Developments in Military Medicine

During the Administration of

Surgeon General Norman T. Kirk [1]

[*This is the second of two articles on this subject, the first part having been published in the June issue of The Bulletin.*]

PREVENTIVE MEDICINE AND PROFESSIONAL CARE

Expansion of the consultant system. The quality of the professional service provided by the Army Medical Department during World War II is indicated by a comparison of the mortality rates of the Army with those for World War I. In the earlier war, the deaths from disease were 16.5 per 1,000 troops per annum; in World War II the rate was 0.6. As regards battle casualties reaching medical facilities, the respective death rates were 8 and 4 percent. The decline is the more remarkable in that military operations in World War I were confined to relatively stable trench warfare, while those of the recent conflict were of all types, including amphibious operations—which are especially costly in terms of men. One of the most important steps taken to evaluate and improve the quality of Army medical care has been the medical consultants program. Even before the entrance of the United States into the conflict, a large number of civilian experts in preventive medicine were designated as consultants to the Secretary of War in connection with the activities of the Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army. After Pearl Harbor, outstanding civilian members of the Nation's medical profession were commissioned in the Army and assigned not only to the Office of The Surgeon General but also to the Army Air Forces, the service commands, and the overseas theaters. These men likewise bore the title of "consultant." Through their professional and training activities and their control over personnel, they helped to give the sick or wounded soldier the most advanced type of medical care. They also did much to promote medical research and clinical study.

In August 1943, authority was granted the Army Medical Museum to engage resident civilian consultants in pathology to aid in working

[1] Prepared by the Historical Division, Army Medical Library. Because of lack of time for adequate preparation, activities in the field of research and development are not covered in this article; however, a full account will be included in the published history of the Medical Department in World War II.

up the great quantity of pathologic material which was being sent to that institution. Seventeen civilian pathologists were invited to act in this capacity and to undertake, or collaborate in, certain investigations. Most of these men spent about a month in residence, but several remained for as long as three months or returned for additional tours of duty. Most of them also continued to pursue at their own institutions investigations they had begun under Army auspices. In the latter part of the war, the civilian consultant system was extended to give the Medical Department as a whole the benefit of the knowledge of experts who were not available for military service. For a long time, the advice of such specialists had been utilized on an informal basis. It appeared desirable, however, to establish an administrative mechanism which would permit some financial compensation to these authorities when they were employed on official missions and, at the same time, give them a recognized position in the Medical Department commensurate with the work they were doing. Early in 1944, experts in the fields of gastroenterology, cardiovascular diseases, dermatology, infectious diseases, chemotherapy, allergy, tropical diseases, and tuberculosis were appointed as civilian consultants to the Secretary of War. In subsequent months, as special needs arose, additional consultants were designated. A small number of experts in nonmedical fields also were appointed. The civilian consultants usually were ordered to active duty with the Army for a period of a few days, after which they submitted comments and recommendations regarding the problem in hand. Sometimes they visited Army medical installations in company with the military consultant of the command. Such visits were found to be most stimulating to the morale of the medical service and were highly profitable to the military consultant. The number of civilian consultants in the Medical Department reached, on 9 June 1945, a peak of 212 for the war period.

In April 1946, the civilian consultant system was placed on a permanent basis. "By continuing the system of employing consultants we shall insure maintenance of the Army's high medical standards," The Surgeon General stated in announcing the plan to maintain and extend the system. "Consultants, acting as representatives of my office, will evaluate, promote, and improve the quality of medical care and sanitation." Nonmilitary consultants, with their consent, might be called to active duty in the Officers' Reserve Corps or be given civilian appointments under authority vested in the Secretary of War. At the same time, overseas commanders, in addition to utilizing suitable medical officers within their commands as consultants, were authorized to procure professional advice from locally available civilian medical experts. There are now far more civilian consultants in the Medical Department than there were during the war—653 in April 1947 as

against 191 on VJ-day. Virtually all function in the professional field. Many of these specialists served in the Army during the war.

The consultant system and the professional organization of The Surgeon General's Office. In terms of the organization of The Surgeon General's Office, the strengthening of the consultant system since May 1943 has meant granting to the individual branches of medicine a more potent voice in the determination of Medical Department policies pertaining to the prevention and treatment of disease. At the beginning of the period under consideration, all such activities were concentrated under a "Professional Service," consisting of five divisions: Medical Practice (which included both internal medicine and surgery), Preventive Medicine, Dental, Veterinary, and Nursing. About 15 July 1943, separate Medical and Surgical Divisions, replacing the Medical Practice Division, began to function, and in another month a Reconditioning Division, the result of the same reorganization, was in operation. At the beginning of 1944, the Preventive Medicine Division became a separate service. The Medical Division was shorn of three branches, Neuropsychiatry and Physical Standards becoming fellow divisions in the Professional Service and the Nutrition Branch becoming a division in the new Preventive Medicine Service. Tropical Disease Treatment and Tuberculosis Branches were added to the Medical Division. At the same time, the Surgical Division lost one branch (Physical Therapy) but added three—Orthopedics, Transfusion, and Chemical Warfare—while the Reconditioning Division gave up its War Exhaustion Branch and gained new branches for Educational and Vocational Rehabilitation and for Blind and Deaf Rehabilitation. In August 1944, the Professional Service was dissolved. Four of its eight divisions, the Medical, Surgical, Neuropsychiatry, and Reconditioning Divisions were renamed the Medical Consultants, Surgical Consultants, Neuropsychiatry Consultants, and Reconditioning Consultants Division, respectively, and, together with the Dental and Veterinary Divisions, they became responsible direct to The Surgeon General in advisory and policy-making capacities. The other two divisions, Physical Standards and Nursing, were transferred to a newly created Professional Administrative Service.

The process of emphasizing the policy-making and advisory aspects of the professional service was continued after the end of the war. In October 1945, the Dental and Veterinary Divisions were redesignated, respectively, as the Dental Consultants Division and Veterinary Consultants Division, and in April 1946, the Reconditioning Division was redesignated as the Physical Medicine Consultants Division. The Educational Reconditioning Branch of the Reconditioning Consultants Division was inactivated and its place taken, in part, by a Convalescent Services Branch established in the Hospital and Domestic Operations Division. In May 1946, the Professional Administrative

Service was abolished and the Physical Standards and Nursing Divisions became independent entities. A wholly new consultants division—for dietetics—also made its appearance on 1 April 1947, therefore, the agencies having to do with professional service consisted of eight consultants divisions (Medical, Surgical, Neuropsychiatry, Physical Medicine, Dental, Veterinary, Nursing, and Dietetics),[2] the Preventive Medicine Division, and the Physical Standards Division, all reporting to The Surgeon General. The appointment, on 19 February 1947, of a Coordinator of Professional Consultant Activities, in the person of the head of the Medical Consultants Division, did not alter this relationship.

In the latter part of the war, recognition also was given to the problems of particular groups entitled to Army medical care. On 10 July 1943, a liaison officer was allocated to the Women's Army Auxiliary Corps. This officer had been serving since the end of May 1943 in the Venereal Disease Control Section of the Preventive Medicine Division, with the function of studying problems peculiar to female personnel and formulating policies for meeting these problems. She now had to handle in the Office of The Surgeon General all matters pertaining to the WAAC. In February 1944, the better to fix responsibilities among the various services dealing with the health of women and to assure greater coordination in such activities, the Office of the WAAC Liaison Officer was changed to the Women's Medical Unit, to which was assigned the development of policies and coordination of all activities pertaining to the health and welfare of women in and connected with the Army. The head of the unit was designated as Consultant for Women's Health and Welfare. The unit was dissolved in December 1945.

Before the end of June 1943, a "Board to prepare, develop, and implement the medical portion of the War Department's program for aid to civilian populations in liberated countries" had been created. At the beginning of 1944, a Civil Public Health Division was also established in the Preventive Medicine Service, in recognition of the Army's responsibility for the maintenance of the health of such populations. Within the division, branches for Communicable Disease and Laboratories, Public Health Engineering, Nutritional Deficiencies, and Maternal and Child Health were established. Shortly afterward, The Surgeon General decided that the Operations Service should be responsible for assuring adequate and coordinated action by the services involved in the program pertaining to liberated and occupied areas. Accordingly, in February 1944, a Civil Affairs Branch was established in the Special Planning Division of the Operations

[2] On 7 April 1947, division titles of three of these divisions were changed to the following: Dental Division, Veterinary Division, and Nursing Divison.

Service to coordinate all activities relating to medical relief, including supplies, sanitation, training, personnel, and medical and veterinary service, in such countries during the period of military responsibility. The activities of the Civil Affairs Branch were transferred to the International Division, Supply Service, on 24 September 1945; by that time the planning stage had passed and emphasis had shifted to the actual delivery of supplies. In October 1945 the Civil Public Health Division of the Preventive Medicine Service was incorporated in a new Civil Public Health and Nutrition Division of that service.

In July 1943 a Prisoner of War Liaison Unit was established in the Office of the Provost Marshal General. Like liaison with the WAAC, liaison providing medical service for prisoners of war was placed under the jurisdiction of the Liaison Branch of the Hospital Administration Division. The duties of this unit were to make effective the medical provisions of the Geneva Convention of July 1929 and the policies of the Office of The Surgeon General relating to the treatment of prisoners of war. Shortly after the cessation of hostilities, a Board to Survey and Evaluate the Medical Problems of Repatriated American Prisoners of War Returning from the Far East was constituted on 30 August 1945. It existed until April 1946.

Dissemination of professional information. Besides attempting to maintain the level of Medical Department professional service at a high point through the expansion of the consultant system, The Surgeon General adopted certain measures for keeping Medical Department personnel informed of new developments in military medicine. In the fall of 1942, representatives of the Surgery and Medicine Branches in the Office of The Surgeon General suggested that a medium be established for quickly disseminating throughout the Army professional data of practical importance concerning problems affecting the Medical Department. Such a medium was made available in January 1943 in the form of a *Medical News Letter*. Only two numbers of this publication were issued as S. G. O. circular letters, and three numbers were photomailed to overseas headquarters, before administrative difficulties necessitated abandonment of the procedure. By 15 September 1943, the decision was announced to convert the quarterly *Army Medical Bulletin*, which had been a medium of publication of The Surgeon General for nearly twenty-four years, to a monthly publication under the title of *Bulletin of the U. S. Army Medical Department*, and to discontinue the issue of separate Dental and Veterinary supplemental Bulletins. The first issue of the new periodical was published in October 1943, and the monthly schedule has been maintained to the present time. Despite transport problems and movements of tactical units, overseas distribution of *The Bulletin* maintained an average coverage of 80 percent of *individual* officers of the Medical, Dental, Veteri-

nary, and Sanitary Corps, according to monthly spot checks throughout the war period. Advance copies were furnished by air mail to theater and base command headquarters and to many numbered hospitals overseas. Similar publications combining timely professional news items and formal medical discussions, although on a much smaller scale, had been inaugurated in the China-Burma-India Theater in August 1942, and in the European Theater in March 1943. The latter grew considerably in size toward the end of the war. *The Medical Bulletin* of the North African Theater was inaugurated in January 1944, and the *Journal of Military Medicine in the Pacific* began publication in September 1945. Much of the material which appeared in these theater organs originated and was published first in the zone of the interior. In December 1943, issuance of the mimeographed circular letters of The Surgeon General's Office was discontinued in favor of a new series known as "TB MEDs" (Medical Department Technical Bulletins). Revised editions are published from time to time to incorporate the latest knowledge concerning advances in medicine.

Army Institute of Pathology. Besides the special research establishments which the Medical Department had at the beginning of the period under consideration, it also possessed a number of facilities for research which were concentrated at the Army Medical Museum. As the war progressed, the functions of this agency as a reviewing and diagnostic center for the laboratories of the Medical Department acquired greater importance than its museum activities. As a result, The Surgeon General approved in November 1943 a new designation for the establishment, "The Army Institute of Pathology." The Institute, operating under the direct control of The Surgeon General, comprised four sections: the Department of Pathology, the Army Medical Illustration Service, the Army Medical Museum, and the American Registry of Pathology. The importance of its diagnostic function is indicated by the fact that during 1945 alone the Institute received for review the records and tissues from 18,895 postmortem examinations and from 20,539 selected surgical operations. To supplement its pathologic specimens, the Institute expanded its photographic program. During 1945, the photographic laboratory made, in round numbers, 10,000 negatives, over 50,000 prints and enlargements, over 10,000 lantern slides in color and 5,000 more in black and white, over 30,000 photostats, and over 1,000,000 offset prints. In addition, the Institute acted as administrative headquarters for the photographic units of all Army hospitals. During 1945 it received for review from zone of interior hospitals over 75,000 photographs and nearly 100,000 feet of moving picture film. After June 1943, the Institute sent overseas six additional mobile photographic units—making a total of nine—to produce

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moving and still pictures of nearly every phase of medical activity in combat areas.

The wealth of information that flowed into the Institute as the war progressed afforded an unusual opportunity for research on the pathology of the soldier. Among the subjects investigated were: coronary sclerosis in young soldiers, epidemic hepatitis, tropical diseases, trench foot, peripheral nerve injuries, the so-called crush syndrome, tuberculosis, sarcoidosis, infectious mononucleosis, and neoplastic disease. The results of all definitive studies which were of interest to both the Medical Department and the medical profession in general were promptly published.

The close relationship between the medical problems of the Army and the Veterans' Administration resulted in an offer of the facilities at the Institute to the Veterans' Administration. This offer was accepted and the Institute is now being used as the central laboratory of the Veterans' Administration.

The Army Medical Library, which is recognized as one of the outstanding collections of medical literature in the world, is an important facility for Medical Department research. Military demands on library facilities and services and an intensive survey sponsored by the American Library Association in 1943 led to a series of innovations and increased activity, designed to expand the functions of the library. To keep pace with the enlarged program, the staff has more than doubled since 1943. An inventory of the monographic and serial collections has been created and photoduplicated to provide a temporary alphabetical list of all holdings of the library. A catalog division has been established to undertake the complete recataloging of the entire collection, which, when completed, will make all of the library's resources accessible to the public. In the field of medical bibliography, the library began a new supplementary service in August 1946 with the publication of the *Current List of Medical Literature*, a weekly listing of the current writings in each medical specialty. The acquisition division, which now receives over 4,000 current serial titles in almost every language, has been greatly enlarged. The record total of some 60,000 pieces of medical literature was added to the collection in 1946.

