

## TYPHUS FEVER IN ITALY, 1943-1945, AND ITS CONTROL WITH LOUSE POWDER

By

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### INTRODUCTION

A suggestion from the Office of The Surgeon General of the United States Army to the National Research Council led, in 1942, to the development of an effective pyrethrum-containing louse powder, MYL, by a United States Department of Agriculture group working in Orlando, Fla. Field tests of this powder in artificial louse infestations during the summer of 1942 gave such promising results (Davis and Wheeler, 1944) that similar studies on natural infestations were planned for Mexico (Davis et al., 1944) and the Middle East. Early in 1943 it was demonstrated in Egypt by the United States of America Typhus Commission that two applications of MYL powder with a 14-day interval between treatments would reduce the louse infestation of an individual to a low level, and that with an adequate staff large numbers of persons could be deloused at central powder stations in spite of the time consumed in removing the clothing of each individual for dusting. Furthermore, in a village where typhus was epidemic the spread of the disease ceased following the delousing treatment.

Later in 1943, in Algeria, a technique was evolved for blowing louse powder on the inner surfaces of garments, especially those next the skin, without undressing the person treated (Soper et al., 1945). Tests of MYL and the

then new DDT powders, carried out in the absence of typhus infection but controlled by louse counts before and for a considerable period after hand or mechanical application of the powders, indicated that either should be efficacious in arresting transmission of epidemic typhus.

Since a resumé of the Naples epidemic with an account of the measures instituted for its arrest has appeared (Wheeler, 1946), the present report will not attempt to relate the particular activity of each of the organizations which collaborated in the fight against typhus in Naples. Rather, it will describe the evolution of the epidemic and the persons affected thereby; it will discuss the measures instituted for the control of the outbreak and evaluate their merits; and it will describe in some detail the techniques and procedures recommended for applying louse powder in the event of subsequent typhus outbreaks.

The typhus team of The Rockefeller Foundation Health Commission organized and administered the delousing service in Naples under Col. W. H. Crichton (British), Public Health Officer, Allied Military Government (AMG), Region III, 15th Army Group, from December 9th, 1943, to January 2nd, 1944; continued in charge of the mass delousing section of the typhus control service under Brig. Gen. Leon A. Fox and Col. Harry A. Bishop, United States of America Typhus Commission, January 3rd to February 19th, 1944; and resumed full responsibility for all de-

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lousing under Brig. G. S. Parkinson and Lt. Cols. W. C. Williams and Gordon Frizelle, director and deputy directors of the Public Health Sub-Commission for Italy, from February 20th, 1944, to July 31st, 1945.

Administrative personnel were drawn from both military and civilian sources including: Allied Military Government agencies; the Municipal Health Service, Naples; the Public Health Sub-Commission of the Allied Control Commission for Italy; the Peninsular Base Section, United States Army; the North African Theater of Operations of the United States Army (NATOUSA); malaria control units from North Africa, Iran and Iraq; the Royal Army Medical Corps (British); the United States of America Typhus Commission, the United States Navy, and the Italian Red Cross and civilian medical profession.

#### *Evolution of the epidemic*

The earliest incursion of typhus in the mainland of Italy during World War II apparently occurred in late February of 1943 when a hospital train bringing soldiers from the Russian front arrived at Foggia, where 281 soldiers and officers were hospitalized. The train then proceeded to Bari, where 226 others were discharged to hospitals. On the 12th and 13th of March, 80 cases of typhus appeared among these repatriated soldiers. Two additional cases were reported from the crew of the hospital train, a third in the staff of the Red Cross Hospital in Foggia and another in a soldier who had gone to Messina on leave from one of the military hospitals.

The first cases of typhus in Naples were reported in March among patients in the military hospital, one in a soldier returned by train from the Russian

front and 3 others in men brought by hospital ship from North Africa. The initial case of typhus in civilians was reported at Aversa, some 12 miles from Naples, where the first of 8 cases, all in the same family, had its onset on April 24th. The diagnosis was confirmed serologically at the Cotugno San Giorgio municipal contagious disease hospital in Naples. This patient had traveled to Foggia province twice during the week preceding onset, making portions of the trip in military vehicles operating to and from the military hospital. The commandant of this hospital at Aversa claimed that there was no typhus among his patients; however, his records of wounded and sick included several typhus convalescents who were brought from North Africa directly to Aversa.

In July two cases were reported among patrons of a bathing establishment in Naples and a third case (Giuseppe Grassi) with onset on the 16th of the month, occurred at the Poggioreale prison, a large provincial institution located in the industrial area of Naples. Grassi was released on July 21st. On the 28th he was taken to the Cotugno Hospital where a diagnosis of typhus was confirmed serologically.

Poggioreale prison, the most important in the area, was surrounded by military barracks, airplane and locomotive works and soap and textile plants. Several direct hits during the Allied air raids of 1943 rendered some of its pavilions uninhabitable. The bathing plant was demolished, and hygiene in the prison sank accordingly. There were no shelters, and while raids were in progress the prisoners were herded together in the basement. The inmates were almost all louse infested, so that conditions for the transmission of typhus were ideal once the causal agent had been introduced.

There were many opportunities for the introduction of typhus into Poggioreale during the winter and spring of 1942-1943. The disease was unusually prevalent in North Africa at this time, and there are records of large numbers of prisoners, both French and Italian, who were evacuated from Tunisian prisons, some by way of Sicily and others directly to Naples. Dr. Saporito, Medical Inspector General for Italian prisons, admitted that there was typhus among the prisoners in Sicily<sup>2</sup> and that louse control there consisted of burning and replacing clothing because there were neither chemicals nor equipment for delousing. Large numbers of Yugoslav prisoners also passed through Poggioreale as late as April, 1943, and the names of some of these appear in the infirmary reports.

The records at Poggioreale are restricted largely to the infirmary registers which escaped destruction when the rioting prisoners burned the personnel records in the late summer of 1943, but a number of the inmates were traced through transfer records at branch prisons. Following the case of Grassi, mentioned above, Vincenzo Petriccione, who apparently contracted the disease in the prison infirmary, became ill on July 19th. On the 23rd he went to Cotugno Hospital, where the diagnosis of typhus was made. De Luca, a clerk in the prison, became ill with the disease on August 13th and Guerrino, one of the carabinieri, contracted it on August

15th. How many other cases occurred among the prisoners and staff between this time and December, when the first cases were actually reported from the prison, is not known, but inspection of the infirmary records reveals a long list of suspicious diagnoses, and one is impressed by the frequency with which acutely ill prisoners were liberated or transferred to branch prisons.

Typhus appeared in men transferred from Poggioreale in at least 4 branch institutions. One prisoner with a fully developed infection was transferred to Casoria on July 17th. In July and August the Poggioreale infirmary was filled to capacity so that patients from the prisons at Gragnano, Casoria and Aversa, in whom typhus was diagnosed serologically, were refused admission. Some of these patients returned to branch prisons while others were liberated.

The Pozzuoli prison, a reformatory for boys and mental delinquents which was evacuated in July to receive the overflow from Poggioreale, is the most interesting of the 4 branch prisons where typhus occurred during the summer of 1943. Large numbers of prisoners were transferred to Pozzuoli on July 12th, 26th, and 27th, and shortly after their arrival some 25 cases of typhus developed. One patient died only 6 days after admission, and onsets among the others began on August 5th. When the disease was finally diagnosed the prison was quarantined, and the patients were sent to Cotugno Hospital. Of no little significance is the fact that during August, when at least 25 typhus patients were present, no less than 100 prisoners were liberated, 40 or more were transferred to other institutions and some 25 escaped. In the mounting confusion of August and September in Naples these potential carriers of the disease were

<sup>2</sup> The first outbreak was at Milazzo, Sicily, where 37 cases with 9 deaths occurred among Libyan prisoners between January and April, 1943. Twenty cases occurred among 130 Libyans at Nicosia in July, 1943, just before the Allied invasion. No civilian cases had been registered up to the prison break which came in August during the invasion, but escaping prisoners may have been responsible for scattering the infection in Sicily.

lost to sight. Many probably sought refuge in the air-raid shelters, locally called *ricoveros*, which were as admirably designed to protect runaway prisoners from the law as honest citizens from bombs. The *ricovero* in "Tunnel 9th of May," a main traffic artery between Naples and Pozzuoli, began to yield cases of typhus in August and September.

