

# LOUSE-BORNE TYPHUS FEVER IN THE EUROPEAN THEATER OF OPERATIONS, U. S. ARMY, 1945

By JOHN E. GORDON

DEPARTMENT OF EPIDEMIOLOGY, HARVARD UNIVERSITY SCHOOL OF PUBLIC HEALTH, BOSTON, MASS.

EPIDEMIC louse-borne typhus fever has always developed its greatest potentialities under conditions of war and famine. Medical intelligence summaries of the Office of the Chief Surgeon, European Theater of Operations, U. S. Army, medical notes of the health division of United Nations Relief and Rehabilitation Administration, and the weekly epidemiological records of the Health Section of the Secretariat of the League of Nations all served to reveal that typhus fever became established in Germany shortly after the outbreak of World War II. These reports continued thereafter to give pertinent facts about its incidence and its distribution. No question existed that typhus would be encountered in Germany when the U. S. Army entered that country in the early spring of 1945. The important consideration which faced army medical authorities was how much typhus would be uncovered and where it would be found.

*Typhus in the German Reich, 1939 to the Allied Invasion.* Wartime typhus first appeared in Germany in 1939, when 8 cases were reported. The source of infection was presumably Russia or Poland, but the exact geographical origin was not determined.

In the years that followed, the number of cases increased sharply and the disease was scattered throughout Germany as the direct result of the importation of the infection from the eastern theater of war by the German armed forces, by prisoners of war and by conscript labor from endemic typhus fever areas. Many outbreaks of typhus fever occurred in prison and conscript labor camps; and sometimes the disease extended to the native German population, but the essential freedom from lice of most Germans prevented development of the infection to epidemic proportions. Cases were nevertheless so numerous that German health authorities began systematically to delay publication of information concerning typhus fever, and stopped announcements altogether after January, 1944. The annual distribution of typhus fever

for the period 1939 to 1945 for Germany and annexed territory is presented in Figure 1.

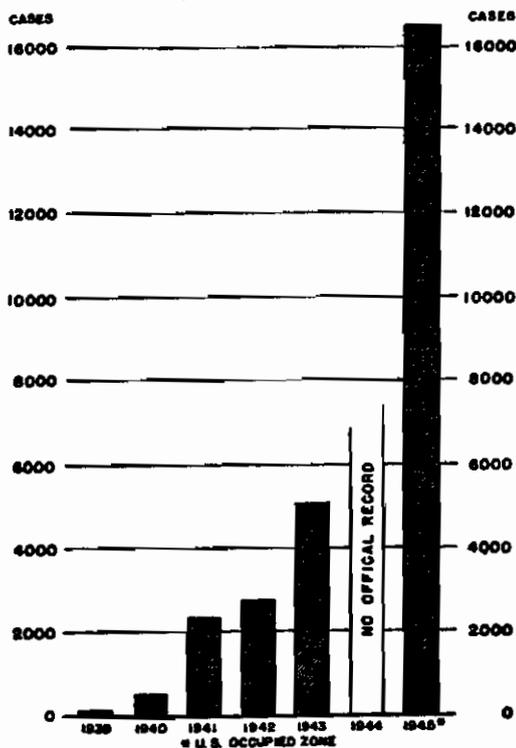


Fig. 1. Typhus fever in Germany and annexed territory, by years, January, 1939, to June, 1945.

## A PROGRAM FOR TYPHUS CONTROL

*Principles:* The program of the United States Army for control of typhus fever in Europe gave attention to 6 major considerations:

- (1). An adequate system of reporting cases of typhus fever in all population groups involved. Satisfactory procedures already existed in respect to military personnel of the U. S. Army and to prisoners of war. Reporting of the disease among displaced persons and German civilians required special consideration and methods.
- (2). A system of case finding, employing the epidemiological method for prompt discov-

ery of new cases and the existence of newly developing foci of infection.

(3). Provision for isolation and hospital care of patients with typhus fever.

(4). The establishment of a policy in respect to quarantine of highly infected areas or camps; and the institution of a cordon sanitaire to protect larger districts relatively free of typhus from infection transmitted from areas of high endemicity or actual epidemic.

(5). Delousing of patients, of contacts, and at times of large segments of the normal population, particularly of camps and of highly infected villages, by the use of DDT powder. Delousing is the core of typhus fever control, the one reliance above all others.

(6). Specific protection by immunization of all military personnel, of civilians intimately concerned with typhus control, of immediate contacts, and, as determined by circumstances, of large population groups such as inmates of concentration camps.

#### *Technical Details of Typhus Control*

(1). *The prevention of typhus fever* among troops of the United States Army was based on the principle that the best way to attain that objective was to provide them with an environment as nearly free from typhus as possible. That involved the help of the army in the control of typhus fever among civilians in areas where troops were operating. The actual plan for control was formulated and built around these measures. The plan as presented consequently represents methods and procedures tested by use in the most extensive outbreak of louse-borne typhus in recent years.

(2). *Field problems in typhus control* may be said to fit within the fabric of three basic situations. The first is that presented by entrance or contemplated entrance of susceptible persons into a recognized endemic typhus area, or into a region where current information indicates its likely occurrence. Typhus fever is not present; the threat of typhus is.