Perhaps the department which experienced the most extensive growth was the photoduplication service. Begun in late 1940, this section has had its activities increased until in 1946 it performed more than 40 percent of the public lending function. The expansion of the photoduplicating service and the attendant increase in facilities, stimulated by wartime activities, permitted a great extension of the microfilm program. During the war years approximately 90 percent of the total microfilm output went to the armed services in foreign theaters. In 1946, six million pages of medical literature were made available to medical officers and scientists all over the world.

Physical standards. In its work of determining physical and psychological criteria for admission into the Army and assigning personnel to various kinds of service, the Medical Department, after 1 June 1943, even more than before that date, saw its possibilities of choice restricted by a constantly diminishing supply of the Nation's available manpower. Even today, difficulties in obtaining personnel have precluded any general raising of the level of physical standards. The powerful influence exerted by the state of the manpower supply affected even the qualifications for flyers. In July 1943, procurement objectives made necessary the relaxation of physical requirements for applicants for air crew training. In December 1943, President Roosevelt appointed a commission composed of the Surgeons General of the Army and Navy and three civilian medical men to study the requirements for admission to the armed forces. Congress had directed the appointment of this commission in the hope of obtaining from the large group classified as IV–F (estimated at that time at 3,000,000) more men available for induction, especially for limited service. On 26 February 1944, the commission submitted its report, stating that the existing physical requirements for admission to the armed forces could not be reduced further without impairment of efficiency. The chief need, the report concluded, was for men for general duty. This need would progressively increase until the war was won, and it was apparent that it could not be met by lowering the physical standards or by increasing the induction of men for limited service. However, the commission recommended some changes, permitting some men previously classified for limited service to be listed as acceptable for general service.

During the period under consideration, much attention was given to the fixing of standards for female personnel. In the early part of the war the physical standards which were applied to applicants for entrance into the Army Nurse Corps were those outlined for commissioned officers, with the exception that special provisions were made governing height, weight, chest measurements, etc. In March and September 1943, detailed instructions with respect to the examination of women were published. In September 1943, when the Women's Army Auxiliary Corps was incorporated into the Army as the Women's Army Corps, the physical standards prescribed for members were raised to those required for Army nurses, with certain exceptions pertaining to height, weight, and vision. At the same time, all personnel, prior to commission or enlistment in the WAC, were required to undergo a final-type physical examination, if such examination had not been made after February 1943. The reason for this requirement was that many of the early enrollees had not had a complete final-type physical examination, and it was desired to protect the government again inequitable claims for compensation and retirement benefits.

Limited service status for WACs was authorized in April 1944, the standards being those prescribed for female components of the Medical Department. At this time the dental requirement for enlistment in the WAC was lowered to that required for the induction of male personnel.

Meanwhile, physical standards for certain military occupational specialties were developed. In July 1943, standards were put into effect for officers and enlisted men engaged in training and service in marine and simulated marine diving and in the use of rescue apparatus. In October 1943, physical qualifications for parachute duty for both officers and enlisted men were adopted. The list of disqualifying defects for this type of service dealt chiefly with orthopedic conditions. In the fall of 1944, The Surgeon General's Office established physical standards for civilians going overseas for service with the Army. The qualifications incorporated were expected to be merely a guide to examiners and not to be applied without discretion.

A simplified method of physical evaluation also was adopted. In the latter part of 1940, the War Department issued instructions requiring an initial classification of enlisted men as they entered the service. Pertinent data concerning the enlisted man's intelligence, education, previous military experience, civilian work history, aptitudes, interests, hobbies, and other attributes were recorded, to be used as a basis for an assignment in which he would be of the greatest value to the service. It was realized early that this initial classification was not enough. Since the intelligence and skill of the individual must be supported by physical stamina, some simple method of determining physical qualifications also was needed. With a view to satisfying this need, the so-called Pulhems System of physical classification used by the Canadian Army was tested beginning in the spring of 1942 and, with modifications, was put into general effect in May 1944. Known as the Physical Profile Serial System it involved an estimate of six factors in an individual: (1) his general physical stamina and strength; the development and defects of his (2) upper and (3) lower extremities; a measurement of his (4) visual and (5) hearing acuity; and (6) a psychiatric evaluation. The profile system proved to be a timesaving procedure in that it emphasized the items demonstrated by experience to be of principal importance in the physical examination and afforded a commander, at a glance, a picture of the physical and emotional stamina of an individual and an understanding of the type of assignment for which he was best fitted.

The basic policies and procedures governing the physical examination of troops during redeployment were incorporated in directives issued long before the surrender of Germany. To simplify the huge task involved, virtually identical procedures were prescribed for those

units scheduled for direct shipment to active theaters and those to be returned temporarily to the zone of the interior for rest and recuperation. In the selection of personnel for redeployment, the physical and mental standards for overseas service were applied. It was seen, nevertheless, that removal of trained personnel for other than definitely disqualifying conditions would be not only a great waste of manpower, but also would be detrimental to the morale of the individual and the efficiency of his unit. Hence, personnel who had performed their duties satisfactorily were allowed to accompany their units unless they had defects which might be complicated or aggravated by additional overseas duty. A screening-type examination was made of all officers and enlisted personnel subject to redeployment. The physical profile was determined and a medical history was obtained. So far as possible, the medical and dental officers associated with the units being examined made the examinations, and thus they were able to apply extended periods of observation of an individual in judging his fitness for further overseas duty. Final authority for rendering a decision on such fitness was vested in the unit medical officer. Placing the responsibility for the performance of medical examinations on medical officers in the inactive theaters spared the reception centers in the zone of the interior a great deal of work.

Health education. As the war progressed and the participation of of the United States Army in the actual fighting increased, certain problems in the solution of which health education plays an important part became of increasing significance. A similar situation arose when the tropical and semitropical areas became the scenes of large-scale operations. Developments growing out of the occupation of conquered territories have had a like result. After the beginning of June 1943, an organization was developed in the Office of The Surgeon General for the production of educational materials. In January 1944, this work was assigned to education branches in the Tropical Disease Control, Venereal Disease Control, and Sanitation and Hygiene Divisions of the Preventive Medicine Service. On 6 January 1945, the three education branches were consolidated into a single Health Education Unit directly subordinate to the chief of the Preventive Medicine Service.

Meanwhile, in September 1943 War Department Circular No. 223, which had been initiated by The Surgeon General, prescribed four hours of special training in malaria control for all men in the Army, and in February 1944 the amount of basic training time devoted to teaching recruits personal hygiene had been increased from eight to ten hours. This formal training was supplemented by propaganda in the form of posters, booklets, and cartoon films. Schooling of the soldier in individual protective measures against tropical diseases

was given special emphasis during the last year of the war as part of redeployment training. In January 1944, the War Department called for an intensification of the Army venereal disease education program. The responsibility was placed on the Office of The Surgeon General for selection, procurement, and distribution of pamphlets, films, and other materials, and for the initiation and preparation of directives regarding the manner of their use in the venereal disease education program. Posts, camps, and stations, however, were encouraged to produce supplementary materials to meet specific local needs. The most intensive venereal disease education program in the history of the Army was conducted during the last year or so of hostilities. Arrangements were made with the Venereal Disease Education Institute, Raleigh, North Carolina, for the production and distribution of one poster each month within the continental United States. Poster needs of the major theaters also were ascertained and steps taken to supply them. Several million venereal disease pamphlets were shipped to the theaters at their request, including 50,000 in Spanish.

Throughout the war and postwar periods, the active cooperation of civilian agencies was solicited and largely obtained in the suppression and control of prostitution near Army concentrations. On 24 April 1945, a memorandum was issued by the War Department with a view to promoting this cooperation in all theaters. The Venereal Disease Control Division of the Office of The Surgeon General also supported renewal of the May act of 1941, which provided for the suppression of prostitution near Army encampments in this country. This law was renewed on 15 May 1945. The Army's present venereal disease control program consists of two parts: (1) control activities essentially military, and (2) control activities dependent on the support and cooperation of civil agencies. The Army's share in the program comprises discovery and adequate treatment of infected personnel; increased emphasis on educational, moral, and religious programs; and provision of adequate recreational and athletic activities.

To combat a rising venereal disease rate in the postwar period, the Secretaries of War and Navy in October 1946 established a central Joint Army-Navy Disciplinary Control Board, under which local boards function with the purpose of assisting responsible commanders in (1) effecting closer coordination of their respective law enforcement agencies in the reduction and repression of conditions inimical to the morals and welfare of service personnel, and (2) discharging their responsibilities under the "eight-point agreement" made with the Federal Security Agency and State health departments in 1940. In addition, a War Department Venereal Disease Control Council was established in December 1946 with the recommendation that similar councils be established wherever feasible at all lower echelons, in-

cluding posts, camps, and stations. Members of the governing council include The Surgeon General, the Chief of Chaplains, the Chief of Public Relations, the Provost Marshal General, and representatives of the Secretary of War, the Army Air Forces, and the Army Ground Forces. The council was directed to meet at least once a month to consider venereal disease problems as they affect service personnel, as well as to develop standard educational and control measures to be applicable to all such personnel. Since the beginning of 1947, an experimental program of venereal disease control emphasizing moral training and responsibility of the individual has been initiated at the Universal Military Training Center, Fort Knox, Kentucky.

Another disease which gained considerable attention from those responsible for the health education program was trench foot. This term designates a type of injury sustained when the feet are exposed to wet cold short of freezing. Circulatory and sudomotor changes in the feet and signs of sterile inflammation characterize the condition. Although trench warfare, which had made the disease a tremendous problem during the first World War, was practically nonexistent in the second conflict, analogous conditions were present in foxhole fighting. Statistics on trench foot have not been completely analyzed, but it is known that there were about 50,000 cases in American troops during the war period. In the winter of 1943–1944, in the Italian campaign, over 500 cases were reported by the Fifth Army in a single week. The incidence of trench foot was greatly reduced in the winter of 1944–1945 in the Mediterranean Theater, but in that year the disease became a serious problem in the European Theater. Trench foot does not occur if the feet are kept fairly warm and dry and are exercised frequently. In July 1944, special directions were issued in War Department Circular No. 312 for instructing troops in the care of their feet. The problem of trench foot, however, is not one of education alone, but also one of supply. Adequate quantities of socks, shoes, overshoes, and, particularly, rubber shoe pacs and dubbin are needed under combat and climatic conditions which bring out the disease. Hence, the Medical Department recommended the provision of adequate clothing and footgear as well as instruction of troops in the use of such equipment. Education of line officers and training of troops in the precautions to be taken against the disease, however, offered great difficulties. This problem was partially solved by forming teams from Medical Department personnel to train front-line troops. Such teams were organized in the Mediterranean Theater as early as December 1943. In classes held for enlisted men, educational material was distributed, special quartermaster equipment was demonstrated, and the effects of poor foot hygiene were explained. To combat negligence, the unit commander was made responsible for

proper instruction and equipment of his subordinates and was held accountable for all cases of trench foot occurring in his command. Since the termination of hostilities, the Health Education Unit has been abolished. Its functions, however, are still carried on by the Preventive Medicine Division.

Troop housing. Because of large-scale inductions of men into the Army, it became necessary during the war to reduce the space standards governing troop housing. A revision of AR 40–205 in December 1942 cut the minimum allowable floor space per soldier from 60 square feet to 40 square feet, although the hope was expressed that a minimum of 50 square feet would ordinarily be maintained. To alleviate the consequences of such crowding, men were required to sleep with "the head of one man opposite the feet of the two adjacent men." These space regulations applied to the zone of the interior; it was understood from the first that any standard would be difficult to enforce overseas.

On 30 August 1945, War Department Circular No. 262 directed that, where practicable, troops be allowed 60 square feet per man. In March 1946, The Surgeon General, pointing out that respiratory diseases were responsible for 30 percent of disease admissions of troops to hospitals and quarters and that new inductees constituted a large proportion of such cases, emphasized that, in all instances, basic trainees should each be provided at least 60 square feet of barracks space. In a War Department memorandum and three circulars promulgated between 2 April 1946 and 3 January 1947, an allowance of 72 square feet per man was specified as the optimum and 60 square feet as the absolute minimum. Reduction of personnel, both in the zone of the interior as well as overseas, has made it possible for almost all commands to live up to these new requirements.

Nutrition. During the period under consideration, problems of nutrition became of increasing importance to the Army Medical Department, particularly as the responsibility of the Army for the care of civilians under its jurisdiction grew. The training and assignment of nutrition officers was continued. As of 30 June 1945, there were 157 nutrition officers on duty in the zone of the interior and in overseas theaters. The work of the Medical Department as consultant on nutrition to the Quartermaster Corps was facilitated by the transfer, in September 1944, of the Nutrition Laboratory, Division of Food and Nutrition, Army Medical Center, to Chicago. Construction of the new establishment, known as the Medical Nutrition Laboratory, was completed and nutrition research was begun in April 1945. The unit was located in the same building with the Quartermaster Subsistence Research and Development Laboratory, Quartermaster Central Market Center, and the Quartermaster Food Testing Laboratory, thus concentrating all of the major food research and development organizations of the Army in one place. Much of the work done at the

Medical Nutrition Laboratory has had as its object the improvement of research techniques in the field with which it is concerned. To study problems pertaining to troop menus in the overseas theaters, teams were sent out by the Nutrition Division of The Surgeon General's Office.

The studies of the Medical Department pertaining to diets for Army personnel included menus for effectives and for patients on hospital ships. It was ascertained that bomber crews could be fed nutritious, warm diets while in flight and that the efficiency of their operations was thereby enhanced. Such diets were not materially different from those used in standard good feeding at sea level. Emphasis was placed on relatively high carbohydrate content in preference to excessive protein. A study at Camp Lee, conducted in 1943, revealed certain deficiencies in the so-called "Expeditionary Ration." Further studies on the subject were conducted at Camp Carson, Colorado, during the summer of 1944, in the most extensive controlled ration test conducted up to that time with United States military personnel. The tests were under the immediate supervision of the Armored Medical Research Laboratory. Canadian military officers assisted in the project. One Canadian ration and United States C, K, and 10-in-1 rations were tested. The health of the troops undergoing the test improved, even while engaging in strenuous activity at high altitudes. Only a few items in the rations proved to be unacceptable. Following extensive tests at Camp Carson in September 1946, a new packaged ration, the E ration, was accepted for issue. The new package included more beverages, canned fresh fruit, and cigarettes than the C and K rations which it replaced. The canned bread which formed part of the E ration was one of the factors which made it highly acceptable to troops.