Although Naples is a city of nearly a million inhabitants it is relatively small and compact. The tenement districts about the port and industrial areas suffered extensive damage during the Allied raids in the spring and summer of 1943, so that large numbers of families were forced to reside in air-raid shelters. These were large underground chambers, most of them old quarries for tufa, the chief building material of the region. Many of the *ricoveros* were equipped with lights, some had water and toilet facilities and a few afforded some measure of privacy in cubicles built of wood or stone, but in general the shelters were draughty, damp and almost always dirty. Most of their permanent dwellers came from the poorest sections of Naples.

There are no official or reliable estimates of the usual population of the air-raid shelters in the summer of 1943, but their estimated capacity of 220,000 must have been severely taxed during the heavy raids of July, August and September.

On September 23rd the Germans ordered the evacuation of a zone 300 meters deep about the port and coastal area, and some 300,000 persons were obliged to leave their dwellings on that day, which resulted in further crowding of the air-raid shelters. Among the evacuees were thousands who lived in the "Tunnel 9th of May." Typhus had been incubating in this shelter for weeks,

and its occupants were now dispersed to the shelters beyond the 300-meter zone. With characteristic thoroughness the Germans, before leaving Naples on September 30th, opened the doors of Poggioreale and Pozzuoli prisons and emptied their infested occupants into the already overcrowded shelters of the city. Owing to the disorganization caused by the German evacuation and the Allied occupation of Naples this serious situation went unchallenged. Transportation and communication facilities were inadequate for the needs of the civilian health authorities, with the result that the investigation of reported cases, isolation of known cases and even the preparation of reports were all delayed.

*Persons affected by the epidemic*

The final record of cases of typhus in Naples and the vicinity from July 1st, 1943, to June 1st, 1944, may be classified as follows:

	Cases	Deaths
Civilian cases in Naples	1,403	318
Civilian cases outside Naples	511	82
Italian military personnel	23	3
Italian civilian prisoners	37	11
Unverified civilian cases	46	15
	2,020	429

The unverified cases were those not hospitalized nor seen by the control service staff, and the diagnoses were not confirmed by laboratory tests.

These data and the data presented in table 1 differ from those reported during the epidemic, when lists of cases were being received from various sources. Duplications have been eliminated by careful checking of the names and identifying information regarding cases reported in municipal and provincial health department lists, death certificates, hospital admission records and laboratory reports, and the daily reports of the case-finding section.

Only the 1,914 civilian cases in and outside Naples are included in the analysis in table 1, since soldiers and prisoners constitute specially selected groups. Of the 1,914 patients, 91 per cent were hospitalized; and serological confirmation of diagnosis, based on Weil-Felix, Castenada or complement-fixation test, was recorded for 61 per cent. Eighteen of the patients were nurses or hospital attendants and two were physicians.

TABLE 1—Continued

Week ending	Naples		Outside Naples		Total	
	On-set	Re-port	On-set	Re-port	On-set	Re-port
Jan. 2	189	199	18	11	207	210
9	137	237	23	24	160	261
16	143	153	35	18	178	171
23	117	116	57	25	174	141
30	64	130	31	63	95	193
Feb. 6	43	75	37	32	80	107
13	33	38	35	34	68	72
20	16	38	28	37	44	75
27	9	20	26	24	35	44
Mar. 5	10	12	38	22	48	34
12	5	9	17	42	22	51
19	1	3	17	32	18	35
26	3	2	13	18	16	20
Apr. 2	4	3	16	21	20	24
9	2	4	9	2	11	6
16	0	1	10	21	10	22
23	1	0	10	3	11	3
30	0	2	4	5	4	7
May 7	0	0	2	11	2	11
14	0	0	0	3	0	3
21	0	0	1	0	1	0
28	0	0	0	3	0	3
Before July	1,403	1,403	500	500	1,903	1,903
Uncertain			8	8	8	8
Totals	1,403	1,403	511	511	1,914	1,914

TABLE 1

Distribution of typhus cases among civilians in Naples and vicinity, by weeks, July, 1943, through May, 1944

Week ending	Naples		Outside Naples		Total	
	On-set	Re-port	On-set	Re-port	On-set	Re-port
July 4	0	0	0	0	0	0
11	1	0	0	0	1	0
18	2	0	0	0	2	0
25	1	3	1	0	2	3
Aug. 1	0	1	0	1	0	2
8	2	0	2	0	4	0
15	3	2	1	1	4	3
22	1	3	0	2	1	5
29	4	1	0	0	4	1
Sept. 5	5	3	0	0	5	3
12	6	8	1	0	7	8
19	8	4	1	0	9	4
26	11	7	0	2	11	9
Oct. 3	8	11	1	0	9	11
10	3	8	0	1	3	9
17	8	3	2	0	10	3
24	6	6	1	2	7	8
31	1	6	0	1	1	7
Nov. 7	9	5	2	0	11	5
14	12	5	3	2	15	7
21	32	12	5	3	37	15
28	46	26	6	3	52	29
Dec. 5	40	42	11	7	51	49
12	64	42	7	9	71	51
19	129	48	8	11	137	59
26	224	115	21	4	245	119

Table 1 contains the distribution of these 1,914 cases, by week of onset and of report, for Naples and outlying communities from July 1st, 1943, through May 28th, 1944. Between July 1st, and September 26th (13 weeks), 32 cases were reported in Naples and only 6 outside. During the next 5 weeks the corresponding figures were 34 and 4. In the following 5 weeks (to December 5th), 90 cases were reported in Naples and 15 outside, bringing the totals of

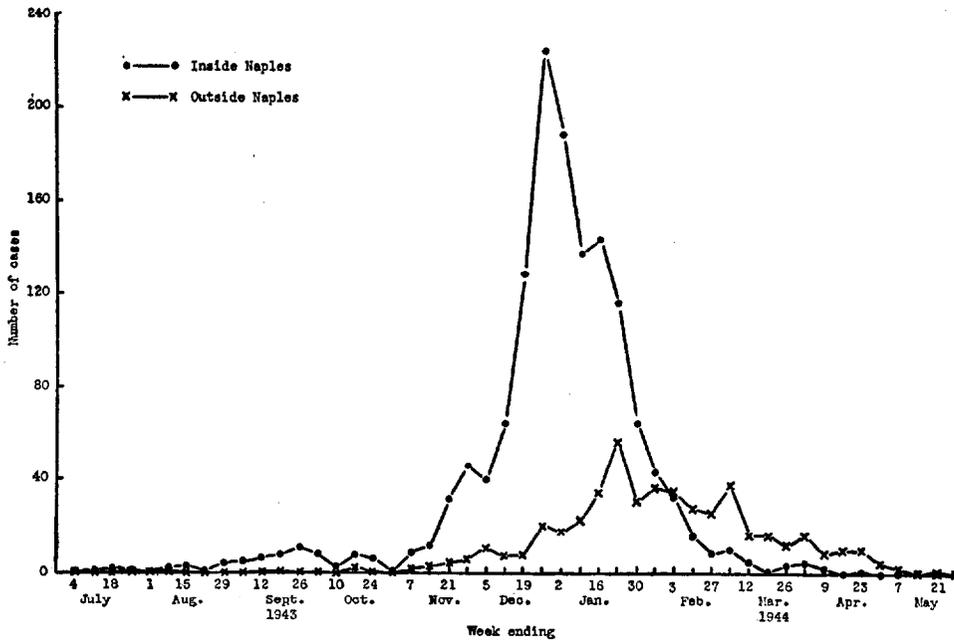


FIGURE 1. Typhus cases, by date of onset, in Naples and vicinity, July, 1943, through May, 1944.

reported cases to that date up to 156 for Naples and 25 outside. During this interval, however, 209 cases had their onset in Naples and 37 outside.