The second situation is that in which typhus has appeared in isolated cases or in small groups of cases. Then there exists the beginning or the potentiality of an epidemic. In this critical situation, the future extent of the disease is largely determined by the promptness and thoroughness of the actions taken.

The third situation is that where the first word of the disease is the report of a full blown epidemic already under way. Because of the places in which typhus occurs and the circumstances under which it arises, this is not unusual.

The preventive measures that follow are designed to meet the first situation. The control measures apply to the second and third situations, the specific program depending upon local conditions and the size of the problem.

*Preventive measures.* (1). Immunization against typhus is required of all military personnel and is recommended for foreign residents of the area. The initial vaccination consists of two subcutaneous injections of typhus vaccine, 1 cc each, at a seven-day interval. Re-immunization by injection of a stimulating dose of 1 cc in November and February is required of troops subjected to special hazard.

(2) A 2-ounce can of DDT insecticide powder is provided each man. The weekly use of the powder on the underclothing and inner surfaces of shirt and trousers is encouraged.

(3) Close liaison is maintained by unit surgeons with local military government and civilian public health authorities to assure early information of the presence of typhus in the region or in adjoining areas.

(4) Case finding and insect control teams are given special training in delousing procedures and in special measures for typhus control.

(5) Adequate stock piling of supplies for typhus control is one of the first measures to be taken.

(6) Displaced persons, refugees and repatriates arriving from typhus endemic areas are rigidly examined for signs of the disease and the presence of lice.

*Control measures.* (1) Clinical diagnosis should be confirmed by a rise in titer of agglutinins to *B. proteus OX19*. The macroscopic slide agglutination test, using *B. proteus OX19* antigen, has proved to be a valuable field method under epidemic conditions.

(2) Patients with typhus fever should be isolated from other persons, given baths, clean clothing and disinfected with DDT powder. All attendants should be immunized with typhus vaccine and protected from lice by daily use of DDT powder.

(3) Military patients transported to other countries must be certified free of lice, and other military personnel must show evidence of vaccination against typhus, absence of clinical symptoms suggestive of typhus, and freedom from lice.

(4) All military and civilian personnel should be given a stimulating dose of typhus vaccine if more than 3 months have elapsed since the last prior injection. On the occurrence of one or more cases of typhus in a camp of displaced persons, refugees, or prisoners of war, vaccination should be practiced to the extent required by local conditions.

(5) When one or more cases of typhus have occurred in a civilian community of less than 500 population, delouse every individual and when feasible vaccinate every one. In the case of larger populations the preventive measures may often be restricted to definitely infected areas. When patients are admitted to a civilian hospital, delouse all personnel and other known contacts in the hospital. Vaccinate all known contacts of the patients, including the hospital personnel. Carry out delousing of all persons living in houses adjacent to those in which typhus patients lived. Place all infected communities off-limits to troops.

(6) In case of an outbreak in a military installation delouse all personnel and reimmunize all attendants and those others concerned with typhus control who have not received an injection of typhus vaccine within 2 weeks. Limit passes and leave privileges until 15 days after the last reported case.

(7) Camps for prisoners of war, refugees and displaced persons present more serious problems than civilian communities of the same size. All immediate contacts of a case of typhus should be immunized and it is generally advisable to immunize all residents of the same barracks and general camp area. Complete immunization of the entire camp is usually not necessary, but all residents of the camp should be deloused. Establish quarantine of the camp until 15 days have elapsed since delousing was completed.

(8) Case finding teams are the principal reliance in initiating the specific epidemiologic procedures just outlined. Their equipment includes 10% DDT powder, hand dusters, vaccine, syringes and needles, and macroscopic

Weil Felix kit. They should examine and obtain full history of every confirmed or suspicious case of typhus whether the patient is actually ill or convalescent, and check diagnostic impressions by the Weil-Felix test of the blood serum of the patient.

In case of a positive diagnosis, the patient, attendants, and all members of the household should be immediately deloused with DDT powder and all except the patient should be given an initial 1 cc dose of typhus vaccine. A full history should be had to determine possible sources of infection (e.g., the bite of the infected louse occurred approximately 12 days before onset of fever). Arrangements are to be made for care of the patient in hospital under isolation precautions.

When the situation gives evidence of involving more than sporadic or endemic infections, case finding teams should interview all doctors and officials (mayor, police chief, high school principals or teachers, priests) of infected areas to learn of possible typhus which is occurring or might have occurred within the previous year. They should visit every hospital, making similar inquiries, and investigate the history of all patients in order to uncover sources of infection in neighboring villages, jails, concentration camps, barracks, air raid shelters, or hospitals. In serious situations, house-to-house canvass should be organized, using all civilian and military help available, in a search for missed or unreported cases.

Full use should be made of the police in organizing mass delousing, in apprehending relatives and friends of patients for immunization and delousing. Each medical officer should prepare a written summary of each day's activities to be compiled into a weekly report to the area authority by the senior medical officer among the case finders. All new cases should be reported daily to the area health authority.