In order to meet wartime demands, and to provide a safe fresh milk supply for soldiers, the Veterinary Corps of the Medical Department, in cooperation with local and public health officials, developed, in 1942 and early 1943, an unprecedented nationwide inspection and control program whereby an average of one-half pint of fresh milk each day was made available to each soldier in the zone of the interior. The problem of providing overseas troops with milk has been more difficult. Since the liberation of Denmark, it has been possible to obtain fresh milk meeting Army requirements from that country for troops in Europe, but the Pacific area has offered a more difficult problem in this respect. Both the Medical Department and the Quartermaster Corps have conducted continuous research to devise means whereby milk could be made a regular part of the overseas soldier's diet. In the earlier part of the war in places where fresh milk could not be provided in sufficient quantity it was compensated for by including in the menus milk solids and butter fats in non-

perishable forms. Dry skim milk having all the food value of fresh milk with the exception of fat and vitamin A was used by the Army in beverages, soups, gravies, sauces, and custards, by reconstituting it with the proper amount of water.

However, in the case of hospital patients who could not be fed the regular menu, reconstituted dried milk was not successful because of its lack of flavor. The development of frozen fresh milk, undertaken by the port veterinarian at Boston, Massachusetts, in early 1944, for use on hospital ships, was therefore of particular significance. This, in conjunction with research work conducted at the Army Veterinary School, resulted in a method whereby fresh homogenized pasteurized milk was successfully frozen for the first time in history and shipped under refrigeration. The frozen milk received immediate and enthusiastic acceptance by convalescents. After VJ-day, frozen milk began to be shipped to hospitals in Pacific areas, and in little over a year it had become a standard item of procurement for hospital use only. In September and October 1946, there were shipped to hospitals in Japan and other Pacific installations 121,000 pounds of frozen milk.

At the request of the Secretary of War, the Medical Department made a study of means of improving food utilization in the Army with special emphasis on reducing the use of critical items, and in the spring of 1945 suggested changes in menu planning which would effect a daily saving of about 750,000 pounds of carcass meat and yet not interfere with nutritional adequacy. The food conservation program got under way in the middle of the same year. Somewhat similar considerations were involved in the Medical Department's studies of prisoner of war diets. As a result of such studies, ASF Circular 191 was issued on 29 May 1945. Not only were dietary standards established for prisoners of war, but it also was provided that nutrition officers should play an important part in the formulation of their menus. Requests from prisoner of war camps for food providing over 3,700 calories were to be submitted to the service command surgeon for approval, his representative in these matters being the nutrition officer. Civilian nutrition work abroad was begun by surveys to determine the subsistence level in some of the liberated countries such as Holland, Denmark, and Belgium. The Nutrition Division assisted the United States Public Health Service in these surveys. By the end of 1945 there were five survey teams in Germany. These were made up of doctors and technicians provided with mobile laboratory units. Up to the middle of 1946, over one million Germans were weighed and, in many cases, a more complete physical examination was made. It was determined, in the latter part of 1945, that caloric intake was generally low but not dangerously

so. Food and agricultural authorities took these studies into account in determining the amount of food supplies needed, the movement of food, and estimates for food production. After the middle of 1946, there were not enough personnel available to continue the work effectively. German civilian teams were formed to carry on this work, but the value of their reports was open to question.

Veterinary food inspection. The Medical Department supplemented its efforts to improve the nutrition of Army personnel and other persons for whom it was responsible by inspectional activities which were designed to assure that the food served in the Army was of acceptable quality.

All food of animal origin procured for the armed forces by The Quartermaster General received inspection by Veterinary Corps personnel to insure that it was wholesome, of the designated grade, and properly packed to withstand the rigors of wartime shipping. Inspection at time of procurement reached its height in June 1945, when a daily average of 36,137,901 pounds of meat and dairy products was inspected. In addition, all foods were reinspected many times—in storage, in transit, and at time of issue, both in the zone of the interior and in all overseas theaters. During April 1945, a peak load of over 22,500,000 pounds of foods of animal origin were being inspected daily by the veterinary service as issued to troop messes. By an agreement between the War Food Administrator and the Under Secretary of War, concluded in 1944, Army veterinary personnel were employed for antemortem and postmortem inspections at slaughter and packing plants having contracts for supplying meat to the Army, and, by further agreement in 1945, boneless meat produced under Veterinary Corps supervision was marked with the Federal Meat Inspection stamp. Foods of all kinds procured in foreign countries also received veterinary inspection. This included billions of pounds procured in New Zealand and Australia to support United States forces in the Pacific. It also included the supervision of milk supplies and slaughter of thousands of cattle, swine, lambs, and poultry for American troops in disease-ridden countries of Africa and Asia. In the year or so preceding the termination of the fighting, the Medical Department, in cooperation with the Chemical Warfare Service, developed and standardized a screening kit for detection of poisonous chemical warfare agents in food.

Water purification. Halazone tablets, in which the principal sterilizing element is chlorine, were in use for purifying water in the canteen of the individual soldier as early as June 1942. However, the taste and odor of halazone-treated water and the relative ineffectiveness of the tablets in destroying amebic cysts led to the search for a better compound for individual use. Through the efforts of the Sanitary En-

gineering Committee, National Research Council, on request of The Surgeon General and The Quartermaster General in 1944–1945, attention was called to globaline (tri-glycine-hydro-periodide), an iodine compound which was believed to be equal or superior to halazone. Because the tests of globaline are still deemed to be incomplete, the compound has not yet been made a standard item. As laid down by Corps of Engineers manuals prior to 1942, water purification practice with respect to mobile sand filters did not include pretreatment with chlorine. Instead, alum was added to the water entering the rapidly operated filters. Experiments conducted in 1943 at the Engineers Water Equipment Laboratory at Fort Belvoir indicated that, to remove amebic cysts and bacteria, pretreatment with chlorine together with coagulation and settling was necessary. It was also found necessary to slow the rate of filtration, mainly to allow time for effective pretreatment to take place. The new procedure became standard practice in many theaters. In 1944 the Engineers Water Equipment Laboratory, seeking a more serviceable type of field purification unit, cooperated with the Sanitary Engineering Division of The Surgeon General's Office in the development of a diatomaceous earth filter. In the new process the filtering agent is an earthlike substance made up of silicified skeletons of microscopic algae. This material is lighter than the material used in ordinary sand filters and has the fineness which enables it to filter out amebic organisms. Its lightness and wider effectiveness made the diatomaceous filter superior to the conventional sand filter. Use of pretreatment was recommended even with the diatomaceous earth filter. The new type of equipment was given field trials in the United States and some small models were flown to China in late 1944 for use at ATC installations. Other diatomaceous units were later supplied to troops in Italy, India, and the Philippines. The war ended before they could be put to very extensive use. Through the efforts of the sanitary engineers the fresh water tank capacity of troop transports was increased in the latter years of the war. This was done by cleaning out and using as fresh water storage space those sections of the ship ordinarily filled with water ballast.

Insect and rodent control. The most significant development in the sphere of insect control during World War II was the adoption of DDT and its increasing usefulness against the vectors of disease. When, in 1942, the supply of pyrethrum reached a low level, search for a substitute was initiated, and DDT was recommended by the United States Department of Agriculture, which had demonstrated its effectiveness against lice. In February 1943, the Orlando Laboratory of this agency reported the effectiveness of DDT as an anopheline larvicide, and field studies during the summer and fall confirmed the value of DDT oil solutions and dust preparations as mosquito larvicides. Toxicity studies had shown that it could be used with relative safety

in a number of ways. It was later added to the "mosquito bomb" to prolong insecticide activity. Production of DDT was limited, however, during 1943, and, except for experimental purposes, it was used in that year as a louse powder only. A serious epidemic of typhus in Naples in the latter part of 1943 provided an unusual opportunity to test the Army's DDT powder. From the middle of that year typhus had progressively increased, and by December about 50 cases a day were being reported. Early in that month DDT dusting stations were set up in all parts of the city. By March of 1944, more than 1,250,000 persons had passed through the stations. In addition to the delousing, extensive immunization was practiced, and the epidemic declined rapidly. Not a single case of typhus was reported among American troops in Italy up to early 1945. In the last year of the war more efficient delousing equipment was perfected and placed in use at ten ports of embarkation. The use of DDT, however, kept infestation of troops at a low level.

The Surgeon General's DDT Committee, established early in 1944 and consisting of representatives of the various Government agencies concerned with this insecticide, served as a means of exchange of information and correlation of the various phases of research, production, distribution, and field uses of DDT. In November of the same year this was superseded by the Army Committee for Insect and Rodent Control. Minutes of these meetings and other technical information on insect control were disseminated to workers in the field as they became available. DDT supplies, by the spring of 1944, were sufficient for use in mosquito control, and by January 1945 it was possible to make full use of DDT in the Army's program for the control of insect pests as well as of insects concerned in the transmission of diseases. Not only was DDT a potent insecticide, but its effect was extremely persistent. Airplane spraying with DDT was furthered by a conference held in the Office of The Surgeon General in January 1944, and during the summer of that year spraying projects were accomplished, with highly successful results, in all theaters where mosquito-borne diseases were important. The war ended before special Air Forces squadrons had been organized to perform this work, but in March 1946 a program was inaugurated through coordination of the Corps of Engineers, Army Air Forces, and the Medical Department providing for airplane spraying of DDT within the United States.

Other methods of insect control employed by the Army consisted of elimination of breeding places by area clearing, burning, draining and oiling of water, and personal protective measures such as the use of bed nets and repellents. In 1944, studies were made on the suitability of dimethyl phthalate for repelling insects other than mosquitoes. This resulted in its adoption in controlling scrub typhus, applied as a spray to the clothing or used as an emulsion in which clothing

is dipped and then dried. The combined repellent—dimethyl phthalate, Rutgers 612, and indalone—was standardized and used routinely for individual application to the skin. Bulk dimethyl phthalate was adopted for issue in clothing impregnation. Dimethyl phthalate, dibutyl phthalate, and benzyl benzoate were allocated for use in treatment of clothing in 1945, but large-scale use was not under way by the end of war. As early as 1940, consideration was given to the possibility of outbreaks of such diseases as plague and murine typhus, in which rodents act as the reservoir of infection, and plans for rodent control were made at a very early date. In the early stages of the war, the lack of good rat poisons handicapped control work. Thallium sulfate, one of the most effective rodenticides, was limited in supply and was reserved generally for overseas plague control work. Even though a stockpile was accumulated, a directive provided in late 1944 that it might be issued only by order of The Surgeon General. Sodium fluoroacetate, called "1080," perhaps the most effective poison developed in the closing months of the war, was fully tested in the field.

Based on experience gained with the highly successful malaria control and survey units, some of which were already engaged in rodent control work in the Pacific, tentative plans were drawn during 1944 for establishment of similar units for rodent control. But the need for such units was not sufficiently pressing and rodent control was conducted by personnel already in the field, under the direction of malaria units or sanitary engineers. In April 1944, a plague outbreak among civilians in Dakar, French West Africa, caused considerable concern, and a Sanitary Corps officer was sent there to aid in antirodent work. There were 567 cases with 514 deaths in this epidemic, but not a single case occurred in American military personnel. The epidemic was brought under control in November 1944. In addition to a continuous rat-control program in American installations, the measures used to handle the epidemic had comprised immunization, restriction of movement of military personnel, and systematic treatment of natives and native dwellings with DDT.

Immunization. At the beginning of the period under consideration, Army policy provided that on induction every soldier be actively immunized against smallpox, typhoid and paratyphoid fevers, and tetanus. Special immunizations were applied, as potential dangers were encountered, against typhus, cholera, plague, yellow fever, diphtheria, and Rocky Mountain spotted fever. Immune serum globulin (human) was used occasionally as passive protection against measles. In the autumn of 1944 the new influenza vaccine developed under the Army Epidemiological Board was given its first field trial in selected units. The immunization was required for all military personnel in the fall and winter of 1945–1946. This procedure was again applied during the early months of 1947 for all troops in this country and in certain

overseas areas. Immunization against Japanese B encephalitis, also developed by the Army Epidemiological Board and the Medical Department Professional Service Schools in this war, was first used in American troops in the late summer of 1945 in Okinawa, where there was an epidemic of the disease in the native population. In 1946 all troops in Okinawa, Japan, and Korea were thus immunized. In the same year a program for the development of a new type of Japanese B encephalitis vaccine was inaugurated at the Medical Department Professional Service Schools.

The low incidence of typhoid and the paratyphoid fevers was a result of modern sanitation and the use of vaccines. The incidence of these diseases in World War II was about one-seventh that of World War I. There were fewer than one hundred cases of epidemic typhus in the Army, and those that developed in vaccinated personnel were mild. Louse control and vaccine were both important in the prevention of this disease. Cholera was epidemic or semiepidemic in a number of areas where United States troops were stationed, but only thirteen cases occurred in the Army. There were no cases of plague or yellow fever. Immunization against the latter disease considerably expedited movement of troops in certain areas. Only twelve cases of tetanus occurred during the war, despite the fact that there had been fighting on terrain heavily infested with the spores of tetanus, and only one of these cases developed in a battle casualty. In the field of immunization, a substantial contribution was made by the Veterinary Corps. By June 1944, the laboratory at the Army Veterinary School was producing an improved equine encephalomyelitis vaccine of chick-embryo origin suitable for human use, according to a new centrifugation technique. The large-scale production of louse-borne typhus vaccine was also under way. In the early months of 1946 the technique for mass production of Japanese B encephalitis vaccine was completed and put into operation. The period since the termination of hostilities has witnessed a great increase in the production of vaccines by the Army Veterinary School Laboratory. In 1946, the value of the output of biologicals was approximately $2,000,000.

Internal medicine. War experience afforded exceptional opportunities for the study of many unusual as well as common diseases, and, as knowledge increased, the general management of these diseases improved. For example, before the United States entered the war many foreign observers had reported a "crush" syndrome. Army investigations (published in 1946) demonstrated that this syndrome was initiated by many different circumstances, including burns, transfusion with incompatible blood, heat stroke, and poisoning, as well as by crushing injuries. Infectious hepatitis attained pandemic proportions in various parts of the world during the war and was responsible for

a large number of man-days lost in the American Army. This serious disease is not well understood; the causative agent has not been isolated nor has the mode of transmission been established. Late in the war when a fulminant form of the disease was widely seen in the Army, reports on this variant were published and studies on various aspects are still in progress. Experimental reproduction of infectious hepatitis under direction of the Army Epidemiological Board demonstrated that the agent exists in intestinal discharges as well as in the blood stream. Further experiments in 1945 and 1946 on its transmission by contaminated water emphasized control of sanitation as an important factor. Early and prolonged rest in bed and dietary management, especially the use of a low-fat, high-protein diet, were shown to be the best methods of treatment.

