain correlations of temperament and prognosis are clearly recognizable. It is too early to say more with regard to this investigation, but the results are expected to be available in the near future, and to be of general value in estimating the prognosis of cases of tuberculosis.

**SUMMARY**

Tuberculosis was recognized as a problem of grave importance in the armies of the first world war. When mobilization began in the United States for the war just concluded specific measures were taken to avoid a repetition of the high incidence in troops in the other world war. Standards are set which were designed to exclude men with active lesions or potentially active lesions of extent or character likely to break down under military strain. The experience of the years since the first world war had shown that the only way to detect the majority of cases of minimal asymptomatic tuberculosis is X-ray examination. Accordingly, early in mobilization, as soon as facilities and trained staffs were available, X-ray examination was made mandatory in the induction physical examination. The method employed was photoröntgenography, using the method developed by D'Abreu some years previously; 4 x 5 inch stereoscopic films were employed. Induction films were filed with corresponding films made of all men on discharge.

The induction examinations have been an important factor in the tuberculosis control program of the United States. Approximately 150,000 cases of tuberculosis have been rejected; their discovery has made treatment possible at an early stage favorable to recovery, and at the same time disclosed potential sources of further infection. The success of the examinations for a military point of view has been reflected in a relatively low admission rate for tuberculosis, only one-tenth of that prevailing in the first world war. The number of cases that escaped detection, however, has been by no means insignificant, and adequate measures have been established by the Army for their care. All Army hospitals give initial treatment for tuberculosis and two large general hospitals give specialized care.

The admission rate for tuberculosis in Army forces overseas has been less than that in troops in the United States; the explanation is that soldiers dispatched overseas represent a selected group from which cases have been removed during the period of strenuous combat training and in the course of a variety of medical examinations to which troops may be subject, such as examination for officer candidate school or special military services. The extent to which exogenous tuberculosis has developed is under study at the present time; up to the present there have been no indications that it reached serious extent. Cases of tuberculosis recognized overseas were evacuated as rapidly as possibly by hospital ship, troop transport and airplane, and hospitalized in the United States.

The program of tuberculosis control carried out by the Army includes certain important investigations. Among these are one on the therapy of tuberculosis, with agents analogous to penicillin, and one on the prognosis of cases of minimal tuberculosis. The widely varying conditions of military service and ready availability of Army records place the Army medical service in a peculiarly advantageous position for pursuing the latter research.