(9) Routine and continued control measures in respect to the general population, observation of the progress of outbreaks, and further responsibility for medical care of patients are not functions of the case finding teams but of the regularly constituted medical authorities of the region. The second special control group, the Insect Control Team, aids in these matters, organizes mass delousing operations, assists with

cordon sanitaire and other quarantine measures, and protects international maritime and air traffic at ports and airports.

(10) In civilian outbreaks, serious considerations should be given to mass delousing where new admission have been maintained or have increased after two weeks. The advise of a consulting epidemiologist should be requested.

When typhus fever is widely disseminated within an area, consideration should be given to the establishment of a cordon sanitaire, to protect uninfected regions. The essentials are a strong natural barrier such as a river or a mountain range separating an infected region from the clean or relatively uninfected region. A cordon sanitaire based on an ordinary political boundary is difficult to maintain.

#### *Typhus Control during the Early Phases of the European Campaign.*

Activities in typhus control in the United Kingdom, 1941-44, were wholly a matter of training and the development of methods.

The beginning of continental operations, June, 1944, brought problems in connection with prisoners of war and the possibility of introducing typhus fever into Great Britain. This second phase lasted until March, 1945. Military progress toward Germany brought the Armies nearer to known centers of infection. It introduced problems connected with refugees and displaced persons, and demanded increased watchfulness to prevent introduction of infection into territory acquired in the progress across France.

(1) *The United Kingdom.* No active typhus control was necessary in the United Kingdom until after D-Day 1944, when incoming infested German prisoners presented the hazard of introducing typhus. Since the delousing of prisoners of war on the Continent before their transshipment to Great Britain was not feasible during the early phases of the Normandy campaign, delousing was done on arrival in the United Kingdom. Prisoners under American jurisdiction were processed through a single center where their persons, clothes and belongings were thoroughly disinfested by use of bathing, methyl bromide, and louse powder.

(2) *France, Belgium and the Netherlands.* Although no authentic cases of typhus occurred

in France, Belgium, Luxembourg or the American sector of Holland from D-Day through 1944, certain groups of the civilian population were deloused as a preventive measure. The groups so treated included native refugees returning to their homes as their section of the country was liberated; foreign Todt workers left behind by the retreating Germans; and political prisoners found in local jails.

Prisoner of war labor came into use on the Continent on an extensive scale after September, 1944. The prisoners were a heterogeneous lot, including not only native Germans but persons of many nationalities who had been impressed into the German military service. Many were heavily louse infested and disinfestation was necessary before assigning them to American units as labor crews. This was the most serious problem in typhus control encountered during military operations of 1944.

With the steady and progressive liberation of more areas in Northern France, Belgium, Holland, and Luxembourg, the problem of disinfesting refugees and displaced nationals became greater. In addition, numbers of conscripted laborers began to trickle back from Germany to their home countries. During this period (late summer, autumn, and winter of 1944-45) the standard plan for handling displaced persons began to function.

#### *Typhus in the Rhineland*

The Rhine River constituted a natural boundary within Germany, separating the Rhineland or Westmark, from the main part of the country, the Inner Reich. Advance intelligence had yielded information that while typhus fever was more or less scattered throughout Germany, the Rhineland was relatively free in contrast to other parts of the country, especially the easternmost districts contiguous to the Russian front.

The broad program of epidemic control in Western Europe was therefore based on an effort to free the Rhineland of typhus as expeditiously as possible, through use of all possible facilities for case finding and intensive application of control measures, in order that a cordon sanitaire could be set up along the Rhine. The first purpose of the cordon sanitaire was to provide and maintain an area close to the front and essentially free of typhus, in order that sup-

ply operations and the necessary regrouping and reorganization of troops before assault of the Rhine might be facilitated. It had the purpose of limiting the penetration of typhus to the liberated countries to the South and East, particularly France and Belgium, and to the British Isles, all of which were important from a military standpoint as a center for supplies and for reserves of troops. It permitted a base for typhus control activities directly contiguous to the area of greatest involvement.

Tactical considerations required that after the advance of American troops through the Rhineland to the river, a time lag would be introduced before assault of the Rhine was undertaken. From the standpoint of time, and epidemiologically, the differences in the problem of typhus control in the Rhineland and within Germany proper were distinct.

(1) *Aachen*. Typhus was first reported in the Rhineland, not by one of the advance units or hospitals as might have been expected, but by the 10th Medical Laboratory, then assigned to the First Army. Several Italian conscript laborers traveling from Holland to Aachen had fallen into the hands of the Ninth U. S. Army. A Military Government medical officer of the First U. S. Army made a tentative diagnosis of typhoid or typhus, transferred them to the hospital for communicable diseases in Aachen, and sent serums to the laboratory for examination. All 4 patients were convalescent at the time, and the onset of symptoms apparently dated from about February 15, 1945.

(2) *Muenchen-Gladbach*. The first cases of typhus fever had scarcely been reported from Aachen when the Ninth Army discovered 5 patients in the city of Muenchen-Gladbach, March 5, 1945.