The diarrheal diseases, including amebic dysentery, the various types of bacillary dysentery, and the infectious diarrheas increasingly were brought under control by enforcement of sanitary discipline and provision of safe water and food supplies. Bacillary dysentery was a major problem in the Mediterranean Theater in 1943, accounting for almost 90 percent of the acute diarrheas. Response to sulfonamide therapy was dramatic, and complications of the disease were very infrequent. Adherence to sanitary measures and check on food handlers were shown substantially to affect the diarrheal rate. The incidence rate of common diarrheas dropped in this theater from 132 per 1,000 per annum in 1943 to 54 per 1,000 in 1945. During the last six months of 1944 the Subcommission on Dysentery of the Army Epidemiological Board made a study of diarrheas and dysenteries in the India-Burma Theater and strains brought back from these areas have been studied at the Rockefeller Institute. Microscopic stool examinations of 506 American soldiers who had been in India twenty-three months revealed a rate of 9.3 percent of *Endamoeba histolytica* infection as compared with 4.1 percent in native Indians, but a higher rate of orally transmitted nematode infection in Indians. A similar study conducted in Assam on 833 patients treated for amebic dysentery between February 1944 and April 1945 revealed frequent histories of prior infection with bacillary dysentery. Again, complications were rare. An extensive follow-up of 101 cases showed 98 percent cured. Troops on most of the South Pacific islands came into contact with natives heavily infected with intestinal parasites, and stool examinations became almost routine for all hospitalized patients. It was found that the incidence of ankylostomiasis was high while that for amebiasis was low. Only one significant epidemic of *E. histolytica* infection occurred at Bougainville in the first half of 1944.

Coccidioidomycosis was endemic in the southwestern United States where numerous air fields and desert training areas were located. Mortality from progressive coccidioidomycosis was very low, but

morbidity from the primary form of the disease was high. Extensive epidemiological and clinical studies were carried on in 1944 and 1945, particularly at the Army air fields in the San Joaquin Valley. Various methods of dust control were instituted and were of value in localized situations. The possibility of future endogenous reinfection in veterans who have had the disease must be borne in mind.

Studies of streptococcal infections in 1945 emphasized the value of streptolysin and antifibrinogen in the acute and convalescent sera of patients, not only for confirming the clinical diagnosis but also in epidemiological studies requiring determination of carrier states. Studies on hemolytic streptococcal infections with particular reference to their relation to rheumatic fever were made at Camp Carson between November 1943 and July 1944 and continued to be carried on in several university laboratories. Among the conclusions arrived at were (1) that rheumatic fever is induced by group A hemolytic streptococci, (2) that the disease is only part of the whole complex involved in the poststreptococcal state, (3) that these clinical manifestations are the result of altered tissue sensitivity to products of the hemolytic streptococcus, and (4) that repeated infection with different types of hemolytic streptococci may be necessary to the development of rheumatic fever, carditis, or continued infection. A probable factor in the control of respiratory disease in the latter part of the war was the development by the Army Epidemiological Board of methods for application of oil to barracks floors and to bed clothing. Studies by the board also demonstrated, by experiments on human subjects, that so-called atypical pneumonia can be produced by bacteria-free filtrates of nasal and throat washings, indicating the probable virus nature of the agent of this disease.

As the war progressed and troops were deployed in tropical theaters of operations, the Army encountered an increasing number of diseases which either do not occur or are not widely prevalent in the United States. Formulation of tropical disease control policies was included in the functions of the preventive medicine unit in the Office of The Surgeon General as early as 1940, and a tropical disease control unit was established and expanded until it attained the status of a separate division of the Preventive Medicine Service in January 1944, remaining in that status until the end of the war. The clinical aspects of tropical disease were handled in the unit of The Surgeon General's Office concerned with internal medicine. Most important in the special tropical disease training program for Medical Corps officers was the continuous eight-week course in tropical medicine, with field training, offered at the Army Medical School as early as November 1941. Teaching materials and special instruction in the subject were also offered by the Army to the medical schools of the country. When the war ended in Europe, a two-week refresher course, known as the Course in Dis-

eases of the Pacific Areas, was established at Carlisle Barracks, Pennsylvania. By late 1943, increased numbers of patients with tropical diseases were being seen in Army hospitals in the zone of the interior, and subsequently the need for a special center for observation and uniform management of these cases became apparent. In August 1944, Moore General Hospital, Swannanoa, North Carolina, and, in April 1945, Harmon General Hospital, Longview, Texas, were so designated.

In addition to malaria, at times scrub typhus, dengue, filariasis, sandfly fever, schistosomiasis, and hookworm infection were disease problems of military significance in certain areas. However, many of the tropical and parasitic diseases which have been scourges of native populations proved to be little or no problem to the military forces. This was true of such diseases as yaws, leprosy, trypanosomiasis, and leishmaniasis, as well as many of the minor tropical afflictions. Deaths from tropical diseases were few. Scrub typhus was widely encountered by the Army in the Southwest Pacific and in Burma. Over 6,000 cases were reported. Three major epidemics of this serious disease occurred in Northern Burma and in Netherlands New Guinea in 1944. As a result of Army experience, ecologic concepts of this rickettsial disease were changed (it was found that there was no typical scrub typhus area), wider geographic distribution of the disease became known, its etiology was confirmed, vector species were proved, strains isolated, a new complement-fixation test was evolved, and the clinical picture and pathologic changes were established. Beginning in 1943, field teams from the United States of America Typhus Commission were dispatched to the scene of outbreaks to study the epidemiology of scrub typhus and institute control measures consisting of (1) personal protection and mite avoidance, and (2) mite reduction by area clearing. A method of clothing treatment with a 5 percent emulsion of insect repellent was developed by the Typhus Commission team in New Guinea and was widely used, beginning in 1945, in endemic areas for protection of both combat and staging troops.

Filariasis in American troops was limited almost entirely to soldiers who had been exposed to the disease in the South Pacific area in the region of Samoa early in 1942. Not until nine to twelve months later did symptoms and signs of early filariasis begin to appear in sufficient numbers of troops to clarify the disease entirely and lead to proper diagnosis. Approximately 2,200 cases were diagnosed as filariasis. All cases were mild and no serious complications developed. The type of filarial involvement encountered was limited to the early stage of the illness, about which there had been little information prior to the war. The policy of evacuating infected personnel permanently from endemic areas to the zone of the interior was adopted. It was found that filarial infection, when limited in duration by prompt evacuation

to nonendemic areas, is rarely if ever followed by permanent disability or significant lasting bodily changes. Relapsing symptoms tended to disappear in about twenty months. Psychologic management and reconditioning were important aspects of treatment.

Dengue is a nonfatal disease and seldom of more than a week's duration, but because of its tendency to occur in epidemics, with resultant incapacitation of large numbers of men, it sometimes assumed considerable military importance. Localized outbreaks took place in United States troops in Australia, the New Hebrides, and elsewhere throughout the war, the most extensive epidemic occurring in Saipan in 1944. In 1943, an extensive epidemic occurred in Hawaii; but mosquito control measures averted an explosive outbreak among United States troops, and similar measures succeeded in controlling an epidemic in Hankow, China. Mosquito control measures used against the malaria vector were effective in dengue control. Dengue rates remained low during the year 1945, even though large numbers of troops operated in endemic areas, which may have been due to improvements in mosquito control measures in the last year of the war. The Commission on Neurotropic Virus Diseases of the Army Epidemiological Board undertook in 1944 studies on the causative virus. Although the etiological agent of dengue had been generally accepted to be a virus, the virus itself had not been propagated in animals as in cultures, nor had strains been preserved for comparative study. At least two immunologically distinct types of dengue virus were isolated. Although some progress was made, a satisfactory vaccine for use in troops has not yet been developed.

The Army's experience with schistosomiasis resulting from infection with *Schistosoma japonicum* was confined to Leyte. The first cases among American troops were observed in December 1944. The experience with the disease provided opportunity for study of the early stages, and advances were made in diagnosis and treatment. Diagnostic difficulties were encountered in mild or nonsymptomatic cases and those complicated by concurrent parasitic infections or other diseases. Only by persistent, exhaustive examinations of stools for ova and by routine proctoscopy were many of these cases identified. The control program was almost entirely preventive, stressing avoidance of infested water. An extensive program of education was launched, including distribution of posters and booklets, and two mobile laboratories were sent from unit to unit to acquaint troops with the disease. By April 1945 the number of new cases had reached a low level.

The disease which was of the greatest strategic importance to the Army in World War II was malaria. In all major theaters of operation, except the European, it was an ever-present hazard to troops.

It has been conjectured that in the absence of effective means of prevention and control, malaria casualties would have been sufficient to lose the war. The importance of the disease lay in its frequency rather than its mortality. The mortality rate for malaria during World War II was about 1 per 100,000 troops per annum. In the zone of the interior, Army malaria rates dropped to almost negligible figures after 1942, but in that year they began to reach alarming proportions overseas and attained their peak for the entire war period in 1943, when there were about 152,200 attacks in the overseas theaters where malaria was prevalent—an incidence of 96 per 1,000 troops per annum. In the following year, in the same theaters, the incidence dropped to 38 per 1,000 troops per annum and continued to decrease thereafter despite the fact that highly malarious areas were increasingly the scene of military operations. In 1945, the rate of incidence of malaria among overseas troops was reduced to 17 per 1,000 strength per annum.

That malaria was brought under control in the last two years of the war is attributed to two factors: (1) expansion of the Special Medical Malaria Control Organization set up by The Surgeon General's Office, with resultant intensification of preventive measures and improvements in methods of mosquito control; and (2) revision of the standard dosages of atabrine, making it an effective agent in the treatment and suppression of the disease. On 21 September 1943, War Department Circular No. 223 directed the formation of antimalaria details in each company or similar unit to carry out measures for malaria control in an area immediately around the company encampment.

All through the war medical officers trained as malariologists were assigned to major headquarters in malarious areas and charged with responsibility for malaria control. For the training of such officers the Army School of Malariology was established in the Panama Canal Zone in September 1943. Special malaria survey and malaria control units which had been authorized in October 1942 were sent overseas, particularly after the middle of 1943. The survey units were established to determine the incidence of malaria and the incidence and type of mosquito vectors; the control units, to supervise mosquito eradication and control. During the latter half of the war, over 150 special malaria control and over 60 malaria survey units were sent overseas. The principal advance in control of malaria mosquitoes during the war was the increasing application of DDT. Throughout the war, the Office of The Surgeon General encouraged the suppressive-drug treatment of malaria and guided the search for new and better agents which, though not preventing infection, would enable troops to operate in highly malarious territory. When, in the spring of 1943, the clinical testing of new antimalarials was expanded under

an enlarged Office of Scientific Research and Development (OSRD) contract, three medical officers were assigned to assist in the drug research program, and, in the winter of 1944, this group was enlarged to fifteen officers. Early in November 1943, an interservice Board for the Coordination of Malarial Studies was created by joint action of The Surgeon General and representatives of the Navy, the Public Health Service, the OSRD, and the National Research Council. The board was brought into existence because the customary consultative arrangements with committees of the National Research Council were found inadequate to deal with the complexities and size of the malaria problem with which the armed services were confronted. Through the Malaria Board, as it was commonly called, most of the planned studies of malaria treatment in the Army in the United States and much of those overseas were coordinated with research outside the Army on the same problems. Some 90 of the more than 600 numbered reports submitted to the Board were contributed by various Army sources.

In the latter part of the war, atabrine became the drug of choice for the suppression of malaria. On the basis of studies concerning the relation of plasma concentration of atabrine to dosage, conducted in the fall of 1943 and confirmed by reports from the field, the recommended standard dose of suppressive atabrine treatment was raised in July 1944 from a total of 0.3 gm. to a total of 0.7 gm. per week. Such adjustments in dosage transformed atabrine into a highly effective antimalarial, superior to quinine both as a suppressive and curative drug. It was found that its early inferiority in the treatment of acute attacks disappeared when large doses were given in the first twenty-four hours. Fears regarding its toxicity proved to be exaggerated. Atabrine was usually administered several weeks before troops entered malarious areas and was continued for one month after leaving the endemic area. It was found, after adoption of this regimen, that atabrine will both prevent and cure clinical attacks of falciparum malaria, but does not prevent the relapses of vivax malaria. In addition, studies conducted in the field indicated that long-continued suppressive medication abolished permanently a large amount of vivax malaria which would have become clinically active had suppression been withdrawn too soon. The specific effect of atabrine was widely credited by medical officers for the low mortality rate for malaria, the rarity of blackwater fever, and the comparatively low incidence of malignant malaria.

As troops returned to this country from tropical theaters, there was fear that certain tropical diseases and vectors might be introduced into the United States. The number of malaria relapses among veterans, especially, caused concern to civil health authorities in 1944. The

armed services had been aware of this potential danger and a number of conferences were held to discuss protective measures to be taken. Recommendations adopted by the Subcommittee on Tropical Diseases of the National Research Council in July 1943 served as the basis for Army policy and remained essentially unchanged. Measures to prevent the introduction of disease vectors were handled by the Interdepartmental Quarantine Commission of the Army, Navy, and Public Health Service. The continuance of atabrine suppressive medication for twenty-eight days after exposure to malaria, special terminal physical examination for persons with a history of malaria, dysentery, filariasis, schistosomiasis, leishmaniasis, or hookworm infection, and utilization of antimosquito measures in and around military installations were adopted. It was decided that control of the mosquito vectors in endemic areas of the United States, rather than control of individual cases, was the most practical solution to the problem of preventing postwar malaria epidemics, and that the presence of microfilariae in the blood without symptoms of disease should not warrant restriction of the location or movement within this country of persons who had been infected with filariasis. So far no serious tropical disease problem has been introduced into the United States as a result of the world-wide deployment of American troops. This may be accounted for in part by the fact that, except for the malaria rates of the earlier period of the war, tropical disease rates in general were low and the majority of men who served in the Tropics returned with their health unimpaired.