The date of onset was that given by the patient or his family, and there was a tendency for these dates to cluster about days readily recalled; e.g., 45 cases with onset on New Year's Day. Likewise the date of report is not always epidemiologically significant, since it did not necessarily coincide with the date of hospitalization or of dusting with insecticide.

Although one or more cases occurred in Naples each week after the middle of August, the epidemic rise did not actually begin until the week ending November 7th, when there were 9 cases. It reached its peak with 224 cases in the week ending December 26th. The

recession was not quite so rapid, but by March 5th, 1944, the number of cases in Naples by date of onset had dropped to 10.

Figure 1 shows the gradual rise of the epidemic in November, a sharp skyrocketing in December, followed by a reversal in the form of the curve in late December and a rapid decline in the following months. When incidence in Naples is compared with that outside the city it is apparent that both acceleration and deceleration of the epidemic were more rapid in the city than outside. The median date of onset for the 1,403 cases in Naples was December 29th and that of reporting January 6th, giving an average lag of about 8 days.

The distribution of families or households with two or more cases is shown below:

*Cases in families*

No. of cases	No. of families
2	130
3	49
4	42
5	28
6	16
7	9
8	8
9	6
10	2
11, 12, 16, 18, 20	1 each

Although louse-borne typhus is essentially a contact disease, only 1,089 of the 1,914 patients came from households having more than one case. The breaking up of families due to conditions prevailing in the city may have been partly responsible for this, but it is also probable that many cases were never reported. The application of louse powder to persons in the incubation period may also have prevented the spread of the disease within the family.

The distribution of typhus cases and deaths by age and sex are contained in table 2, and in figure 2 the histograms showing the age distributions of cases among males and females are compared. The large number of persons between the ages of 10 and 24 years in each sex group is a conspicuous feature of figure 2 and may be a reflection of the breakdown of the normal discipline and order of family life in this war-torn area. Young people, when homeless, probably frequented the shelters, where the risk of exposure was greatest. Thus 9 of 14 cases recorded for one of the shelters were in boys from 13 to 20 years of age.

No less interesting is the greater number of cases in females between the ages of 35 and 44 years. Greater exposure may have been a factor here, and since women at these ages are usually mothers with numerous children, their illness disrupts the life of the family and they

TABLE 2

*Age and sex distribution of typhus cases and deaths, Naples and vicinity, 1943-1944*

Age (years)	Cases			Deaths		
	Male	Female	Total	Male	Female	Total
0-4	40	33	73	5	5	10
5-9	70	64	134	2	3	5
10-14	124	112	236	2	3	5
15-19	175	134	309	16	13	29
20-24	94	121	215	6	11	17
25-29	57	75	132	9	6	15
30-34	55	77	132	16	13	29
35-39	50	109	159	22	19	41
40-44	51	97	148	24	27	51
45-49	59	70	129	31	21	52
50-54	35	64	99	20	27	47
55-59	24	35	59	14	18	32
60-64	15	24	39	9	15	24
65-69	12	11	23	11	9	20
70-74	4	9	13	4	9	13
75-79	2	2	4	2	2	4
80-84	3	2	5	3	2	5
85	0	1	1	0	1	1
Unknown	1	3	4	0	0	0
Totals	871	1,043	1,914	196	204	400

are more likely to receive medical aid and to be reported.

It is probable that cases of typhus were less well reported among young children in whom the disease may be mistaken for a childhood exanthema. The low frequency of cases among men of middle age may have been due partly to their employment on night shifts, which reduced their risk of exposure in the shelters, and to a large number of missed cases.

Owing to the uncertainty regarding the completeness of these data, attack or fatality rates derived from them would have little significance.

For practical purposes an assumption of universal susceptibility is believed

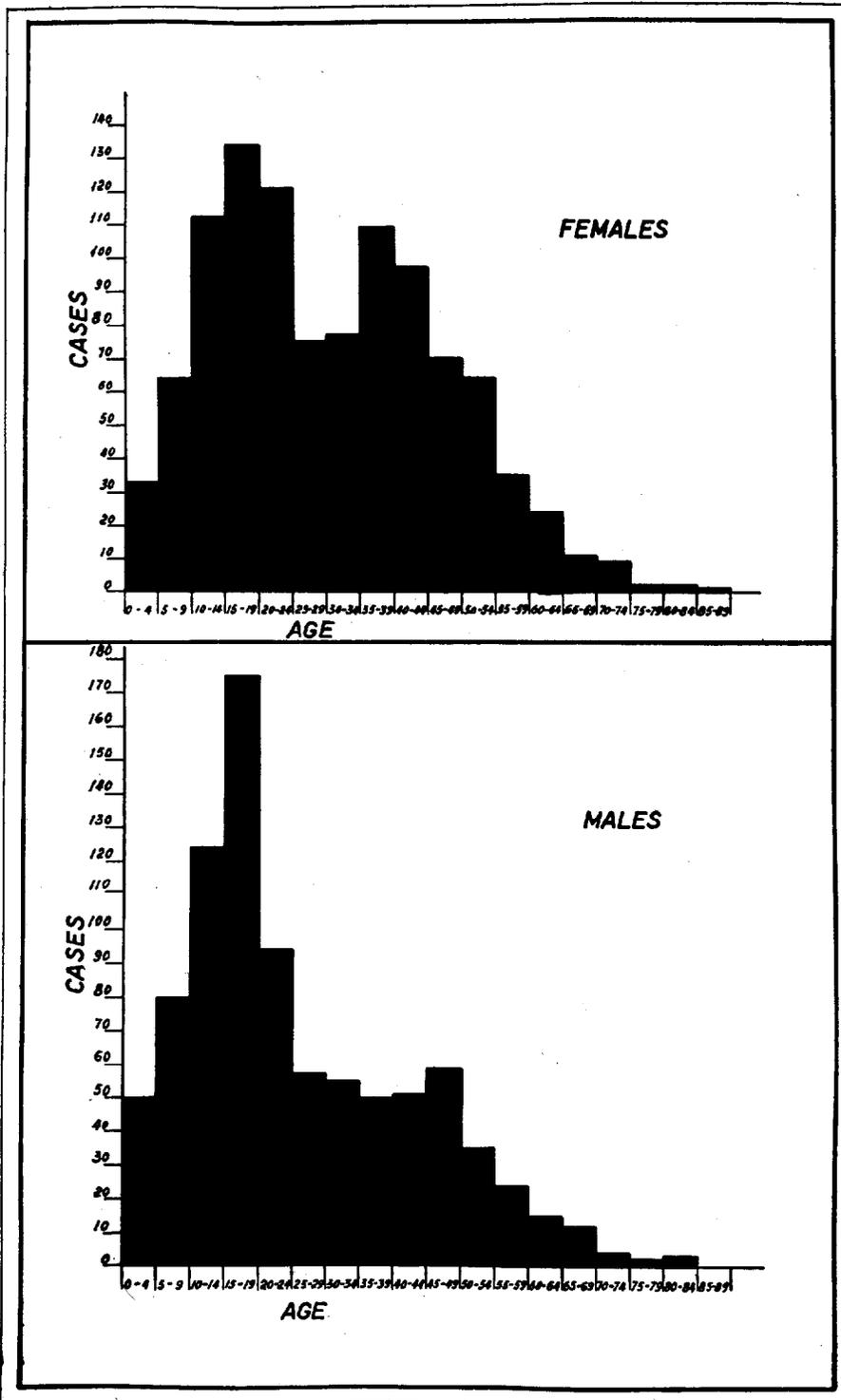


FIGURE 2. Typhus cases by age and sex, Naples and vicinity, 1943-1944.

justified. The only recent account of typhus in Naples was that of a group of 42 cases described in a bulletin of the Commune of Naples in 1927, originating in the winter of 1925-1926 from two small ships from North Africa, which entered the port without the formality of quarantine inspection. Vigorous measures appear to have suppressed the spread of the disease at this time. Prior to the epidemic, murine typhus was not reported from Italy. It is now known to be present in the area, but it seems unlikely that the disease is sufficiently widespread to affect appreciably the susceptibility of the population as a whole.