A rapid survey of the surrounding area demonstrated the outbreak to be of greater import and extent than that encountered in Aachen. Not only was the city involved, but also the labor camps in the immediate vicinity, with typhus apparently disseminated rather broadly. The epidemic had started in Neuss in November, 1944, and included 183 cases, of whom 75 patients were found by American troops.

A reportedly appreciable number, of whom several had died, were treated in camps or dispensaries and are not included in the numbers

cited. Russian and Polish laborers were principally affected, with some few patients of Dutch and Italian origin. The 15 native Germans were without exception exposed in caring for patients.

(3) *Cologne*. At almost the precise time that a center of typhus infection was being uncovered in the Munchen-Gladbach area, evidence came to light that an epidemic of almost equal importance existed in the First Army area in the region of Cologne.

Promptly after entrance of American troops into that city, a survey was made by medical officers of the Cologne Military Government detachment to determine the possible existence of typhus fever. They found 65 patients with acute or convalescent disease scattered throughout the city, in hospitals, air raid shelters and prisons.

Including patients found by American troops when they entered the city March 5, 1945, 120 cases of typhus fever had occurred in Cologne, all essentially within the previous 6 weeks. Thirty-five patients had died of typhus fever. During the remainder of March, 68 new cases were found. The control measures served virtually to eliminate the disease within the month, for in April only 2 new cases were reported, and 9 occurred in May, to give a total of 199 cases in Cologne up to June 1, 1945.

(4) *Hermülheim*. A group of 16 Ukrainian laborers, both men and women, left Cologne in the early days of the American occupation. They stopped for 2 days in Hermülheim, population 1,600. During the 2 nights they remained in the village they slept in an air raid shelter which cared for the residents of 2 streets of the town. Hermülheim had previously been free from typhus fever. The Ukrainians went their way, but subsequently 2 were seen in Aachen with classical typhus fever infection.

During the 2 days immediately preceding March 24, 1945, 30 German residents of the town developed typhus fever. All had used the air raid bunker in which the Ukrainians had slept.

When Hermülheim was visited that evening, the bürgermeister and his health officer had already instituted quarantine. The following morning the entire population of the village was deloused by dusting, and vaccinated. In

the course of the following week the number of demonstrated cases increased to 58. No secondary case occurred after the accepted incubation period. This outbreak and the control measures employed demonstrated clearly the potentialities associated with the introduction of typhus into a susceptible civilian community, and the results to be expected from prompt inauguration of modern control methods.

(5) *Foreigners in the Rhineland.* Within the Rhine Province proper and the contiguous German territory west of the Rhine, the Saarland and the Palatinate, about 400 cases of epidemic louse-borne typhus fever were found to have occurred in the weeks immediately preceding the entrance of U. S. Forces, or within the first few days of occupation. The region from North to South was heavily seeded with infection. The potentialities for spread were great.

The whole area seethed with foreign peoples, conscript laborers moving this way and that and in all directions, hoping to reach their homes, in search of food, seeking shelter. Most of the typhus was within this group and they carried the disease with them. They moved along the highways and in country lanes—now a dozen Roumanians pulling a cart loaded with their remaining belongings; here a little band of Frenchmen working their way toward France, there some Netherlanders, or perhaps Belgians; and everywhere, the varied nationalities of the East—Ukrainians, Poles, Czechs, Russians. They moved mostly on foot, halted, then gathered in great camps of sometimes 15,000 or more, extemporized, of primitive sanitation, crowded, and with all too little sense of order or cleanliness.

These were the people where typhus predominated, more than a half million of them in the Rhineland, wearied with the war, undernourished, poorly clothed and long inured to sanitary underprivilege and low level hygiene. Add to this shifting population the hundreds of released political prisoners, often heavily infected with typhus but happily far fewer in numbers; the German refugees, first moving ahead of our troops and then sifting back to their homes through the American lines. Rarely if ever has a situation existed so conducive to the spread of typhus.

Typhus fever in a stable population is bad

enough. It has demonstrated its potentialities in both war and peace. The Rhineland in those days of March, 1945, could scarcely be believed by those who saw it—it is beyond the appreciation of those who did not. It was Wild West, the hordes of Genghis Khan, the Klondike gold rush, and Napoleon's retreat from Moscow all rolled up into one. Such was the typhus problem in the Rhineland.

#### *The Course of the Rhineland Epidemic*

(6) The two major centers of infection around München-Gladbach and Cologne were determined shortly after entrance of American troops into the area. At no time thereafter did typhus fever increase in numbers, despite rapidly deteriorating sanitary conditions and factors conducive to its spread. The end of March saw the situation safely under control. April had almost no cases in comparison with March—one sixteenth the number—while May ended with the disease essentially absent.