The sulfonamides, penicillin, and streptomycin. The role played by the sulfonamides and penicillin was a large factor contributing to the low fatality and noneffective rates in the war. Not only were these extremely valuable adjuncts to the management of wounds and the treatment of disease available for use by the Medical Department of the Army, but it has been said that the experience thus gained advanced our knowledge of these therapeutic agents by about fifteen years. The prophylactic use of the sulfonamides was a significant advance of the war period. Their effectiveness was proved on a particularly large scale in the prevention of meningococcal infections and the complications of the upper respiratory infections. In the treatment of acute gonorrhea the sulfonamides must be credited with a large share in the tremendous reduction in number of man-days lost from duty—particularly after duty-status treatment was instituted as routine in February 1943—and with lessening the incidence of complications due to this disease. It was found that, when properly used, the sulfonamides had minimal toxic effects; however, they were found to be ineffective in many infections, including most tropical diseases. They were not uniformly successful even in infections which were known to be most susceptible to them. The local use of sulfanil-

amide on wounds was found less beneficial than it was thought to be in 1942, and was gradually discontinued.

The almost miraculous action of the antibiotic, penicillin, against the organisms which were susceptible to it, and its development into an almost completely nontoxic agent, made it the drug of choice in the latter part of the war in the treatment of infections in which both penicillin and the sulfonamides were effective. The sulfonamides, however, continued to be used in infections that were peculiarly susceptible to their action, such as bacillary dysentery. While a considerable amount of knowledge concerning the sulfonamides had been accumulated before the war, the therapeutic properties of penicillin were known only sketchily during the first stages of American participation in the conflict. Its production also was negligible. Although many agencies under stimulus of the Army played a part in developing penicillin and in indicating its value, its effectiveness was confirmed and its range of usefulness extended by Army studies and field trials. As a result, the statement has been made that perhaps never before in the annals of medicine has the gap between experimentation and practical application of a drug been bridged in so short a time. The Army program of penicillin investigation was begun in April 1943, and conducted in ten general hospitals chiefly for evaluation of the drug in the treatment of surgical infections. In that month, although the drug was being doled out with the strictest economy, shipment overseas was begun. By October of that year, penicillin had become a standard therapeutic item. The Bushnell and Halloran General Hospitals were used as teaching centers where medical officers from other general hospitals were trained to continue penicillin studies at their stations, and "penicillin committees" were set up in hospitals to determine the cases in which the still scarce drug should be used. By January 1944, twenty-eight general hospitals were engaged in the study of penicillin in surgical infections and sixteen centers were conducting studies in the treatment of sulfonamide-resistant gonorrhea.

In its earlier application, penicillin was used chiefly in surgical infections and only in infections caused by staphylococci, streptococci, pneumococci, and in sulfonamide-resistant infections. It was frequently used in conjunction with the sulfonamides. As a prophylactic in conjunction with good surgical treatment, it was a large factor in the low incidence of wound and burn infections in this war. In the treatment of wound infections, it was a factor in reducing mortality and often shortened hospitalization periods by many months. With the great increase in the production of penicillin in 1944 and 1945, restrictions on its use were gradually eased; by March 1945 nearly all demands could be met. Meanwhile, various Army hospitals were studying the efficacy of penicillin in diseases such as pneumococcic pneumonia, meningococcal infections, and certain dermatological

conditions. When the drug had been sufficiently purified, it was administered intravenously as well as intramuscularly. Experience with penicillin confirmed its promise as a cure for diseases caused by staphylococci, streptococci, pneumococci, and gonococci. In addition, Army experience demonstrated its effectiveness in subacute bacterial endocarditis and in syphilis. Its greatest quantitative use was in the treatment of gonorrhea and syphilis. As early as September 1943, The Surgeon General authorized the use of penicillin in sulfonamide-resistant gonorrhea, replacing fever therapy, and in September 1944 complete replacement of the sulfonamides by penicillin in the routine treatment of gonorrhea was ordered, with recommendation for duty-status treatment in uncomplicated cases. Many cases of gonorrhea were cured by injections of penicillin administered for a single day.

In the treatment of syphilis the lengthy bismuth-mapharsen therapy recommended at the beginning of the war was replaced in October 1944 by the 7½-day treatment with penicillin. There is no doubt that a new antisyphilitic agent of great importance has been found. Army experience showed that, owing to penicillin therapy, approximately four out of five patients with septicemia produced by staphylococci survive. In these diseases the sulmonamides had been relatively useless. In wounds infected with staphylococci, penicillin controlled this infection and made surgical interference possible at an earlier time. When used in combination with gas-gangrene antitoxin, it is considered to have greatly decreased the mortality from this infection. In septicemia due to hemolytic streptococcus, penicillin was more consistently effective than the sulfonamides. So, too, in the treatment of the pneumonias, meningococcic meningitis, and various other infections in which the sulfonamides had been used, penicillin was highly effective and without the toxic effects of the sulfonamides. On the other hand, it does not affect the plasmodia of malaria, the most important viruses and rickettsiae and the gram-negative bacilli.

Other antibiotics are at present still in the developmental stage. In July 1945, a Streptomycin Board was established at Halloran General Hospital for evaluation of this drug in clinical use, particularly in the treatment of infections of the urinary tract and in battle wounds, and by October 1946 data had been collected on nearly 1,000 cases. Used in 1946 by the Army largely in treatment of urinary infections of paraplegics, streptomycin is being employed more extensively as supplies become available. It is at present undergoing clinical trial against infection by organisms susceptible to its action in selected cases in all Army general hospitals in this country and abroad. Streptomycin has been found effective against some organisms not amenable to treatment with penicillin.

Surgery. The emphasis on bringing surgical skill to the patient by keeping medical installations and surgical teams as close to the front

as possible, and by other means, was increased as the great campaigns were executed. Prior to the invasion of the European continent in June 1944, a project supplementing surgical facilities in the forward Army areas was developed, at theater request, by the surgical consultants in the Office of the Chief Surgeon. To meet the need for rapidly transportable units similar to those used in World War I, twenty-five mobile surgical units were provided, each with enough motor transport and medical and other supplies to be self-sustaining, and each able, when staffed with one or more teams from an auxiliary surgical group, to function attached to an Army field or evacuation hospital. The planning basis of issue was ten mobile surgical units for each auxiliary surgical group. The first five units landed in Normandy with the first U. S. Army medical installations on D–day plus 22 and functioned to advantage with evacuation hospitals throughout the remainder of that campaign. Ultimately, more than forty mobile surgical units were in operation on the continent. Matters of surgical policy were established by the theaters and disseminated from time to time in theater publications, always taking cognizance of necessary departures from policy because of special circumstances associated with individual cases.

A number of advances in surgical treatment evolved from experience in the Mediterranean and European Theaters. One of the chief advances was the concept of wound management which involved the "phasing" of surgical treatment. Begun on a small scale in 1943, it grew to major proportions in the late months of that year and offered the nearest possible approach to ideal surgery while conforming to military requirements. In the first step, initial wound surgery was performed, consisting of those procedures necessary to save life and to prevent or eradicate infection. Arrest of hemorrhage, closing of chest wounds, proper handling of abdominal wounds, forming of colostomies and enterostomies, and free use of whole blood transfusion and plasma were procedures employed in this phase. At this time also an attempt was made to perform primary suture of peripheral nerves. When amputation was required, it was directed that only the guillotine type be performed, with the minimum amount of surgical procedure possible in these cases. The second step was taken at general hospitals in the communications zone and consisted of more definitive and reparative wound surgery designed to shorten the healing period, restore early function, and minimize ultimate disability. The third step in surgical phasing was undertaken in general hospitals in this country and was concerned with the surgical correction of deformities and the rehabilitation of certain disabilities. At this stage, colostomies were closed, abdominal defects repaired, remaining foreign bodies removed, and reconstructive and plastic surgery performed. This general plan of wound management was applied to all types of injuries, including

the more serious wounds of the abdomen, the thorax, the head, the extremities, and the nervous system.

Another major advance of this period concerned thoracic surgery, in which the primary closure of large sucking wounds of the chest became standard practice. This, together with new agents to prevent infection, resulted in a very low incidence of empyema. In the field of anesthesia, a new development was the use of splanchnic block and regional anesthesia in cases where this was the indicated or preferred procedure. In 1944 and 1945, increasing use was made of maxillofacial surgical teams in evacuation hospitals and other strategic installations. These teams, consisting of a plastic surgeon and an oral surgeon, rendered skilled initial treatment to men with face wounds, reducing disfigurement and conserving vital tissue for later reconstruction in specialized hospitals in the rear. Dentists cooperated with surgeons to develop a technique for the fabrication of accurately fitting tantalum plates for the repair of skull defects. With his special knowledge of impression materials and metallurgy, the dental officer was able to produce a tantalum plate which could be placed in position with a minimum of alteration and which reproduced the normal contours of the skull.

The evolution of hand surgery as a highly developed specialty led to the establishment of special centers for the treatment of these cases. This program was under way in 1944, and nine such centers were in operation by 1945; at present, four such general hospitals are still in operation—Percy Jones, Beaumont, McCornack, and Valley Forge. Sympathectomy was found to be valuable in late stages of trench foot. It relieved chronic vasospasm and hyperhydrosis and its complications. In the field of surgical equipment, the adjustable field operating table was an important product of the research and development program. This item was collapsible, constructed entirely of aluminum, provided with all necessary accessories, including cerebellar headrest, and, when inverted and open, was suitable for use as an instrument table. Research conducted under the whole blood program yielded a newly modified field blood transfusion assembly. A darkroom tent for field x-ray units also was developed. A project coordinated with The Quartermaster General's Office resulted in development of a lightweight, dual-temperature medical refrigerator for the use of forward medical units.

Dental care. As in the case of surgery, efforts were made to bring dental service as near to the fighting lines as possible, and in the period after 1 June 1943 important improvements in equipment were made to facilitate the attainment of this objective. Development of a mobile dental laboratory, which had lagged since 1941, was pushed to completion, and a contract for one hundred and seven units was let in December 1943. These laboratories, mounted on 2½-ton trucks,

made it possible for an officer and four men to provide the most modern prosthetic service in isolated locations and in forward areas. Men requiring dental replacements were no longer sent to hospitals in the rear for a week or more while their appliances were being constructed, but had their cases completed in the vicinity of their own units, while on a duty status. In December 1943, The Surgeon General approved development of a mobile dental operating truck, and action on this project proceeded so rapidly that a pilot model was completed in February 1944 and a purchase order for thirty-five units was placed in June 1944. With delivery of these operating trucks overseas in 1945, dental officers caring for smaller, isolated organizations were provided convenient, complete outfits which could be moved on short notice without loss of time for unpacking and assembling equipment. The sturdy, 2½-ton, 6-wheel-drive truck could cover any terrain accessible to wheeled vehicles and carried its own water supply, heating facilities, and electric generating outfit. The operator had cover from unfavorable weather and all the advantages of running water, good light, and electrically powered equipment. Dental field equipment was also modernized by the addition to the operating chest of an electric light in June 1945, and a motor in November 1944; and by the provision in the laboratory outfit of an electric lathe in October 1945.

Aviation medicine. Throughout the war, the Air Forces, with Army Air Forces funds, conducted an extensive program of research in the field of aviation medicine. The main centers of research were the Aero Medical Laboratory at Wright Field and the Research Laboratory of the School of Aviation Medicine at Randolph Field. Both operated under the supervision of the Office of the Air Surgeon. Three additional research centers operated overseas. In the United Kingdom, the Eighth Air Force Provisional Medical Field Service School was activated in 1942. In November 1943, it was redesignated as the Eighth Air Force Central Medical Establishment and later came to be known as the First Central Medical Establishment. The Second Central Medical Establishment, activated at Guadalcanal on 5 June 1944, later moved to the Philippines. The Ninth Air Force Central Medical Establishment was activated in the United Kingdom in March 1944. Later designated as the Third Central Medical Establishment, it moved to the Continent in September 1944. Continuous efforts to improve the demand-type oxygen system resulted in the development, during 1943, of a new demand-type oxygen mask, standardized in 1944 as the Type A–14. This not only fitted the flyer better, but virtually eliminated the danger of the mask freezing up. With the introduction of adequate training equipment in the latter part of the war, the program of indoctrination of air crews in the proper use of oxygen equipment produced more effective results. The anoxia

accident rate among heavy-bomber crew members of the Eighth Air Force was reduced in a one-year period from 115.5 per 100,000 man-missions in November 1943 to 23.4 in November 1944. Meanwhile, the fatality rate from anoxia dropped from 21.6 to 7.1 per 100,000 man-missions.

Another medical problem relating to high-altitude warfare was frostbite. From August 1942 to January 1944, there were 2,008 crew members of the Eighth Air Force frostbitten on combat missions, as against 1,362 wounded by enemy gunfire. To reduce the dangers from exposure to extreme cold, the Air Forces developed and improved electrically heated flying equipment during 1943 and 1944, and these electrically heated flying suits, gloves, and shoes afforded the best solution. The unreliability of the underwear type of electric suit, caused by breakage of fine wires through wear and tear, was surmounted by the development of a new type worn as an outer garment. From January to August 1944, the rate of frostbite per thousand man-missions steadily declined from 0.5 to 0.03 percent. With the development of long-range, high-altitude, high-speed fighter planes, air crew combat personnel were subjected to conditions which produced adverse physiologic effects, such as blackouts. To protect the crews of planes from the effects of centrifugal force, pneumatic anti-"g" (anti-gravity) suits were developed during 1943 to counteract accelerative forces in the air. After service tests in December 1943 and January 1944, they were ordered for operational use in the Eighth and Ninth Air Forces. One of the improvements which led to their ready acceptance by fliers was the extremely lightweight valve for controlling the bladder assembly, which reduced the weight of the suit. By the middle of 1944, they were in extensive use. Reports from personnel using these suits showed that they helped to prevent physiologic consequences of the high "g" forces produced by combat flying and were an important factor in increasing combat efficiency of crews.

About 80 percent of combat wounds in bombardment aircraft were attributable to flak and the 20-mm. cannon. To protect crew members from long-range flak and 20-mm. shell fragments, the surgeon of the Eighth Air Force developed a flak suit, made of overlapping plates of manganese steel secured in pockets and worn as an apron or vest. The vests and aprons varied to give maximum protection to the back, chest, abdomen, crotch, and upper legs of crew members in different positions in flight. By October 1943, the flak suit came into regular use. In the spring of 1944, it was improved to give greater protection to the armpit and neck. Its effectiveness is revealed by the fact that from March to September 1943 unarmored combat crew members of the Eighth Air Force incurred thoracic wounds accounting for 13.28 percent and abdominal wounds accounting for 6.28 percent of all wounds. From November 1943 to May 1944, only 6.45 percent of the

wounds sustained by protected crew members were thoracic and only 4.58 percent abdominal. Although the Air Forces encountered difficulties in gaining the suit's adoption and proper use, its effectiveness in saving life made it an important morale factor. In the summer of 1943, the Eighth Air Force also developed an improved type of helmet for flying personnel. Radio men and certain of the gunners could not wear existing models because of their bulk. In addition, they were excessively cumbersome when worn over the winter flying helmet and the attached earphones. The new model, which came to be known as the "Grow Helmet," was a quick-release type made from the same kind of steel and fabric as was used in the flak suit. It was considerably lighter than the head protectors in use and, by leaving space for the ears, made the use of radio headsets possible. The effectiveness of the helmet in averting wounds and fatalities compared favorably with that of the flak suit.