Although exposure to infection was by no means universal, the distribution of cases shown in figure 3 indicates that typhus permeated most of the 24 alphabetically designated districts of the

city. Districts T, U, and W to the east were industrial areas with few habitations, and few cases were reported from them. The evolution of the epidemic also varied within the districts. In area A, for example, half the cases occurred by mid-December, while in area V this stage was not reached until January 8th. Areas A, C, G, M, N, P, and Q accounted for more than 50 per cent of the cases.

Outside the city 511 civilian cases were reported from 60 different communities of which 495 occurred within 25 miles of Naples (figure 4). This limited dispersion was probably due to difficulties in civilian travel as well as to less complete reporting of cases. The most remote point reached was Lecce and the greatest number in any one locality was 46 cases in Torre del Greco, a small, but busy, port at the

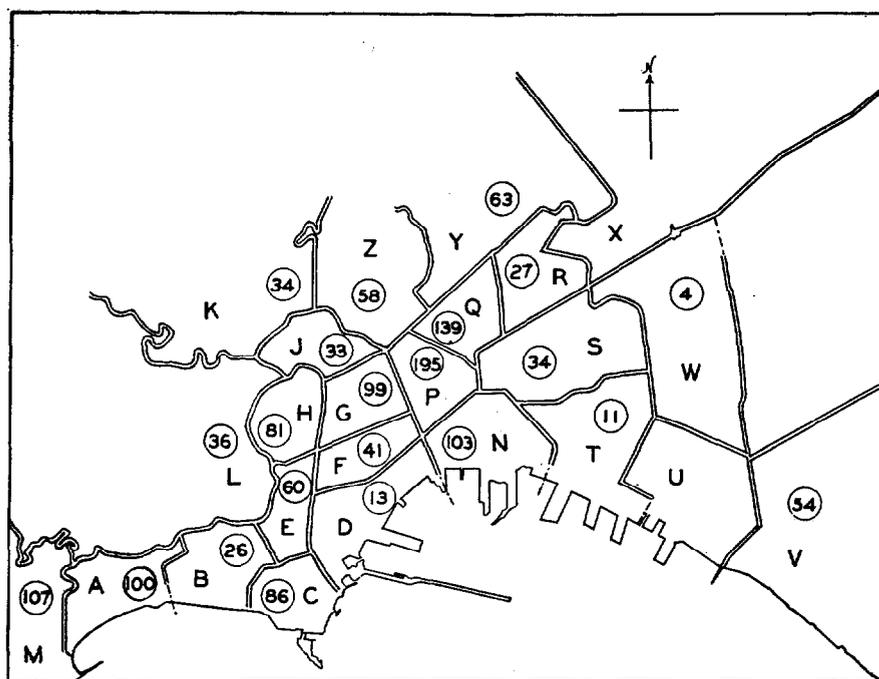


FIGURE 3. Distribution of typhus cases in Naples by administrative district, November 1st, 1943, to April 30th, 1944.

foot of Vesuvius. This town like many others is really an extension of the city of Naples.

### *Epidemic potential*

The question of when a typhus patient becomes a menace to the community is not easy to answer. A person harboring a single infected louse is not a likely focus of disease spread during the period of survival of that particular louse. The individual and his own lice may remain well for 10 or 12 days or until the febrile period begins. The febrile period may last from 16 to 18 days, during which time the patient's lice may become infected and remain so until their death some 10 to 15 days after their first infective meal. During this period the risk of transmission of typhus organisms from the patient to his associates will be greatest. Later

in the attack when fewer rickettsiae are present in the blood stream, the lice develop their infections more slowly and the risk of transmission will lessen. In view of the intermediate character of the period of potential transmission, it was necessary to make an arbitrary assumption regarding its length, and it was decided to define this period as one of 18 days following onset unless in the meantime the patient had died, or had been dusted or isolated.

For each case reported in Naples, therefore, with onset between November 1st, 1943, and April 30th, 1944, the number of days (up to 18) elapsing between onset and isolation, dusting or death was counted. These periods of infectiousness, when accumulated on a chronological basis, may be said to constitute the *epidemic potential* of typhus with respect to the uninfected popula-

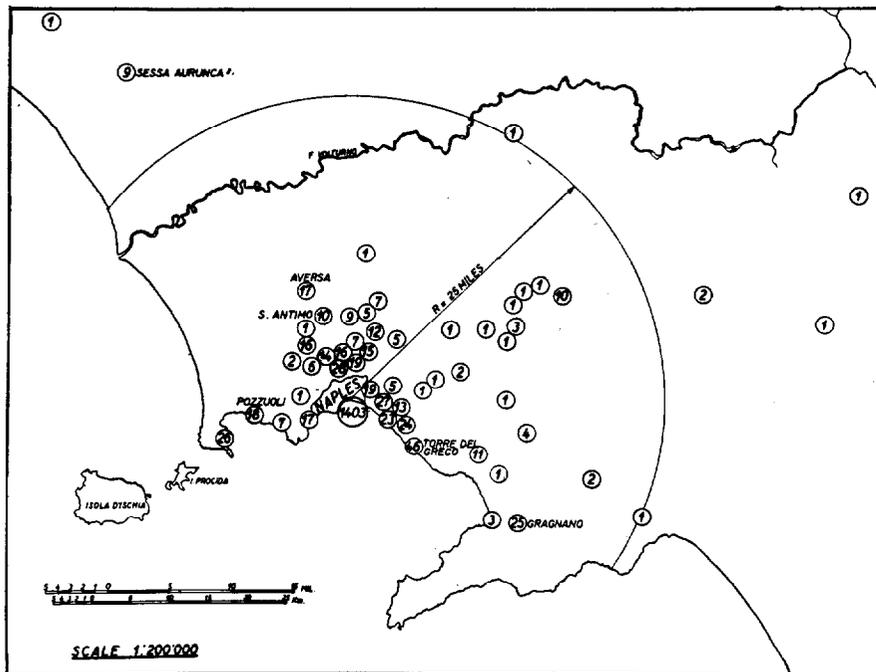


FIGURE 4. Distribution of typhus cases in and around Naples, July 1st, 1943, to May 31st, 1944.