The first patient with typhus fever was recognized on March 3, 1945, although the illness antedated that time. During the first month of active operations in the Rhineland, March, 1945, no less than 31 towns, cities or villages were found invaded by typhus (Fig. 2). In most

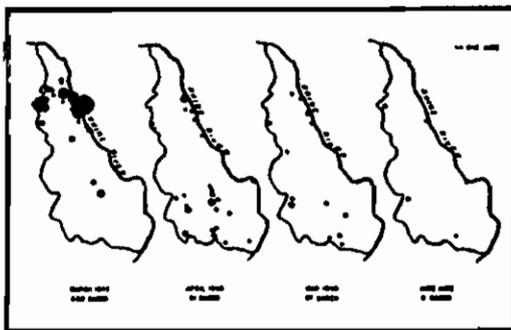


Fig. 2. Progression of typhus fever in the Rhineland, cases and localities, March to June, 1945.

instances typhus fever was frankly present when the community was occupied by American soldiers. The patients commonly represented an accumulation of typhus fever infections over the previous 6 weeks. Many were convalescent. Others were of recent origin and some developed the disease within an accepted incubation period after the American forces took over. Some few true secondary infections occurred.

During March records were obtained of 560 patients with typhus fever. In some few instances these referred to old cases, with the patient no longer infectious and discharged from medical care. The great bulk were still in hospital, had developed the disease prior to the arrival of American troops, and were in various stages of convalescence. The available information was insufficient to determine precisely how many patients had developed the disease before arrival of United States troops and how many first presented symptoms thereafter. It is furthermore impossible to know what proportions of new infections developed within an accepted incubation period and what proportion represented true secondary infections. Nevertheless, an estimate of about 150 new infections within the Rhineland in March after occupation by American forces would be fairly close to fact.

In the Rhineland as a whole, 22 fresh outbreaks were discovered during the month of April. They appear to have developed most often through migration of persons from previously infected communities of the Rhineland, particularly Cologne. The total number of cases discovered in the Rhineland in April was 91, of which 24 were related to existing centers of infection of the previous month and 67 were associated with newly developing outbreaks.

The month of May in turn showed a distinct improvement over April. The number of communities with typhus fever was only 13. Of the 26 localities where typhus had occurred in April, 18 had no cases during May and 8 communities had a limited number of secondary infections, 5 of them large cities. Only 3 new centers of infection were recognized. Two of the communities reporting typhus in May had previously had cases in March but none in April. The course of events remained undetermined.

Total typhus infections in the Rhineland in May numbered 37. Twenty-six came from foci established in previous months, 11 from newly developing outbreaks. The five cases that occurred in June were all single cases in separate localities (Fig. 2).

(7) *Population groups.* Among the many German prisoners of war captured in the Rhineland only 3 contracted typhus fever during the period March to June. Recently captured pris-

oners were usually found free of lice; they were maintained so by repeated dusting with DDT powder. Relatively few had been vaccinated when taken.

The population of the Rhineland, including the Saarland and Palatinate, was about 15 times the estimated population of displaced persons in the region, a number placed at about 500,000. Nevertheless only about one-third of total infections were estimated to have occurred among the native populations. About two-thirds of the cases, some 400, were among displaced persons. Louse infestation was far more frequent than in the native population. Living quarters were more crowded and less provision existed for adequate sanitation and cleanliness.

Accurate records on the number of deaths among the 693 patients were not obtainable. Information was available for 388 patients, of whom 61 were known to have died, a case fatality rate of 16%. Striking differences were observed between the case fatality of native Germans and that of displaced persons, largely of eastern European origin. Twenty-one of a group of 60 German patients died to give a case fatality of 35%. Only 5 deaths occurred among 143 patients from the displaced persons group, a case fatality of 3%.

#### *Typhus in the Inner Reich*

The Remagen bridgehead came into American hands on March 7, 1945. As it gradually expanded through addition of territory the existing opinion that typhus would be a serious problem became more and more justified. Typhus was found in a great many of the cities, towns and villages along the east bank of the Rhine—in Düsseldorf, Mülheim, Remagen and Duisberg; sometimes a few cases only, sometimes as many as 60. Rumors, informal reports and sometimes just plain conjecture brought word of 300 patients with typhus in Siegburg, just ahead of the First Army; and of the conditions in the great concentration camps at Buchenwald, Dachau and Belsen.

*Cordon sanitaire.* The surprise establishment of the bridgehead required immediate action to prevent the spread of typhus westward from the inner Reich. Initially, a verbal agreement was effected with the First Army that civilians would be prohibited from crossing, pending

establishment of formal control by publication of the order for a cordon sanitaire. Similar agreements were made on March 20 with the Third and Ninth Armies. For all practical purposes a cordon sanitaire was now functioning, although it lacked official sanction by higher headquarters.

The original plan for a cordon sanitaire prepared in 1943, served as the basis for a SHAEF directive of March 31, 1945, establishing a Sanitary Border extending from a point at the French-Swiss-German border, along the east side of the Rhine River to the Waal River, and thence along the north side of the Waal to the North Sea.

Delousing stations at ports of entry were located near bridges, usually in a displaced persons center. Military Police permitted civilians and liberated prisoners of war to cross only if their identification papers had the necessary endorsement showing recent disinfestation. Delousing stations were maintained at entraining points for civilians moving across the Rhine by rail, and similar provision existed for air travel.

*The Epidemiologic Situation.* The great assault of the Rhine River got under way on March 24, the British 21st Army Group and the U. S. Ninth Army to the north, the First and Third Armies in the center, and somewhat later the U. S. Seventh Army and the First French Army to the South. All found typhus fever; the British scarcely any, the Ninth some, the First and Third a great deal, while in the south the U. S. Seventh and the First French Armies again encountered relatively little.