Confronted with a high rate of noneffectiveness due to aerotitis media, particularly among heavy-bomber crews, the Air Surgeon organized the Army Air Forces Aerotitis Control Program in May 1944. Highly qualified ear, nose, and throat specialists were sent to various theaters to make and apply observations on the radium therapy of this disease. The results of their study, completed 1 June 1945, indicated that radium therapy was effective in the treatment of a large percent of cases. During the course of the war, the noneffective rate for aerotitis media, like that for frostbite and anoxia, gradually declined. This decline does not reflect any improvements in protective equipment or in indoctrination; rather, it is evidence of progressive therapy, a decrease in respiratory diseases, and a higher experience and adjustment level of fliers as a whole.

Fitting men for Army service. World War II, to a greater degree than any previous conflict, created extraordinary needs for military manpower. This meant increasingly that the maximum number of unfit men must be made fit for service in the armed forces. Work in "conditioning" began early in the war and was especially marked in the field of dentistry. By accepting responsibility for the dental rehabilitation of inductees, the Medical Department dental service made it possible to reduce the rejection rate for dental defects, which reached 8.8 percent in 1941, to less than 1 percent in the following year. This work was continued throughout the war with the result that, at the end of hostilities, the rejection rate for such conditions had dropped to less than 0.25 percent, and a total of 800,000 additional men had been made available for military service. Because of shortages of personnel and equipment during the early part of the war, many troops were sent overseas before their dental treatment had been completed. As a result, the theater dental services, which had expected to provide only maintenance care, were severely strained. Beginning in August

1943, provisions were made for retention of all troops in the United States until their entire class I dental work had been completed. Dental clinics and laboratories were developed rapidly with sufficient personnel to ready men for their shipments. In many instances, clinics were put on double shifts, and laboratories, in some instances, went on triple shifts, to meet demands. The result was that in many instances even routine care was completed. By December 1943 the dental service was treating 3,000,000 patients a month, and from June 1943 to the end of 1946 there were recorded 96,369,853 visits to dental clinics. In the same period, nearly 60,000,000 permanent fillings were placed, 14,272,516 defective teeth were extracted, and 2,505,741 dentures were constructed.

The treatment of uncomplicated venereal disease having been greatly facilitated by recent therapeutic advances, the Medical Department in the summer of 1942 experimented with the feasibility of inducting infected men and curing them before they were assigned to duty. The program was successful. By March 1943, more than 5,000 quickly curable venereal patients were being accepted each month, and by September 1943 the figure was almost 15,000. This program, which had provided from 115,000 to 120,000 men by the end of 1943, continued to be highly active throughout the war.

Nearly 1,500,000 individuals were supplied with glasses in 1942 and 1943. The saving of manpower through these corrections for visual defects was approximately 100,000 men.

To salvage additional men for the Army, a program of inducting men with hernias was put into operation about the end of 1943.

The reconditioning program. The manpower problems of World War II, together with great demands for hospital space in the later stages of the conflict, dictated exertion of every effort to hasten convalescence and return of personnel to fighting trim, or at least to capacity for useful Army service. While it was these pressures which basically gave rise to the reconditioning program of the Army, the program itself received active support by The Surgeon General in the later years of the war. In the zone of the interior, the reconditioning program was inaugurated in the latter part of 1942 in the Army Air Forces, and in December it was applied to all hospitals under that branch of the service. The objectives of the program were "to get a man into physical condition to meet the rigorous demands of full duty in the shortest possible time, to utilize hitherto wasted time with a planned program of military and general education, and to provide a reorientation from the routine of hospitalized life to that of full duty." [3] The program "was definitely planned with some measure of military discipline and was designed to keep the soldier extremely busy and to

[3] Rusk, Howard A.: Convalescence and Rehabilitation, page 304, chapter XIII in *Doctors at War*, edited by Morris Fishbein, M. D. New York: E. P. Dutton and Company, Inc., 1945.

assist him in bridging the gap so as to make him not only physically but psychologically ready for full duty." [3]

At about the same time, a similar program was being evolved in the European Theater of Operations. It had been observed that a significant percent of military personnel had been unable to carry on their former duties after discharge from hospitals, as a result of physical and psychological deterioration which had occurred during hospitalization. No attempt had been made to bring such personnel to their former physical capacity before discharge from the hospital. Study of the manner in which the British had solved this problem revealed that their various armed services had established special "convalescent depots" to which convalescent sick and wounded personnel, after hospitalization, had been sent for rehabilitation. In these depots a complete and comprehensive program of exercises had been given to restore these men to their former physical capacity. In the fall of 1942, a plan for the establishment of a similar Convalescent Rehabilitation Center in the ETO was submitted to the chief surgeon. It comprehended a complete physical, educational, military, and recreational program to rebuild the full physical and mental capacities of the patients. The plan was approved by the chief surgeon. The senior orthopedic consultant in the theater was instructed to select a site for the center and to train the personnel which would be required to operate it. The office of the chief surgeon prepared a provisional table of organization and equipment based on that of a 150-bed station hospital. Five officers and six enlisted men were assigned for training to the 102d British Convalescent Depot and to the British Army School of Physical Training.

On 7 April 1943, the 16th Station Hospital, augmented by this specially trained staff, opened Rehabilitation Center No. 1. There a well-balanced physical and military program was developed. Patients were admitted from station and general hospitals as soon as they became convalescent. Although the hospital load of the theater was light, the number of patients at the center increased rapidly and reached 431 by September 1943. By degrees, a program of reconditioning like that adopted in AAF installations and the European Theater was evolved in the Army Service Forces in the United States. On 11 February 1943, a policy of convalescent reconditioning in hospitals was inaugurated. This provided that a program of graded exercises, games, drill, indoctrination, and entertainment should be fully operated to the end that the physical and emotional reconditioning of the disabled soldier might be rapid and complete. Enforcement of strict military discipline was enjoined. When practicable, disabled soldiers were to be housed in barracks apart from other patients and were to be in uniform. A fourfold classification of patients in accordance with their condition was suggested, and the regimen to

which they were to be subjected was graded accordingly. The plan applied not only to the service commands in the United States but also to overseas theaters. Satisfactory programs to carry out these provisions were developed only in a limited number of zone of the interior hospitals. Notable among these were the Camp Crowder Station Hospital, Missouri; the O'Reilly General Hospital, Springfield, Missouri; and the Fort Benning Station Hospital, Georgia.

In the summer of 1943, The Surgeon General directed that a survey of convalescent management in ASF hospitals be made and that plans for handling the problem be drafted. Consultations were held with Air Forces authorities on the subject, and finally, on 21 September 1943, the basic document governing convalescent reconditioning in Army hospitals appeared in the form of S. G. O. Circular Letter No. 168. A well-balanced program of physical, educational, and occupational reconditioning in all ASF hospitals began to develop rapidly in December of the same year and surged ahead upon the issuance of ASF Circular Letter No. 73, 11 March 1944, under which long-needed personnel to execute the program were provided. Under the reconditioning program, bedridden patients participated, as soon as possible, in convalescent activities designed to restore morale and stimulate interest. Great emphasis was given to educational reconditioning, since physical reconditioning depended on a proper mental attitude. Educational activities were designed to inculcate in soldiers the desire to return to duty. Therefore, military subjects were presented through various media in an attempt to show patients the need for fighting the war; however, subjects of historical and cultural interest also were presented.

The application of physical reconditioning to patients with varying degrees of disability was studied. Athletic activities were supplemented by remedial occupational devices designed to aid in restoring function to disabled joints and muscles. In occupational therapy, work of prevocational value was stressed, including printing and graphic arts, mechanical and blueprint drawing, radio and electric construction, and photography. The superior programs and the enhanced professional quality of reconditioning activities in the last year of hostilities resulted, in great measure, from the training courses prescribed for officers and enlisted personnel conducting the program. Special training was provided for occupational therapists, and WAC enlisted personnel were trained as assistants in this field. Moreover, the issuance of a training film and the publication of training manuals further improved the quality of the work done.

In July 1944, publication of a monthly *Reconditioning News Letter*, was inaugurated by the Office of The Surgeon General. It was distributed to all ASF hospital and service command surgeons. Sources of the items published were reports made by inspecting officers from

The Surgeon General's Office, chiefs of the reconditioning branches in service commands, medical officers, and other persons familiar with the workings of the program. Convalescent training overseas was also extended and improved. In 1944, the program was extended to the Southwest Pacific, Hawaii, and Greenland, with highly favorable results. In the European Theater, from 15 to 20 percent of the total bed capacity during the last year of military operations were devoted to advanced reconditioning. About 90 percent of the patients under the program were returned to duty; this included 83.6 percent of the battle casualties receiving reconditioning training. Even hospital ships provided a regular reconditioning service for patients in transit.

Neuropsychiatry. Methods and principles applied by the Medical Department to the reconditioning of noneffectives were also made basic to the handling of neuropsychiatric problems. The magnitude of these problems in the Army is indicated by the fact that from 1942 to 1945, inclusive, neuropsychiatric disorders accounted for the separation on certificates of disability for discharge of 379,486 enlisted men. These separations constituted 45.0 percent of the CDDs granted to such personnel on account of disease. Although neuropsychiatric disorders continued to be a major medical problem of the Army, by the end of hostilities marked strides were being made in lessening its magnitude. Earlier in the war, Army psychiatrists were primarily concerned with the disposal of psychiatric cases. It was widely believed that normal men did not develop psychiatric disorders. Many Army officials and even some psychiatrists maintained the opinion that the entire problem of psychiatry in the Army could be solved by careful screening at induction and by elimination of abnormal individuals during the training period. Evidence gradually accumulated, however, that anyone could develop a psychoneurosis under certain circumstances. Emphasis shifted therefore from "diagnosis and disposal" to prevention of mental casualties. Study was concentrated on the everyday problems of the soldier. Length of combat, exhaustion, extremes of temperature, mental fatigue, misassignment, low morale, poor leadership, lack of personal conviction about the necessity for fighting the war, and other factors were found to precipitate psychiatric breakdowns. To prevent them, control or modification of the causative factors was necessary.

The preventive psychiatry program was initiated with the placement of psychiatrists in each basic training center of the Army. There they engaged not only in screening and preventive work but also in treatment. Early in the fall of 1943, some of the best young psychiatrists were combed out of hospitals and assigned to combat areas where they could detect signs of impending mental disorders and institute early treatment. Assignment of neuropsychiatrists to all Ground Forces divisions was authorized on 19 October 1943. In No-

vember, sixty-one neuropsychiatrists were assigned to divisions. Their functions embraced all matters pertaining to the mental health of the command. As part of the preventive psychiatry program, attempts were made to provide military personnel with a scientific knowledge of human behavior. It was believed that this knowledge could be used not only to maintain individual mental health, but also to solve some of the problems of leadership and morale. In their preventive work, psychiatrists also concerned themselves with the hardships undergone by infantrymen in combat. Troops in this branch of the service suffered the highest attrition rates and the highest neuropsychiatric rates. Recommendations were consequently made that a policy of rotating infantrymen after a stated combat tour should be adopted whenever feasible.

The abandonment of the "diagnosis and disposition" approach was manifested in the treatment of psychiatric disorders as well as in their prevention. TB MED 28, 1 April 1944, gave much impetus to the program of salvage. The attitude that psychoneurotics should be discharged was altered when it was indicated by experiment and otherwise that a high percent of psychoneurotics could render useful service if properly treated. Every case now was regarded as salvageable until proved otherwise, and treatment priority was given to those patients expected to return to duty. Furthermore, every case was regarded as a medical emergency, since immediate treatment often prevented symptoms from becoming fixed. In combat areas as well as in training centers cases were handled early. It was demonstrated anew that appropriate treatment administered at the clearing station resulted in the return of more neuropsychiatric casualties to duty than when treatment was initiated behind the lines. Particularly in the Okinawa campaign, the excellent results produced by the early treatment of combat neuroses within the divisional area were made manifest. In the Mediterranean Theater, special neuropsychiatric treatment units were improvised as "exhaustion centers." Neuropsychiatric patients were evacuated to these centers from division clearing stations. Basic principles employed were: treatment as far forward as possible, centralization of triage and treatment, and avoidance of a hospital atmosphere. Similar plans were used by the 1st, 5th, 7th, 9th, and 15th Armies in Europe. Psychotherapy with sedation was used extensively for certain types of combat cases, and in some instances hypnosis without sedation was employed. Both methods of treatment yielded good results. Earlier in the war, less than 10 percent of the men who broke down in combat were returned to duty. By 30 June 1945, from 40 to 60 percent were being reclaimed for full combat duty, and 80 to 90 percent of the remainder for limited duty. Indiscriminate evacuation of overseas neuropsychiatric casualties to the United States ceased.

Another principle of treatment was that of keeping psychiatric patients out of hospitals. It was well recognized that hospitalization exaggerated the concept of illness in patients' minds. As a consequence, they were treated on an outpatient basis, in a military atmosphere and under strict discipline. A fourth principle of treatment was based on the fact that many psychiatric cases were caused by situational reactions. Every effort was made to modify or remove the situational factor believed to have precipitated the disorder. This applied particularly to the problem of job assignment. Attempts were made not only to assign individuals to jobs for which they were emotionally fitted, but also to train them for specific jobs as an integral part of treatment. Coincident with the movement to salvage neuropsychiatric cases in the Army was the realization that many men with minor personality deviations and mild neurotic tendencies in civilian life could be of service in the armed forces. Accordingly, a directive was issued on 21 April 1944 advising that men be rejected at induction stations for neuropsychiatric disorders only when their history and examination indicated the existence of a condition clearly incapacitating them for military service. This was an important factor in lowering rejection rates. By August of 1944, two hospitals in the United States were being devoted exclusively to the care of psychotic patients, and twenty-four general hospitals had been designated as neuropsychiatric centers. A year later, the number of the latter had grown to twenty-seven. Special hospitals also had been set aside for the treatment of neuroses overseas.