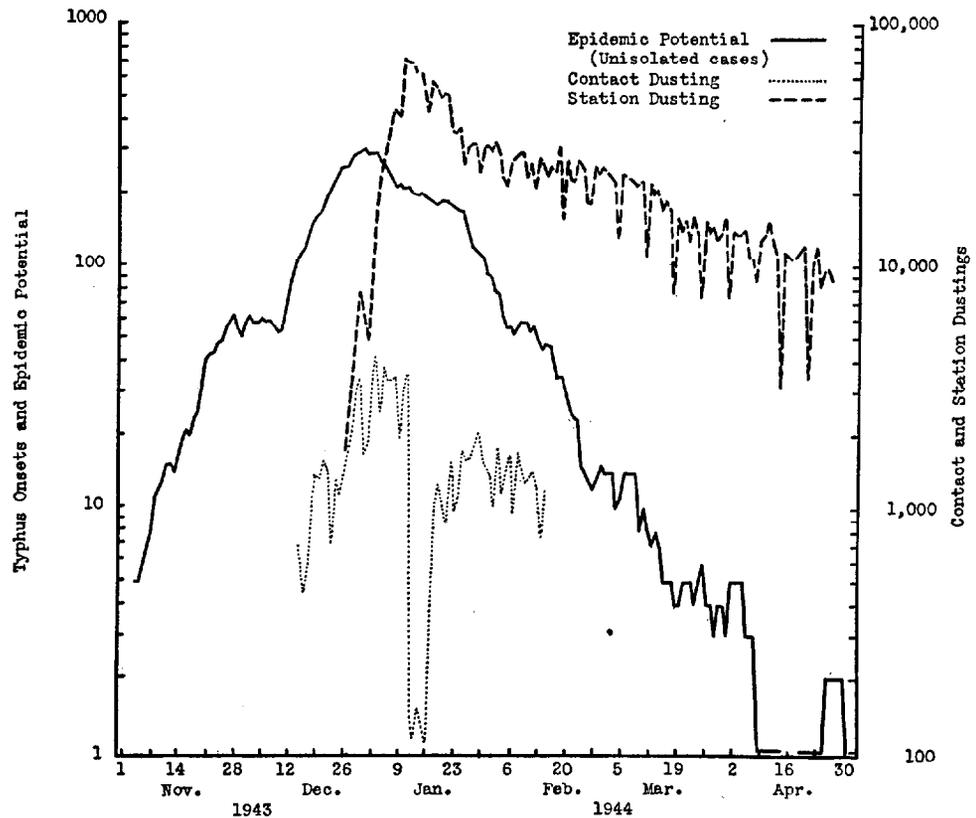


FIGURE 5. Typhus epidemic potential compared with the dusting activities, Naples, November 1st, 1943, to April 30th, 1944.

tion of Naples. Figure 5 shows the trend of these data when plotted on a semilogarithmic scale, compared with the trends of persons treated daily by the contact and station dusting services. The dramatic evolution, progress and decline of the epidemic and the relation of the control measures to its various phases are clearly depicted here.

*The organization and accomplishments of delousing activities*

Headquarters for typhus control activities were established at the Provincial Laboratory on December 14th, and delousing with insecticidal powder began on December 15th with the com-

pulsory dusting of 700 passengers leaving Naples on the first passenger train to depart after Allied occupation. The first dusting crews were composed of nurses and inspectors from the Municipal Health Department. These proved to be intelligent, faithful workers and formed the nucleus around which the greatly expanded service developed later. Subsequently, recourse was had to personnel hired through the AMG Labor Office.

The delousing activities fell naturally into the following categories for administrative purposes and were initiated on the dates indicated:

1. Contact delousing (December 16th, 1943)

2. Air-raid shelter delousing (December 27th, 1943)
3. Mass delousing: (a) Station (December 28th, 1943); (b) Block (February 6th, 1944)
4. Flying squadron for work outside Naples (January 8th, 1944)
5. Institutional delousing (January 9th, 1944)
6. Military and military labor delousing (December, 1943)
7. Refugee delousing (December, 1943)

There will be no discussion of institutional, military or refugee delousing, and no account of the isolation and treatment of the sick. Casual reference only will be made to vaccination as a method of combating the disease.

*Insecticide and dusting equipment.* The Surgeon's Office of the Peninsular Base Section made 20,000 two-ounce tins of MYL available immediately. The Surgeon's Office, NATOUSA, sent 400 pounds of DDT concentrate by air and authorized the use of such amounts of MYL powder, up to 500,000 two-ounce tins, as were required until the Allied Control Commission stocks began to arrive in January. The relative amounts of MYL and DDT used in Naples cannot be accurately determined, but since most of the early work was done with MYL, to this insecticide must go the credit for the early results of the delousing campaign.

Hand dust-guns were used in the application of the powder and the workers were trained to follow a definite procedure in dusting each person, for which written instructions (reproduced below) were issued, so that the chance of omitting certain points might be lessened when dusters were working under pressure. Most of the work in Naples had to be done with the small "Cadet" type of Hudson duster, which

is the least satisfactory of the three pumps eventually used because it requires refilling after each two or 3 dustings, and its delivery of powder tends to be in masses rather than in clouds of dust (Soper et al., 1945). There were a few Dobbins "Super-built" no. 133 guns on hand, and later the Hudson "Admiral" no. 765 gun became available, both of which were found to be equally satisfactory and far superior to the "Cadet" duster (see figures 10-16).

*Contact or spot delousing.* The names and addresses of all typhus patients reported after November 1st were assembled on December 12th so that the homes could be visited and the contacts of the patients discovered and deloused. An immediate result of this work was the finding of additional cases hitherto unreported, and, subsequently, this discovery of new cases became an important function of the contact-delousing squads.

The careful records of names and addresses of families dusted and new patients found, which were kept by the squads, provided the data for grouping the cases by families. They also facilitated the preparation of block histories for certain areas, so that what families had been dusted and when, in relation to primary and subsequent typhus cases, could be determined. Such information has aided materially in evaluating the spot-dusting measures, which were those first employed.

In practice, all members of a patient's family were dusted at the time of the squad's visit but absent members were not sought out. The family was urged to see that such persons attended the nearest mass-delousing station. The squad also powdered those other persons wishing to be dusted who lived in the same or contiguous buildings. Thus

the term "spot dusting" more adequately describes its work. The crew usually worked in the courtyard or street in front of the building in which the patient lived.

On January 12th this spot delousing by persons accompanying the case-finding units was reduced to the immediate family and household contacts. Later in the month, however, the units reverted to a more extensive coverage and shortly afterward collaborated with the mass-delousing service in dusting residents of certain blocks in areas where typhus persisted or where surveys revealed an appreciable amount of louse infestation.

Air-raid shelter delousing. The importance of the air-raid shelter as a focus of typhus transmission was recognized at once, but the organization and conduct of delousing activities there presented certain problems since the work had to be done between 6 P.M. and midnight, when the shelter held its maximum population. The service was organized to care for the dusting of approximately 10,000 persons weekly. Six teams, each consisting of a physician and 12 dusters, made the rounds of some 80 to 90 shelters, at first every 7 days and later once in 2 weeks, as the number of cases reported from the shelters declined.

Mass delousing: (1) Station. When contact delousing was operating satisfactorily and adequate transportation and stocks of insecticide became available, plans were ready for opening 50 public delousing stations with an estimated capacity of 100,000 persons daily. Sites in hospitals, schools, churches, railway and streetcar waiting rooms, etc., were chosen with consideration for population density and the known distribution of typhus. Each station was under the direction of a foreman and an

assistant, who were responsible for the conduct of the work and the keeping of the daily records.

The first two stations opened on December 28th. The one at the Ascalesi Hospital began by bringing children in from the street to be dusted. Its record jumped from 107 persons dusted the first day to 577 on the third and 1,625 persons on the seventh day. The other station at the Anguilli School had the advantage of a large pediatric dispensary in the same building and its clientele was sent to be dusted. This station deloused 837 persons on the first day, 2,200 on the third and 3,585 on the seventh day. The delousing stations became popular overnight, so that soon the sight of persons on the street with powdered hair and clothing was too common to cause comment.

The supervision of the stations was carried out by Italian civilian inspectors, most of them physicians, who had a varying number of stations to visit twice daily. They issued powder and pumps, checked the work of the stations and collected the daily reports of operating personnel, supplies received and used, and the number of persons powdered. When received at headquarters these reports were summarized each day to provide the supervisors and administrators with current data on the operation of every station. In a summary of the work of 33 stations operating in Naples on January 15th, 1944, there were, on the average, 13 persons working in each station, and an average of 1,611 persons were dusted per station. Some 2,500 pounds of powder were used in the 33 stations, with an average of 21 persons dusted per pound. It was only by daily checking of the activity of the stations that a proper level of efficiency could be maintained.