The first really serious condition appeared when Buchenwald concentration camp was occupied by the Third Army on April 12th. The British soon uncovered Belsen camp, with still more typhus and misery. Then followed in order Dachau, Flossenberg and finally Mauthausen, all with hundreds of cases of typhus fever and sometimes thousands.

These concentration camps with their political prisoners and their typhus fever would have been problem enough. Added to the situation were millions of conscript laborers suddenly released from employment and from camps that were many times typhus infested. They scattered throughout the country. Many were gathered in large improvised camps. They spread typhus widely.

German prisoners of war increased by thousands. Changing policy held them in Germany, and the huge aggregations in temporary camps and enclosures gave fertile opportunity for the breeding of typhus. Thousands of native German civilians had evacuated their homes in the early stages of operations and proceeded to Inner Germany ahead of their retreating troops. The end of the war was complicated by their return.

Finally came the release of many thousands of German prisoners of war to return to their homes—agricultural workers, certain trade specialists and the older men of the Wehrmacht. Germany in the spring months of April and May was an astounding sight, a mixture of humanity travelling this way and that, homeless, often hungry and carrying typhus with them.

Succeeding discussion will deal in turn with the progression of the epidemic through the weeks of the Spring of 1945; the outbreaks in the more important centers, particularly the concentration camps; the extent to which typhus was imported into neighboring countries; and finally the incidence of typhus in the United States Army itself.

*The Inner Reich.* For the purpose of this analysis the Inner Reich will be understood to include that part of Germany east of the Rhine and north of Switzerland which fell under the influence of the United States Army. It included not only a major part of Germany, but the westernmost part of Czechoslovakia and the greater part of Austria.

The typhus epidemic in the Inner Reich was no orderly developing process, but a sharp increase to epidemic proportions and a progressive but more slowly ordered decline. The cases reported in a given week represented not so much the progression of the disease as the progression of the armies. The more territory that was uncovered, the greater was the number of reported cases; for Western Germany in the area of the American advance was rather uniformly seeded with typhus. To be sure, there were heavily involved communities and others lightly affected. There were great accumulations of cases in the concentration and prison camps, and in nearby small communities. New cases occurred during the time covered by this analy-

sis, which is March 24 to June 29, 1945. Sometimes they reached considerable numbers, but the great fluctuations from week to week corresponded much more to the discovery of the disease than to its actual occurrence.

Reporting of typhus fever during the advance through Inner Germany proper was even more disorganized and irregular than it had been in the Rhineland. In the beginning no attempt was made to separate cases that developed during the period of report from those convalescent or actually closed. A new community would be uncovered, with typhus promptly discovered. The patients ordinarily included those acutely ill, those convalescing, and some who had recently recovered. Actual records of onset were commonly lacking and about all that could be done was to count noses.

Not until late May and early June, not until the last great concentration camp came under American control, did weekly reports of typhus give indication of the true course of the epidemic—and that course was one of satisfactory and progressive improvement. The first week in June showed far fewer cases than the last two weeks of May, 427, compared with weekly numbers of 1961 and 1502. The end of June saw the number of newly reported cases from all localities, old and new, reach a level of 75. Table I gives 4 kinds of information by weeks from March 24, 1945, to June 29, 1945, inclusive.

For the week ending March 24, 1945, typhus was reported from only one locality, the town of Koenigswinter in the Remagen bridgehead. The 11 patients were all foreign forced laborers. No typhus was recognized during the week ending March 31. In the week of April 7, 42 cases were reported from 8 newly captured localities. The succeeding week 71 came from 9 other places, 52 of them from the Buchenwald concentration camp, which was the first large infected camp to be uncovered by American forces.

During the week of April 21 twelve new cases were reported from two localities which had previously had typhus. In addition, the number of newly recognized cases was markedly increased by discovery of 873 cases in 25 new localities. The majority (777) were from the large prison camp at Siegburg.

For the week ending April 28, 337 cases were found in 29 new places, while 7 old localities reported 25 new cases. Two large epidemics were included, the prisoner of war camp at Nürnberg accounting for 134 patients (all Russians) while Gudersleben in the Nordhausen area had 45.

The numbers continued to be great in the week ending May 4; 848 typhus patients were discovered in 52 newly conquered communities. Two hundred were in the hospital of the labor camp at Flossenburg, and 337 in the camp hospital at Dachau. Typhus was reported from more new places (52) during this week than in any other week of the epidemic period; and an additional 178 new cases occurred in 13 old localities.

For the next week, that of May 11, 451 cases were discovered in 41 new localities, with 246 in the Mauthausen concentration camp. The number of new cases reported from 20 old foci of infection was 1175, of which 882 were from Dachau alone, and represented not so much newly developing as newly recognized cases.

During the 3 weeks ending respectively May 18, May 25 and June 1, many more active cases were discovered in new localities. The majority of the new cases found in old localities during this time were from the Dachau camp, where many patients with illness of undetermined nature were ultimately recognized as infected with typhus fever.