Through the use of subinsulin and electroshock therapy, in the general hospitals, a majority of psychotic patients were sent home either in an improved condition or completely recovered. Previously, a large percent of such cases had been discharged directly or transferred to Veterans' facilities for further hospitalization. A more effective means of handling psychiatric cases was provided by all convalescent hospitals, in the zone of the interior, which by 30 June 1945 were caring for approximately 18,700 psychiatric patients. Here, their psychiatric treatment and the over-all rehabilitation program were supervised by psychiatrists, one of whom was assigned to each company. Since the shortage of psychiatrists did not permit individual treatment in convalescent facilities, group psychotherapy was increasingly employed. The augmented use of group psychotherapy constitutes, together with sedation, the outstanding development in psychiatric treatment during the war. According to this method, a group of patients with similar problems met an hour a day for discussions and comparison of experiences under the leadership of a psychiatrist. The groups usually comprised from fifteen to twenty-five men. Through the insight gained by the patients into their own difficulties, good results were obtained in a fair percent of cases treated in this manner.

Rehabilitation. Although the benefits of some form of reconditioning were originally extended to all patients in the convalescent stage, for well over a year after the program got under way emphasis was on preparation of men for return to duty. Generally speaking, rehabilitating disabled individuals no longer capable of performing any military duty was considered the concern of the Veterans' Administration and allied agencies. Great impetus was given by President Roosevelt to a change in this policy, when, in December 1944, he made the military authorities responsible for rehabilitating all disabled returned soldiers, "to insure that no oversea casualty is discharged from the armed forces until he has received the maximum benefits of hospitalization and convalescent facilities which must include physical and psychological rehabilitation, vocational guidance, prevocational training, and resocialization." In order to comply with this order, additional convalescent hospitals were established, and the reconstruction program expanded and improved its services in all dimensions.

However, in certain fields, the program of rehabilitation was introduced much earlier. A program to rehabilitate the war-blinded soldier had its informal inception in April 1943, when the Office of The Surgeon General appointed a special committee on the care of the blind. This committee surveyed techniques in management of the blind, consulted with leaders in the field, and requested the American Occupational Therapy Association to recommend qualified therapists. On 28 May 1943, the War Department designated the Valley Forge and Letterman General Hospitals for the special treatment of blinded soldiers. The establishment for the treatment of the blind at the latter hospital was transferred to the Dibble General Hospital in 1944. In September 1943, The Surgeon General promulgated a program of rehabilitation for blinded soldiers. This set forth the thesis that early treatment which restored some of the patient's confidence and optimism did much to shorten the rehabilitation period of such men. For this reason, the rehabilitation program was to be initiated in Army hospitals before the patient's discharge. However, the Army did not intend to take over the entire rehabilitation program. The completion of the process was to be left to the Veterans' Administration and State Vocational Rehabilitation Services. Nevertheless, the extent to which the Veterans' Administration and the armed services shared in the responsibility for the rehabilitation of the blind was not clearly defined. On 8 January 1944, the President directed the Army to establish special facilities for the social adjustment training before discharge of blinded personnel of both the Army and the Navy. As a result, the Old Farms Convalescent Hospital was established at Avon, Connecticut, on 21 May 1944, and on 21 July the first group of blinded soldiers arrived there from Valley Forge General Hospital.

In September 1944, the Army defined blindness as existing "when the central visual acuity is 20/200 or less in the better eye with corrective glasses; or central visual acuity with corrective glasses is more than 20/200, but less than 20/40, if there is a field defect in which the peripheral field has contracted to such an extent that the widest diameter of visual field subtends an angular distance no greater than 20 degrees."

Patients in the two general hospitals for the blind were given pretraining consisting of physical, mental, social, vocational, and economic restoration. When the patient had profited to the maximum extent from the surgical and medical service available at the general hospitals, he was transferred to the Old Farms Convalescent Hospital. Old Farms was a convalescent training unit, and not a hospital for medical and surgical treatment. Here the blinded soldier undertook a program to fit him to take his place in life. The course at Old Farms Convalescent Hospital lasted four months. Instruction was given in Braille reading and writing, typewriting, mental arithmetic, and mnemonics; in professional, academic, and business subjects; in manual and mechanical skills; and in agriculture. The authorized patient capacity of 200 at the institution was never reached. The peak patient load was 184 in March 1946, and one year later stood at 28. The total number treated there was about 1,000. Blinded soldiers discharged from the Army prior to inception of the program at the Old Farms Convalescent Hospital were permitted to take the full course there. When men were discharged from Old Farms, the Veterans' Administration assumed the task of caring for their welfare. The same agency is expected to carry on the program at Old Farms Convalescent Hospital when that institution closes on 30 June 1947.

The committee which helped to organize the program for the rehabilitation of the blind was also responsible for inaugurating a program for the deafened. On 28 May 1943, the Walter Reed General Hospital, Hoff General Hospital, and Borden General Hospital were designated for special surgical treatment for those patients whose degree of impaired hearing precluded a return to duty. Later, on 1 July 1943, The Surgeon General sent to each of those "deaf centers" an outline of policies and procedures to be employed in the rehabilitation of the deafened. In November of the same year, the center at Walter Reed General Hospital, together with its personnel, was moved to Deshon General Hospital, and, in conjunction with the centers at Hoff and Borden General Hospitals, continued the work on aural rehabilitation during the remainder of the war years. No patient was sent to these centers unless his hearing loss was great enough to constitute a handicap and was deemed to be permanent. Of necessity, treatment ordinarily was directed toward substitution and adjust-

ment rather than correction of a pathologic process. All cases were given the maximum benefit of medical and surgical treatment, but only occasionally could hearing be restored to a practical level. Nevertheless, the entire regimen at the centers was designed to prove to the individual patient that his handicap could be overcome. The treatment for each individual extended over a period of six to eight weeks. During that time he was maintained on a full and rigid schedule of testing and training. Many of the tests administered were developed as a result of research activities within the centers. They made it possible to ascertain the patient's hearing acuity from a qualitative and quantitative point of view. In addition, psychometric tests were given to determine the patient's emotional status, mental capacities, and vocational inclinations and aptitudes. On the basis of these physical and mental examinations rehabilitative measures were prescribed. In all cases, these included the study of lip reading and attendance at lectures on the conservation of voice and speech.

At the same time, hearing aids of many different makes were tested on the patient. The device which gave him optimum hearing under all conditions became his property. In the meantime, he was required to take an organized course in auricular training, in which he was taught both how to care for this instrument and how to use it in conjunction with lip reading. If needed, various other therapeutic measures, including psychotherapy, were applied. In addition, the counseling section at the center assisted the patient in determining his future pattern of economic and social endeavor. Between the fall of 1943 and January 1947, more than 8,400 patients with poor hearing were given special treatment in these centers. More than 150 civilians of professional rank were employed in this work. At the height of military activity, over 50 percent of the patients at the centers were returned to military service in a limited duty status. Some 2,000 men were thus saved to the Army. In addition, more than 90 percent of the auditory patients discharged to civil life have been able to adjust themselves to their physical deficiencies, and more than 75 percent have returned to their pre-Army employments or have obtained better positions than they had prior to entering military service. As part of the general postwar contraction of Medical Department hospital facilities, the three wartime aural rehabilitation centers were deactivated. However, on 19 January 1947, The Surgeon General dedicated a new Aural Rehabilitation Center at Walter Reed General Hospital.

The success of the rehabilitation program when it came to full fruition in the last year of the war is illustrated by its results in the handling of paraplegics. During much of World War II, the victim of paraplegia had little encouragement offered to him. There was

a pronounced feeling, particularly among administrative officials, that these patients should be rapidly passed through the Army general hospital system and discharged to the Veterans' Administration. This view prevailed until 22 January 1945, when it was decided to retain in Army hospitals these patients, who were perhaps the most severely handicapped victims of the war. After the nineteen neurosurgical centers had been given the responsibility for care of paraplegic patients and had begun to assemble the diverse professional talent necessary for their care—neurosurgeons, plastic surgeons, orthopedic surgeons, urologists, internists, dietitians, and physical therapists—TB MED 162, May 1945, was issued, outlining methods of management. Under the Army's new paraplegic program, it was no longer assumed that men with spinal cord injuries and resulting paralysis must be regarded as hopeless invalids, and all the resources of the medical profession were applied to their management.

Surgery was performed promptly in all proved or suspected cases of spinal cord injury, chiefly because exploration was the only sure way to determine whether or not the condition could be relieved surgically. Only skilled neurosurgeons operated, and the risk was therefore extremely small. The next phase of management was chiefly urologic. The urologist had specially trained attendants to help him, one or more of whom were constantly on duty in every paraplegic ward. The problem of the prevention of decubitus ulcers in paraplegic patients was never completely solved, but the elements of the solution were realized. They consisted of (1) rapid transportation, as soon as feasible after injury, to a permanent hospital, (2) segregation of the patients for transportation under the care of specially trained crews who (3) were adept in turning the patients, in care of the bladder, and in other prophylactic and therapeutic measures of which paraplegics are in special need. "A bedridden patient was simply not thought of," The Surgeon General has stated in describing the paraplegics program. "When a man reached a paraplegic center, it was taken for granted that he would be out of bed promptly, or at least as soon as certain physical deficiencies had been corrected, and that he would attempt to walk with equal promptness. An unexplained neurologic, muscular, cardiovascular, and nutritional improvement always occurs when these patients begin to move about. Passive exercise is not a substitute for early attempts at ambulation, and was never so regarded. To get the patient out of bed and on his feet was the goal in every paraplegic center for every man treated in it. We hitched our wagon to the stars, and we got where we were going in a surprising number of cases."

Those in charge of the execution of the program cherished no illusions concerning the extent to which paraplegic patients could be made ambulatory. However, it was believed that most patients with

cord lesions at or below the second dorsal vertebra could get about on crutches sufficiently to care for themselves. In lesions above that level it was realized that ambulation is not possible, although a wheel chair existence is. Most of the patients were not neuropsychiatric. To prevent their becoming so, they were kept busy. They were taught printing, woodwork, radio repairing, watch repairing, typewriting, photography, and similar occupations at which a handicapped man can do a day's work and by which he can earn a decent living. Efforts also were made to keep their family relationships on an even keel.

"I doubt," to quote The Surgeon General again, "if the doctor-patient relationship which developed in these wards has ever been equalled in the history of medicine; I am sure it has never been surpassed, for, where a paraplegic patient was concerned, the ward physician never took 'no' for an answer."

By the late fall of 1945, the majority of paraplegic patients in neurosurgical centers had received maximal medical therapy. Administrative thought was for the most part directed toward the task of centralizing the load, prior to transfer of the patients to permanent hospitals under the direction of the Veterans' Administration. On advice of the Surgical Consultants Division in The Surgeon General's Office, paraplegic patients who could not be discharged to their homes were centralized in five hospitals—McGuire, Kennedy, Vaughan, Cushing, and Birmingham General Hospitals—which were near centers of population and close to medical and educational institutions. They were also near sources of potential employment for handicapped men. These hospitals have since been transferred to the Veterans' Administration. Paraplegic patients who desired to be transferred to their own homes rather than transferred to any type of institutional care were provided, under the authorization of a War Department Supply Bulletin dated 23 October 1945, with certain nonexpendable equipment, as well as any type of expendable equipment necessary for their comfort and safety.

The development of the reconditioning and rehabilitation programs was paralleled by improvements in equipment for treatment of and assistance to those to whom the new types of regimen were applied. In the latter part of the war, The Surgeon General's Office cooperated closely with the Office of The Quartermaster General in selection and standardization of athletic equipment, the development of furniture for convalescent hospitals, and in the production of numerous items for use in occupational therapy. When war came, the manufacturers of artificial limbs were poorly prepared. Production facilities were widely scattered among small manufacturers and standardization was nonexistent. In June 1943, the Army made plans for the fitting of an artificial limb of standard design which could be obtained in sufficient quantity, readily fitted, and easily altered to meet the changing

condition of the recent amputation stump. This limb, the Trautman fiber limb, had been approved by the Panel on Amputations of the National Research Council before adoption. It has been procured in great numbers and is still used extensively in Army amputation centers.

In November 1943, the Research Institute Foundation, Inc., dedicated to "scientific research and development in artificial limbs and orthopedic appliances," was founded as a nonprofit organization by the Association of Limb Manufacturers of America. The Board of Governors consisted of representatives of public and private groups and agencies, including the Army. However, the effectiveness of this organization was limited by lack of funds, and no tangible results were evident after one year. Consequently, The Surgeon General, in December 1944, requested the Chairman of the Panel on Amputations of the NRC to convene a national meeting for the study of artificial limbs with a view to standardization and subsequent improvement. This meeting was held in January 1945, and, in February, The Surgeon General requested that a permanent committee be established for research and development work on artificial limbs. This committee, known as the Committee on Prosthetic Devices of the National Research Council, was established in March 1945 with headquarters at Northwestern University. The committee, which is a permanent body, has embarked on a long-range program which involves studies of the behavior of both artificial and natural limbs; analysis of all existing prostheses; development of practical improvements in artificial limbs; study of materials and their fabrication; coordination of the art of fitting with the manufacture of prostheses, and study of methods of training amputees in their use.

Since February 1945, the Army has prepared detailed specifications on artificial legs and has established a system of standardization which permits mass production of limbs of various fabrics. The Army uses a standard ankle and a standard knee, thus permitting interchangeability of parts in legs made of fiber, metal, or plastics, each of which is in use in one or more of the amputation centers. Considerable developmental work on plastic sockets has been carried out at the Army centers. It has involved substantial redesign and research in bonding materials carried on with the aid of the National Bureau of Standards. In July 1945, the Office of The Surgeon General assumed a large measure of direct responsibility for research and development of artificial limbs. A plan was outlined to complement the program of the National Research Council. Among the projects undertaken were: further development and improvement of knee and ankle assembly; evaluation of usefulness of plastics in sockets or limb sections; study of metals and alloys used in fabrication of artificial limbs; and

investigation of fabrics and techniques of manufacture and fitting for prostheses at or below the ankle.