A problem involved in the operation

of the stations was the hourly variation in the volume of work to be done. Visiting hours at hospitals, arrival and departure of trains and the opening and closing of business affected attendance at the stations. The staff provided had to be sufficient to deal with persons coming to be dusted at rush hours, which meant an overstaffing in slack hours.

*House to House* Mass delousing: (2) Block. As the work of the stations progressed it became evident that a certain portion of the population was not being reached, since typhus continued to occur in certain blocks within walking distance of busy dusting stations. It was decided, therefore, to survey different sections of the city with a view to answering the following questions: (a) were persons living near the stations being dusted repeatedly while those at a distance were missed; (b) was the dusting of men, women and children of equal proportion; (c) what proportion of those dusted still had lice?

For this survey, groups of blocks representing different sections of a given district were chosen and detailed maps and census forms prepared. By the middle of February the canvass had covered over 100,000 persons, of whom 77 per cent claimed to have been dusted one or more times. The percentage varied from 65 around the Poggioreale prison to 93 in Fuorigrotta. Approximately 20 per cent had been dusted once, 28 per cent twice and 29 per cent more frequently. Of some 13,000 children who had been powdered, 11.6 per cent were found to be louse infested, as compared with 20 per cent of 2,500 undusted children.

As a result of these surveys, squads were organized on February 6th to work blocks having more than 5 per cent of louse infestation, less than 70 per cent

of persons with a record of previous dusting, or both. Where typhus was being reported dusting was carried out if less than 90 per cent had been previously dusted. Block dusting was begun when the epidemic in Naples was definitely on the decline, so that the crews were augmented by persons released from the contact-delousing section. After February 14th the residents of each block where a case was reported were dusted, as well as residents of blocks contiguous to the one containing the infected house.

Block-dusting crews always started at the same point in each block, say the northeast corner, and proceeded to the right, calling at every door, entrance or courtyard, moving from floor to floor in the same manner, until they returned to their starting point ready to begin the next block. The squad kept a record of the dusted and undusted persons living in each household and those who were away from home were reached at school or at their place of employment.

*Flying squadron delousing outside Naples.* The flying squadron began work on January 8th, 1944, investigating typhus suspects outside Naples and operating in much the same manner as did the contact delousing squads in the city. Household and neighborhood contacts of infected persons were dusted, and a search was made for new cases. The squadron also vaccinated contacts as well as others in infected areas. Although 97 per cent of the cases of typhus outside Naples occurred within a 25-mile radius (figure 4), investigations had to be carried out at greater distances, at times even in the zone of military operations.

Some of the infected suburbs of Naples were heavily populated areas, and for these a special mobile unit was

organized to carry on more extensive house-to-house delousing than could be done by the squadron. A report of delousing and vaccination activities performed by the flying squadron is given, by weeks, in table 3 with reference to the probable cases of typhus seen from January 1st through May 28th, 1944. Approximately 630 persons were dusted per case seen.

TABLE 3

*Weekly block dusting and vaccination of contacts performed by the flying squadron outside Naples, January to May, 1944*

Week ending	Probable cases seen	Persons dusted	Persons vaccinated
Jan. 9	1	13	13
16	6	402	44
23	17	8,484	16
30	48	13,430	226
Feb. 6	24	12,150	193
13	21	11,075	77
20	32	20,457	130
27	27	13,758	26
Mar. 5	17	11,720	38
12	37	20,336	63
19	26	12,023	139
26	17	10,066	47
Apr. 2	20	9,636	65
9	4	9,967	28
16	22	7,675	9
23	5	11,284	21
30	8	11,143	5
May 7	8	6,640	17
14	5	7,697	7
21	0	6,888	8
28	3	6,360	18
Totals	348	211,204	1,190

It is difficult to appraise the work of the flying squadron because of the likelihood of reinfection from Naples, and because many persons residing in these areas may have been dusted in the city. In 7 of the 60 places outside

Naples where cases occurred no delousing was undertaken and in 26 places where measures were taken no subsequent cases occurred during a 12- to 14-day post-treatment period, so the typhus potential in these communities must be regarded as minimal.

*Summary of delousing activities.* From the middle of December, when dusting operations began, until the epidemic subsided, over 3,000,000 applications of powder were made in Naples and the surrounding towns. Table 4 contains a day-by-day report of dustings by the services in Naples between December 15th, 1943, and January 15th, 1944, while the work was being organized and developed. Table 5 contains the weekly report of all dustings through May 31st, 1944. From the standpoint of economy of effort and material, it is now important to decide whether contact or spot dusting alone is sufficient for typhus control or whether this method plus station delousing should be employed in future programs.

*An appraisal of typhus control by louse powder*

For evaluating the effect of dusting with louse powder upon the spread of typhus, the outbreak in Fuorigrotta, which was epidemiologically a part of Naples, has been chosen for consideration. This community, with its 11,000 inhabitants, is the area designated "M" in figure 3. Various tunnels through a narrow, high land barrier connect it with western Naples, but for the most part epidemiological factors appear to have operated locally. The eastern half of Fuorigrotta, lying west of the Naples tunnels, is characterized by narrow streets, bad sanitation and housing conditions like those of Naples. The western half contains two municipal housing projects, one of which consists of a

TABLE 4  
Daily dusting totals, Naples,  
December 15th, 1943, to January 15th, 1944

Date	Service				Totals
	Mass dusting	Contact dusting	Ricovero dusting	Institution dusting, etc.	
Dec. 15		700			700
16		435			435
17		576			576
18		1,060			1,060
19		1,387			1,387
20		1,311			1,311
21		1,569			1,569
22		1,391			1,391
23		713			713
24		1,345			1,345
25		1,131			1,131
26		1,404			1,404
27		1,767	600		2,367
28	944	2,042	600		3,586
29	1,765	3,078	180		5,023
30	3,683	3,386	500		7,569
31	4,041	1,675	447		6,163
Jan. 1	2,568	1,808	446		4,822
2	5,158	3,311	492		8,961
3	11,495	4,231	488		16,214
4	19,581	2,463	1,055		23,099
5	22,935	3,838	1,761		28,534
6	28,658	3,344	1,041		33,043
7	37,960	3,360	1,275		42,595
8	38,971	3,405	1,224		43,600
9	37,750	1,911	1,228	200	41,089
10	66,126	2,994	2,092	1,410	72,622
11	63,210	3,533	2,321	—	69,064
12	66,476	147	1,588	1,215	69,426
13	60,862	112	954	667	62,595
14	59,995	149	1,414	1,304	62,862
15	53,153	71	1,648	1,966	56,838
Totals	585,331	59,647	21,354	6,762	673,094

collection of 4-family cottages, each with a garden plot, and the other of a group of large 5-story apartment buildings.

The town suffered relatively slight

damage during the Allied air raids of 1943 so that its two shelters did not have a large resident population, but the German air attacks in the late fall and winter caused many people to resort to shelters at night. Since the combined capacity of the two shelters did not exceed 5,000 they were extremely crowded during the raids.

The first typhus case in east Fuorigrotta had its onset on December 1st, 1943, but was not reported until Janu-

TABLE 5  
Weekly dusting totals, Naples,  
December 15th, 1943, to May 31st, 1944

Week ending	Station*	Other	Total
Dec. 19	—	4,158	4,158
26	—	8,864	8,864
Jan. 2	18,159	20,332	38,491
9	197,350	30,824	228,174
16	408,163	27,558	435,721
23	334,785	19,085	353,870
30	188,346	29,052	217,398
Feb. 6	174,000	24,829	198,829
13	165,493	18,815	184,308
20	147,701	16,742	164,443
27	144,200	20,534	164,734
Mar. 5	139,355	20,664	160,019
12	130,829	18,046	148,875
19	102,421	20,986	123,407
26	83,564	11,931	95,495
Apr. 2	80,902	13,197	94,099
9	66,887	8,914	75,801
16	61,883	16,954	78,837
23	64,442	7,675	72,117
30	52,455	5,933	58,388
May 7	29,732	15,606	45,338
14	24,281	11,215	35,496
21	6,403	3,206	9,609
28	4,550	3,367	7,917
29-31	2,307	1,762	4,069
Totals	2,628,208	380,249	3,008,457

\* Includes mass delousing in out-of-town stations.

ary 6th. The second case in this section occurred December 10th and was reported on the 18th. This patient had slept in the shelter and was the probable source of many of the subsequent cases there and in the Via Grotta Vecchia. At the other end of the town two cases of typhus had their onset in the municipal housing developments on December 2nd. The people in this section used the shelter in Rione Duca d'Aosta.