The month of June showed a progressive and well-marked improvement, to such an extent that only 75 cases were reported for the last week of that month. The number of secondary cases was almost negligible, considering the size of the epidemic in the preceding month. The disease was quickly snuffed out in the newly infected communities where it was found. The epidemic was at an end.

Scattered cases were recognized in July, 64 in all; and a few in August, 32. Subsequent events showed that typhus in Germany had been brought under complete control, for during the winter of 1945-1946 no more than a reasonable endemic incidence prevailed.

The epidemic of typhus fever within American occupied territory of Germany included 16,506 patients. The outbreak within the Inner Reich accounted for 15,810 of that number.

Typhus was recognized in 518 localities of the Inner Reich and about 11,000 active cases in an acute or convalescent stage of the disease were observed during the three months of the epidemic.

### *Special Epidemiological Problems*

The outbreaks in concentration camps and prisons made up the great bulk of typhus infection encountered in Germany. Each presented an individual epidemiologic problem. That of Dachau is illustrative. The Dachau camp, located in Bavaria about 5 kilometers north of Munich, was one of the largest and certainly one of the most notorious of the Nazi installations housing political prisoners. It was liberated by units of the U. S. Seventh Army on May 1, 1945.

An estimated 35,000-40,000 prisoners were found in the camp, living under conditions bad even for a German camp of this kind and worse than any other that came into American hands. Extreme filthiness, louse infestation and overcrowding prevailed throughout the camp buildings. Several car-loads of human bodies were found packed in box cars in the railroad yards adjacent to the camp, the vestiges of a shipment of prisoners from camps farther north who were transferred to Dachau in the late days of the war to escape the advancing United States troops.

The number of patients with typhus fever at the time the camp was first occupied will never be known. Days passed before a census of patients could be accomplished. Several hundreds were found in the prison hospital, but their number was small compared with the patients who continued to live with their comrades in the camp barracks, bedridden and unattended, lying in bunks 4 tiers high with 2 and sometimes 3 men to a narrow shelf-like bed; the sick and the well; crowded beyond all description; reeking with filth and neglect—and everywhere the smell of death.

During the first few days little more could be done with the limited staff that was available than make the rounds of the barracks, pulling out the dead and the dying. Although some hundreds of patients were in the camp hospital with typhus fever on May 1 when the camp was first taken, large numbers died and many were added before the first census of patients was made on May 3. At that time the hospital population was 297.

In the course of the next week this number was increased by 822. For the week ending May 18, 1,253 additional cases were recognized, and the greatest number (1,343) came during the week ending May 25. For the week of June 1, 1945, 277 new infections came to record and as of June 1, 1945, 1,580 patients were under treatment in the several hospitals associated with the camp.

The record is not by day of onset but sets forth the number of patients recognized on a given day as having clinical symptoms of typhus or being in the convalescent stage of that disease.

The records of the first week include two principal groups, patients found in barracks so severely ill with acute and apparent typhus as to be transferred to hospital, and a lesser number reporting ill for the first time and sent to the camp dispensary with early typhus. Thereafter, a thorough search was made barrack by barrack for all patients with typhus. As a result, reported cases increased strikingly. The number of newly recognized cases ranged from 100 to 150 a day, with then a sudden rise to 700. On this particular day a group of some 600 patients previously under observation in the inner camp hospital and carried as typhus suspects were officially notified as typhus fever.

Available records failed to demonstrate how many of the 4,032 patients of the Dachau epidemic were actually ill with typhus at the time the camp came under American jurisdiction, how many developed the disease within the succeeding 14-day incubation period, and how many represented true secondary infections after American responsibility came into play. The relatively small numbers reported in the last days of May, and the essential disappearance of the disease in June suggests that secondary infections were held to a satisfactory level. Certainly the majority were either ill at the time the camp was taken over or were within the incubationary stage of the disease.

Even the appreciable figures cited fail to include all who contracted typhus fever in Dachau concentration camp. Freed from the sort of existence they had been living, it was no wonder that those strong enough should attempt to escape. Many did, and scattered widely through the nearby country, especially to the region south of Munich. Some were actually in the clinical

stages of typhus fever and many were incubating the disease. They were later found with typhus fever in other areas.

The camp was promptly quarantined. Hospitals were moved in to augment the small prison hospital. Case finding teams initiated control work through survey of the surrounding area for former inmates developing typhus after leaving. The dusting of prisoners with DDT powder was started May 3, 1945, and completed May 8.

Immunization of prisoners against typhus fever was put into force as soon as conditions permitted. The primary emphasis was on delousing. In respect to case fatality, data are available for 2,336 cases reported up to June 1. The number of patients who died was 311, and the case fatality rate was 8.3.

Of all the centers of infection encountered in this generalized outbreak in Germany, Dachau was easily the most extensive; and because of the deplorable conditions under which control measures were instituted, it was the most difficult to control and the most serious in its epidemiologic portent.

#### *Typhus in the Liberated Countries*

Typhus fever began to be reported with increasing frequency in the liberated countries of Western Europe during April. Nearly all infections were related to repatriated persons who had returned to their homes from labor and prison camps in Germany. Despite the number of potential sources of infection that were set up in France, Belgium and the Netherlands, only a few confirmed secondary cases were reported. The season of the year was a favoring circumstance and the louse population in the countries to which they returned was low. From political and patriotic motives, prisoners were often returned in violation of the required quarantine period, and in too many instances before they were properly deloused.