Following a search for the best available mechanical hand, the Army adopted in 1944 the "miracle hand" (a trade name) which, during the International Amputation Conference in Canada in February 1944, was stated to be the best available. This prosthesis was produced in limited numbers, about 120 yearly, until 1945 when output under Medical Department contract was expanded to about 500 monthly. The "miracle hand" consists essentially of a metal shell to which are attached the four fingers and the thumb. The fingers, having a common pivot, operate as a unit; but the thumb moves independently on a separate pivot. Fabricated from formed rubber vulcanized over a steel frame, the digits are linked to a palm-enclosed drum to which is attached a cable that, when properly extended by movement of the upper torso, closes the fingers and thumb simultaneously. On the drum also is a ratchet, operated by an external lever on the palmar side of the wrist, whereby the hand may be locked in a closed position if the wearer so desires.

Since the end of hostilities, the Prosthetics Laboratory of the Army Medical Center has been developing an artificial hand which may well be superior to any hitherto devised. Complete service testing of the entire item has yet to be accomplished; but extensive engineering tests of the newly developed cosmetic glove have shown striking results. This synthetic skin is made of a rubberlike plastic which closely resembles the natural hand, even to the finger prints, skin structure, and hair. It has no seams, allows complete flexure of the fingers, shows virtually no discoloration with aging, and has great tensile strength and tear resistance. Built into the hand is a force-amplifier which compensates for mechanical losses in transmitting the original impulse to the grip. Thus aided, the hand provides about 1 pound of grip for 1 pound of pressure in comparison with approximately 4 pounds of grip for 15 pounds of pressure with the "miracle hand." However, the movement of the torso which generates the initial impulse must be much greater than the movement required for the "miracle hand." The design of the new hand concentrates all of the force into the first and second fingers, which meet conjointly with the thumb. The third and fourth fingers, which flex but do not grip when the hand is closed, can be used as a control lever for locking and unlocking the movable fingers. Compared with the "miracle hand," the new prosthesis is of lighter weight and has in its grip greater finger-tip pressure and a greater span, which enables the wearer to pick up larger objects, such as a glass of water. The weight of the glove is between 2 and 3 ounces and the completed hand with the mechanism in it will weigh approximately 12 ounces.

Prior to World War II, glass artificial eyes were obtained from Europe. Initiation of hostilities served to cut off the supply. A plastic (acrylic resin) eye was invented by a dental officer in England in September 1943. The plastic eye not only was a valuable substitute for the glass eye, it was also superior to it in many respects. Glass eyes were extremely fragile, they tended to etch in the fluids of the socket, and they were difficult or impossible to fit to cases involving extensive loss of tissue. They could be constructed only by highly skilled workers following a painstaking, time-consuming process. The plastic eye was superior to the glass eye in appearance, it was well-tolerated in the socket, and it was practically unbreakable. It was easily adapted to unusual cases, and an opposing eye could be duplicated so as to defy detection. Best of all, the procedure for the construction of the plastic eye could be mastered by any dentist or technician after a few weeks of special training. Prompt recognition was assured by The Surgeon General to the importance of the new type of artificial eye. Schools for the training of ophthalmoprosthetists were established in 1943 and 1944, and facilities for the fabrication of acrylic eyes were set up in thirty hospitals in the United States and in strategic locations overseas. By October 1945, over 7,500 of these greatly superior prostheses had been completed for Army patients, and the system had been adopted by the Veterans' Administration and leading civilian manufacturers.

The improvements in the general procedure of handling auditory patients were paralleled by progress in the devices to aid hearing. In 1943 and 1944, dental officers, engaged in a project which had the personal attention of The Surgeon General, developed a technique for the construction of individually fitted plastic hearing aids at moderate cost. From an impression of the external auditory canal an acrylic resin ear mold was constructed which channeled amplified sound waves direct to the tympanum, reduced interference from outside noise, and eliminated feed-back to the receiver. The method developed produced very satisfactory devices and was put in operation in three acoustic centers in the United States. In one of these hospitals six technicians working two shifts produced as many as 350 ear molds a month at the height of the program. As a result, many soldiers with defective hearing, who could have been helped very little with earlier types of appliances, were able to resume normal activities.

Postwar convalescent program. Early in 1946, plans were made to modify the convalescent program. During the war, physical reconditioning and occupational therapy had operated in hospitals as parts of the reconditioning program; physical therapy as part of the surgical service. In order to coordinate and integrate their use in providing

a well-rounded therapeutic program under professional supervision, the three were brought together. Physical Medicine Services were authorized on 28 November 1946 for general hospitals and station hospitals of 750-bed capacity or over. The occupational therapy program was enlarged, and emphasis was placed on its functional, rather than diversional, aspects. Physical reconditioning continued, with greater attention given to its remedial values. The establishment of physical medicine as a professional service alongside medicine, surgery, neuropsychiatry, and nursing reflected the beneficial results obtained by its use during the war in definitive medical care and in shortening the period of convalescence. With the end of the war, emphasis in convalescent programs shifted again—from "return to civil life" to "return to duty." This made feasible a reduction in the scope of educational reconditioning. In addition, the close relation of educational reconditioning activities to those of the American Red Cross, special services officers, information and education officers, and classification and counseling officers made desirable the integration of all efforts that contributed to the education and recreation of hospitalized soldiers. Consequently, on 3 December 1946, a War Department memorandum provided for Convalescent Services Divisions in general hospitals and station hospitals with a 750-bed capacity or larger. Convalescent Services Divisions, which included special services, information and education, educational reconditioning, personal affairs, classification and counseling, and liaison branches were designed to furnish "a coordinated, planned program of recreation, orientation, education, and amusement for the maintenance of high morale of patients and duty personnel at hospitals." In hospitals of less than 750-bed capacity, the organization of the reconditioning service continued as it had previously existed.

Veterinary medicine. During the period under consideration, the Army Veterinary Corps continued to expand and to reveal its versatility. Even though the work of food conservation and inspection and the assistance in the execution of the program of human preventive medicine provided by the Army's veterinary personnel somewhat overshadowed its work on animal diseases, there were discoveries and developments of world-wide importance in that field. In December 1945, results of investigation on equine periodic ophthalmia conducted at the Army Veterinary Research Laboratory, Front Royal, Virginia, were announced, indicating that the addition of crystalline riboflavin to the animal diet offered for the first time a practical means of preventing this disease, which causes more blindness in horses the world over than all other causes combined. Marked advancements were also made in the study, isolation, and transmission of the virus of equine influenza. Veterinary personnel working with the Chemical Corps

contributed to marked advances in the means of protecting and handling animals as well as food supplies under conditions of chemical warfare. Great effort was also exerted in the field of antibacterial warfare. Several veterinary officers were assigned to the wartime Joint United States–Canadian Commission which was highly successful in developing protective measures against rinderpest, one of the most devastating diseases of cattle—a disease which it was feared might be introduced into the North American continent as a method of biologic warfare.

A significant advance in veterinary science was made in March 1944 when The Surgeon General approved the establishment of a Registry of Veterinary Pathology in connection with the American Registry of Pathology under the auspices of the National Research Council at the Army Institute of Pathology, at the same time making this service available to civilian as well as military professional men. The veterinary service was responsible for treating and supervising the care of Government-owned animals in many parts of the world. These included dogs of the K–9 Corps, Signal Corps pigeons, and cattle and other livestock. The prewar veterinary animal service, limited to the care of a few thousand horses and mules, was expanded to cover the procurement and care for an army of animals which, in December 1943, reached a peak strength of over 60,000 horses and mules in the United States and several thousand more in Australia, China, India, Africa, Italy, and many other places in which new and difficult types of jungle and mountain warfare were encountered. An unusual innovation in animal service was the air-lift, under the supervision of U. S. Army veterinary personnel, of 7,118 Chinese military animals in the China-Burma Theater during 1945. Veterinary personnel with military government forces in Italy, Germany, Japan, Korea, and other occupied areas rapidly organized and revitalized the civilian veterinary services, stepped up production and distribution of veterinary biologicals and drugs, and assisted in formulating and enforcing animal disease control measures. As a result, the livestock and dependent agricultural industry of these countries was largely kept in production; and, for the first time in history, war-torn countries were not further devastated by animal disease plagues.

PLANS FOR THE FUTURE

The Army Medical Department has by no means reached its final form as a peacetime establishment, and plans, not all as yet realized, have been under way for some time looking toward its further improvement. As early as September 1944, The Surgeon General established a Postwar Planning Board to work out new policies with regard to a number of subjects.

Personnel. Early in 1946 the Postwar Planning Board issued a *Plan for the Medical Department in the Postwar Army.* It was designed primarily to help the Department attract more and better physicians, and to strengthen the Department in other ways. The plan represented early thinking on the subject, and additional measures to improve the Department are being evolved to supplement it. In this plan, the desired number of each component of the Medical Department per 1,000 authorized strength of the Army was set as follows (certain ratios to vary with total authorized strength): Medical Corps, 5.5; Dental Corps, 2; Veterinary Corps, 1; Medical Service Corps, 3; and enlisted personnel, 7. It had been recognized for some time that physicians were reluctant to accept commissions in the Regular Army at existing rates of pay and promotion; hence, provisions were made for more rapid promotions and for a 25 percent pay increase for qualified specialists. A Medical Service Corps was to replace the Sanitary, Medical Administrative, and Pharmacy Corps; in it would be incorporated officers of scientific or administrative training, formerly commissioned in those corps. A bill establishing a Medical Service Corps, to consist of sections for pharmacists, medical-allied scientists, optometrists, and any other deemed necessary, is now before the Congress. The plan included the creation of a Women's Medical Specialist Corps, with sections for dietitians, physical therapists, and occupational therapists, all members to hold commissioned rank.

Another and most important proposal would give extra financial compensation to Medical Corps officers for their long and costly training. On behalf of nurses, it is proposed to obtain an equalization of retirement benefits for those who retired with "relative" rank. Thus, some proposals for the peacetime Army have already been effected; some are still in the planning phase. The Surgeon General has taken pains to interest physicians in Regular Army careers and has publicized the advantages. In the first Army-wide integration of officers in the Regular Army, in 1946, conducted under the terms of Public Law 281, 79th Congress, over 850 Medical Department officers accepted commissions. Acceptances fell somewhat short of the number of officers desired. Thus, of 210 openings in the Medical Corps, 51 were left unfilled. This reluctance of physicians to enter the Regular Army constitutes one of The Surgeon General's most pressing problems at this time. A second integration is now in progress.

In 1946, The Surgeon General established policies designed to attract physicians into the Regular Army by providing additional opportunities for professional advancement. It was announced that every effort would be made to provide professional work for those desiring it, that approved internships and residencies were available in Army hospitals, that every effort would be made to provide specialist

training in Army and civilian institutions, and that officers would be encouraged to seek certification by specialty boards. Efforts would also be made to place nonprofessional officers in administrative and field duties. A bill now before the Congress to provide for procurement, promotion, and elimination of Regular Army officers, includes a provision to revise upward the number of years of service credited to Medical, Dental, and Veterinary Corps officers for purposes of promotion and permanent seniority. This will correct an inequity occasioned by clauses governing the integration of officers. The bill would also permit more rapid promotion in the Medical, Dental, and Veterinary Corps. A bill for the establishment of a permanent Nurse Corps in the Army and Navy, approved by the President on 16 April 1947, provides that Army nurses shall hold full commissioned status and have the same rights, privileges, and pay as male officers. Retirement, however, will occur at age 55 for officers above the rank of captain and at 50 for others.

Training. In the future, the Medical Department intends to expand its officer training program by reinstituting suspended or inaugurating new courses. At the Medical Field Service School, Brooke Army Medical Center, Fort Sam Houston, Texas, it proposes to establish three-month courses in both basic and advanced hospital administration. At the Army Medical Department Research and Graduate School, Army Medical Center, Washington, D. C., it plans to reinstitute two four-month courses suspended during the war—advanced dental and advanced veterinary—and to add to its training schedules a six-month course in basic sciences, a nine-month course in laboratory medicine, and another nine-month course in preventive medicine. No departures from the present program are contemplated in training enlisted personnel.

Hospitalization. Since the cessation of hostilities, the Medical Department has begun a long-range planning program. Planning boards at all of the general and convalescent hospitals and in The Surgeon General's Office serve as policy groups for long-range planning of physical plants. As a part of this planning, the Medical Department has drawn up a fifteen-year plan to secure a permanent modern general hospital system to replace the present temporary establishment. The Surgeon General's Office has developed preliminary plans, specifications, and estimates for a 1,500-bed general hospital at Fort Totten, Staten Island, New York, for a 1,000-bed general hospital in San Juan, Puerto Rico, and for a new permanent station hospital at Fairfield-Suisun Army Air Field. Meanwhile, construction on the new 1,500-bed Tripler General Hospital in Hawaii has been speeded up and an extensive program of modernization of the Walter Reed General Hospital has been undertaken.

Medical Research Center. In June 1946, The Surgeon General announced a proposal to establish an Army Medical Research and Graduate Training Center at Forest Glen, Maryland, near Washington. The War Department has since approved the planning of the project and allocated funds to draw plans for construction. The center would concentrate the Army's medical research activity at the new location, except such as might be more effectively carried on elsewhere. Present plans contemplate inclusion of the following units in the center: the Institute of Pathology, an Institute of Preventive and Veterinary Medicine, an Institute of Research Surgery and Radiation Therapy, an Institute of Research Medicine and Dentistry, Research and Graduate Teaching Hospitals, and a Graduate School and Library. The center is a long-term project which would take an estimated twelve years to construct.

History of the Army Medical Department in World War II. Plans for a history of the Medical Department during World War II were laid as early as 1941, when the project was conceived of as a history of the "emergency" period. Since then, a staff of historians has devoted its time to collecting material, writing monographs on special subjects, and working on the final volumes of the history. Since the end of the war, more precise outlines of the final history have taken shape. With the assistance of an Advisory Editorial Board appointed in April 1946 and composed of leading authorities in medicine and allied professions, the Historical Division has established a basic plan for the history. At present the plan contemplates three series of volumes: one of eight volumes on the administrative and operational history of the Medical Department, a second (comprising a still undetermined number of volumes) on clinical and professional history, and a third on medico-military subjects, to be dealt with in monographic form as a continuing enterprise. The Historical Division has completed a number of preliminary studies. None of the final volumes has as yet been published, but it is expected that the entire history will be finished within the next four years.

CORRECTION

In the article entitled "Significance of pH Value in the Inspection of Oysters," which appeared on page 502 in the June issue of *The Bulletin*, where the term "coliform count" is used it should read "coliform *score.*" For the relationship between coliform score and coliform count, see the conversion table set forth in Public Health Bulletin No. 295 named in reference 2 of the original article.