Contact and spot dusting with louse powder began in Fuorigrotta on December 20th, and, as elsewhere, disinfection was welcomed by the people. In the western end of the community more persons per case were dusted owing to the greater density of population, with the result that here only one case had its onset more than 15 days after spot dusting began. In the eastern section of the community where the population was more scattered and nearer to Naples the final case had its onset on January 29th, which was 6 weeks after contact dusting was started in Fuorigrotta.

Because of the alarm created by the discovery of 59 cases during the first week of January, a mass-delousing station was opened on January 7th and nearly 20,000 dustings were done in the first 5 days. Beginning with January 24th, applicants were refused dusting if they had been powdered during the previous 2 weeks. In the subsequent survey of Fuorigrotta 93 per cent of the people said they had been dusted, 15 per cent once, 32 per cent twice, and 46 per cent more than twice. When the station was closed at the end of April over 58,000 dustings had been done, representing an expenditure of 1.5 tons of louse powder in addition to the cost of labor and supervision. Could the job in Fuorigrotta have been accomplished with less money and material?

A criterion for determining the effectiveness of dusting operations must now be considered. Obviously delousing an individual during the incubation stage of typhus will not prevent infection from developing, so that cases may be expected to appear over a period of from 10 to 12 days after dusting begins, but when such persons are thoroughly dusted before onset the chances will be materially lessened that they will infect lice and so be likely to transmit the disease to others. Hence if cases decline in number or cease to appear after an interval of from 12 to 15 days, the presumption is that the treatment has reduced transmission of the disease. It is also obvious that with an average lag of from 8 to 10 days between onset and report, the effectiveness of control measures will be reduced. For maximum efficiency, therefore, the dusting service must be accompanied by an adequate and skilled case-finding service.

Figure 6 shows the individual cases in Fuorigrotta plotted in order of onset above the horizontal line and the same cases plotted below the line when reported. On the 20th of December when spot dusting began in Fuorigrotta, only 18 of the 106 onsets had occurred and of these only 5 had been reported. Twelve days later, on January 1st, 87 cases had had their onset with the probability that none could have been prevented by the dusting. During the next 3 days 6 more cases occurred, but by January 5th the epidemic was virtually over although 13 cases had their onset between that date and January 29th.

Figure 7 shows the rise and fall of the epidemic potential curve in Fuorigrotta plotted to a semilogarithmic scale. Between December 10th and 30th, i.e., 10 days prior and subsequent to the beginning of contact dusting, the number of undeclared cases in the area

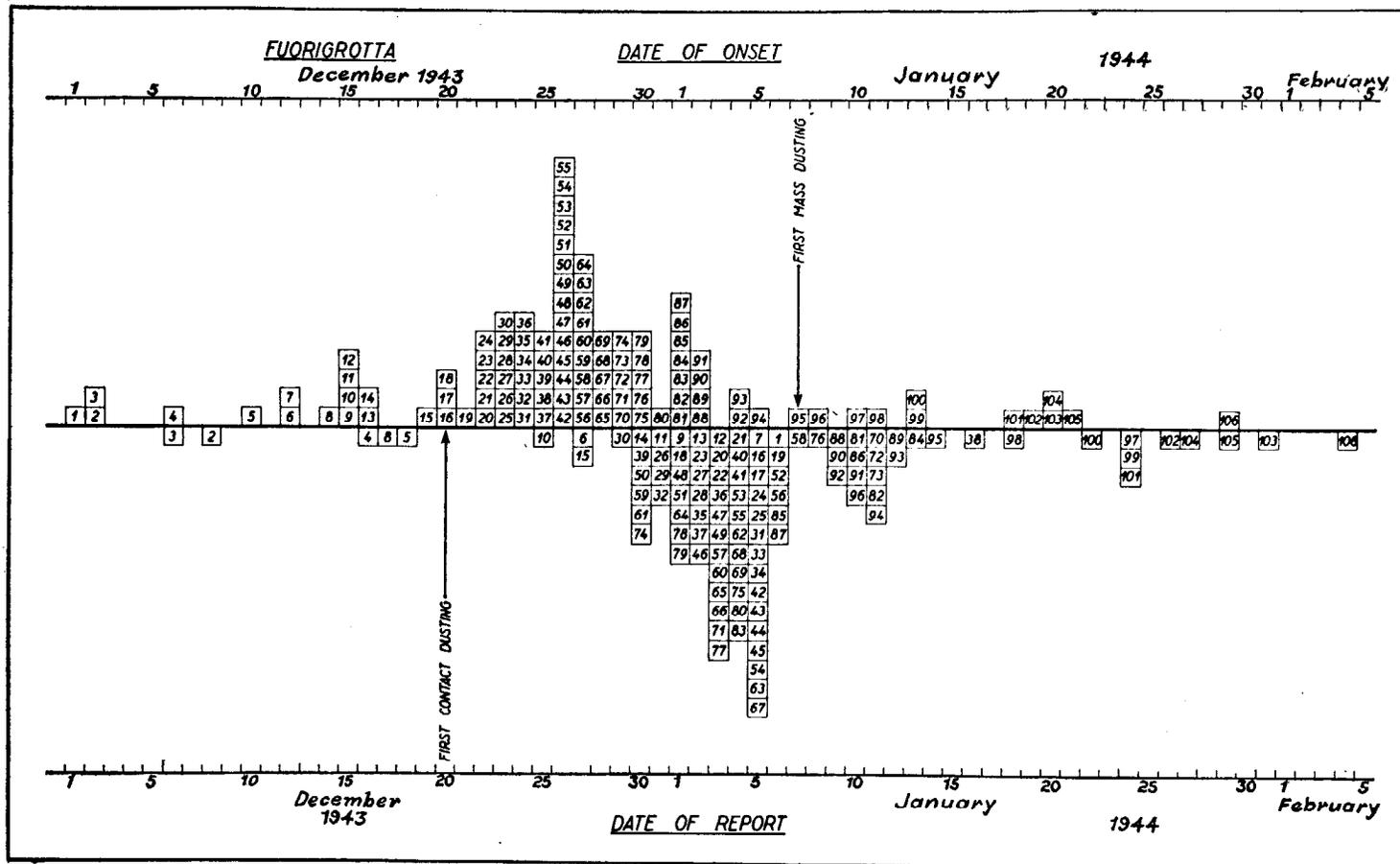


FIGURE 6. Fuorigrotta: individual typhus cases by date of onset and report, with reference to dusting activities.

rose steadily. The straight line fitted to the logarithms of the numbers of cases indicates a rate of increase of 17.2 per cent daily. If the curve had continued to rise at this rate during another 10 days, on January 9th there would have been some 368 undeclared cases in the community. Actually there were only 17. While one cannot prove that dusting was wholly responsible for the subsidence of the outbreak, one can confidently assert that it was an important contributing factor, particularly in view of the fact that no vaccinations were done. Figure 7 also reveals that the fall of the epidemic potential

was not accelerated by the mass dusting activities begun on January 7th.