Typhus fever was reported in France to the number of 276 cases as of June 30, 1945. Table 2. Denmark had 15 cases, Belgium 136 and 49 occurred in Holland, all in countries previously free from the disease. The number in June was essentially half that for May because of the general subsidence of the epidemic.

When by accident or by force of politics, some

relatively few unprocessed individuals were introduced into the country of origin, typhus promptly followed; a circumstance which demonstrated the material protection afforded the other countries of Europe by the cordon sanitaire, the mass delousing and the other control measures which were put into effect in Germany.

#### *Typhus in U. S. Military Forces*

Only 3 confirmed cases of typhus occurred among U. S. Troops serving in the European theater. Two infections were contracted in the Rhineland and one within the Inner Reich. All 3 patients had mild attacks of the disease. Two recovered American prisoners of war were found to have typhus.

#### *Summary and Conclusions*

Conditions in Western Europe in many respects favored a much greater spread of typhus fever than actually occurred. Germany was in chaos. The destruction of whole cities and the path left by advancing armies produced a disruption of living conditions contributing to the spread of the disease. Sanitation was low grade, public utilities were seriously disrupted, food supply and food distribution were poor, housing was inadequate and order and discipline were everywhere lacking. Still more important, a shifting of populations was occurring such as few countries and few times have experienced.

Native Germans, dislodged from their homes and often moving long distances to escape the enemy, were finding their way back home. Millions of foreign peoples imported as conscript labor were milling about the country, often aimlessly, sometimes seeking their way back to their native lands. The roads, the countryside, were full of released German prisoners of war who lacked transportation and were finding their way to their homes on foot. There was the minor group of released allied prisoners of war, not a very important factor in the spread of typhus within Germany, because they were promptly evacuated in an orderly manner, but potentially capable of transmitting typhus to their native countries.

Two important factors served to limit the extent of the outbreak. The most significant was the time of the year that allied troops entered Germany. Had this been December instead of

March, as would have happened except for disrupted military plans, the problem would have been much more serious. Von Rundstedt's Battle of the Bulge, although of serious import militarily, had the favorable aspect of postponing contact with typhus until the spring months.

Spring brought a lower potential of louse infestation, it permitted life outdoors instead of crowding within existing habitations, and the movement of displaced persons and refugees was facilitated, with consequent greater dispersal. Dispersal of course, had advantages and disadvantages. It tended to disseminate infection broadly—it limited concentrated outbreaks.

Early repatriation of all Russian nationals, both prisoners of war and conscripted labor, was undertaken in May and completed in June. A large part of available American transport was turned to this end, with the result that thousands of Russians were repatriated every day. They were the population groups with the heaviest incidence of typhus.

Under any interpretation of governing circumstances, much credit must be given to the efficiency of recently developed methods of typhus control. The value of delousing through dusting with DDT, and the usefulness of typhus vaccine were tried and tested on a scale greater than

ever before and under conditions epidemiologically more conducive to extensive and continued spread of the disease. The results attained in the Naples epidemic were confirmed and extended.

No single factor contributed more to the satisfactory end of the outbreak than that never in the course of the epidemic were the fundamental supplies of DDT powder and vaccine lacking. Occasional difficulties arose in local distribution, but the supply system was such and the stock piles so great that they were promptly remedied.

The middle of July saw Western Europe return to a satisfactory situation of low grade typhus endemicity.

TABLE II  
TYPHUS FEVER IN ALLIED COUNTRIES  
Number of cases reported March to June, 1945, inclusive

Country	March	April	May	June	Total
England	0	0	10	11	21
France	8	0	141	127	276
Belgium	0	3	64	69	136
Denmark	0	1	10	4	15
Netherlands	0	1	11	37	49
Scotland	0		1		1
Total	8	5	237	248	498

Source: Health Section of the Secretariat of the League of Nations, December 18, 1945.

TABLE I  
TYPHUS FEVER IN THE INNER REICH

Week ending	New localities		Old localities New Cases	Total cases	Localities with typhus		
	Active cases	Cases of record			New	Old	Total
March 24	11	—	—	11	1	—	1
April 7	42	—	—	42	8	—	8
April 14	71	2400	—	2471	9	—	9
April 21	873	296	12	1181	25	2	27
April 28	337	—	25	368	29	7	36
May 4	848	775	178	1801	52	13	65
May 11	451	1326	1175	2952	41	20	61
May 18	714	3	1775	2492	50	40	90
May 25	312	—	1649	1961	32	34	66
June 1	320	21	1161	1502	26	38	64
June 8	17	—	410	427	7	25	32
June 15	4	—	447	451	3	27	30
June 25	7	—	75	82	2	11	13
June 29	24	—	51	75	7	9	16
Total	4031	4821	6958	15810	292	226	518

Source: Division of Preventive Medicine, Office of the Chief Surgeon, European Theater of Operations, U. S. Army.