A study of individual block histories in the city of Naples further strengthens the impression that prompt coverage by the contact-dusting and case-finding services resulted in early suppression of transmission. A single block in area P, for example, had 43 of the 195 cases occurring in this district. Twenty of these had onset after spot dusting began, but 13 of them occurred within 12 days of the first dusting. Of the remaining 7, four had been dusted before onset. How many patients in the Naples epidemic were actually dusted before on-

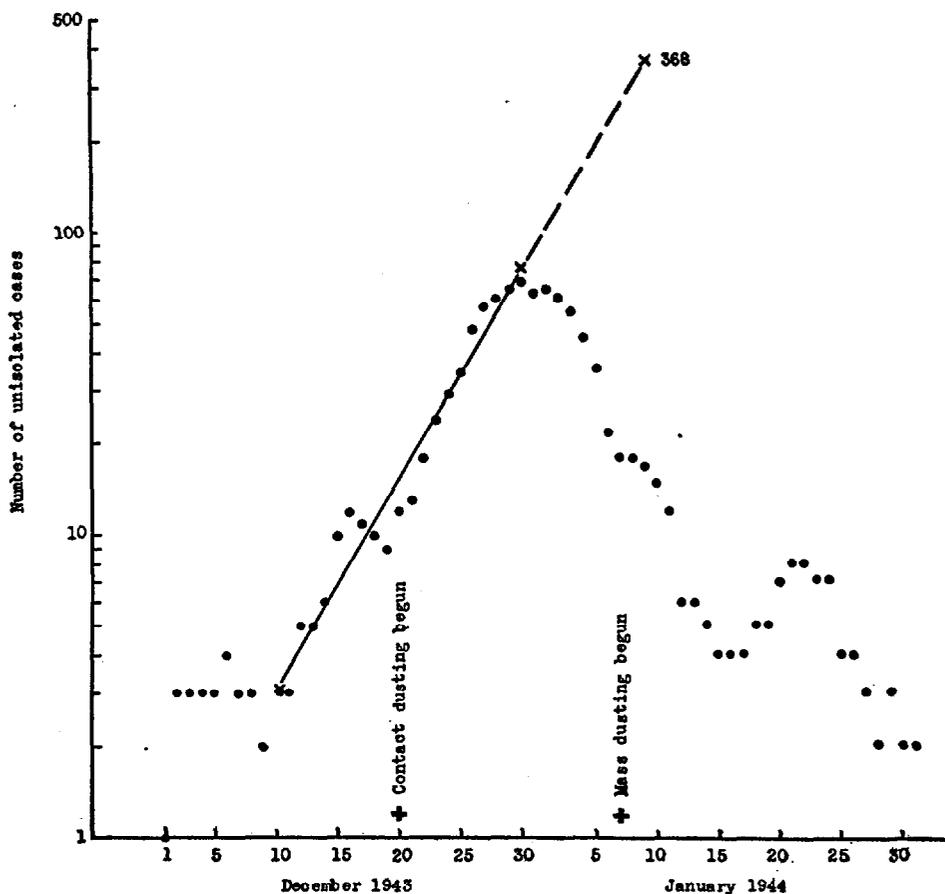


FIGURE 7. Fuorigrotta: rise and fall of the typhus epidemic potential with reference to dusting activities, December 1st, 1943, to January 31st, 1944.

set is unknown, for the case histories are commonly incomplete on this point. From information available, however, it was ascertained that at least 10 per cent of the patients or their families were dusted prior to the onset of illness.

For Naples as a whole (figure 5) the peak of the epidemic potential curve was attained approximately 15 days after contact and spot delousing began. On December 10th there were fewer than 60 undeclared cases in the city, and by the end of the month there were over 300. With the exception of the work at the railway station, dusting in Naples between December 15th and 28th was done around typhus cases in homes, hospitals and shelters, yet within 15 days after dusting was initiated the upward trend of the potential curve was arrested and reversed.

Thus spot dusting by itself was apparently an effective method of controlling transmission of the disease. The dusting stations probably also rendered certain infected persons innocuous by destroying the potential vectors, and the reduction in the lousiness of the population unquestionably decreased the likelihood of transmission by persons unfortunate enough to contract the disease.

#### *Station versus block delousing*

*House to house*  
The mass delousing station probably offers the most practicable method of reaching great numbers of people in a large metropolitan area quickly, but for smaller populations block dusting is preferable because it affords more uniform and extensive coverage.

The relative efficiency of the two methods was tested in two small communities in the metropolitan area: Arzano, with a population of about 8,500, and Casoria with one of about

10,000. Relatively little dusting had been done in either community before the beginning of the experiment. A mass delousing station was established in Arzano after the town had been surveyed and each family given a ticket admitting its members to the station for dusting. Of more than 800 children examined before the station was opened, 33 per cent were found to be louse infested. A similar degree of infestation was revealed in Casoria. Squads with carefully prepared maps and family records then dusted all blocks in Casoria between April 3rd and 12th, with an expenditure of 107 man-days of labor. The station in Arzano operated from April 2nd to 29th, requiring 229 man-days of labor. Both communities were immediately resurveyed. Block dusting in Casoria had reached 86.6 per cent of the inhabitants and the residual louse infestation in approximately 3,000 children was 5.4 per cent, while in Arzano only 53.9 per cent of the population had been dusted and 9 per cent of 2,537 children were found infested.

Block dusting was, therefore, more extensive and effective and became the method of choice for most of the work outside Naples. Its effectiveness, however, depends on the availability of trained personnel and adequate transport, while the stations are more easily supervised and better suited to the training of new personnel for an expanding project. Finally, had an epidemic been present in Arzano, a greater proportion of its population would doubtless have applied for dusting.

#### *Residual lousiness*

A survey in late April at 4 delousing stations in Naples revealed the distribution of residual louse infestation by age and sex of the applicants. Of approximately 9,000 persons, 9.7 per cent

were lousy and 66 per cent of those infested were males. There was less lousiness among both males and females between the ages of 10 and 44 years than among persons over 45. In the latter group, infestation increased with age, especially among females.

In July, 1944, new surveys were made in those districts of Naples where the greatest number of typhus cases had occurred and the most intensive powdering had been done. The results indicated that the epidemic and dusting had not inspired any "louse-consciousness." Some 35,000 persons, including more than 9,000 children, were examined. Of the latter, 641 (7 per cent) had never been powdered and had an infestation rate of 28 per cent, while 34 per cent of those who had been powdered were found to be infested at the time of the survey. In the Pallonetto Santa Lucia district, one of those most affected by typhus, 53 per cent of the children were louse infested at a time when practically everyone lived within a 10- or 15-minute walk from a free delousing station open 8 hours a day.

In late April and early May, 1944, 14,584 persons were examined in 81 shelters, where among 5,300 children, 8.5 per cent were infested. Routine dusting in the shelters stopped in June and another survey in late August revealed about 5,000 still living there, with almost 50 per cent of the children infested.

It should not be inferred from the results of these surveys that DDT is not all that its champions claim it to be, an almost perfect insecticide. Mass dusting in Naples was not a louse eradication project, it was a typhus control measure for reducing the louse population to a point where typhus transmission would cease. Unless all the clothing possessed by all the people is dusted at about the

same time, no more than a temporary reduction in lousiness can be achieved in crowded metropolitan districts.

#### *Vaccination*

Vaccination was not a part of the initial program in Naples and was used on a small scale for only a few weeks following the peak of the epidemic. From January through March, 1944, some 26,000 persons were vaccinated by a 3-dose technique and another 10,000 by a one-dose method, but nothing can be deduced regarding the effect of this measure upon the course of the epidemic. The 1,190 vaccinations administered by the flying squadron outside Naples are reported in table 3.

#### *Postepidemic organization of typhus control teams*

The civilian doctors who were released when the dusting stations in Naples were discontinued were employed to keep the public health officials and practicing physicians in the area alert to the possibility that typhus might remain undetected during the summer and reappear in epidemic form with the return of cold weather. The towns within a radius of 20 miles were repeatedly visited, with special attention paid to those communities where cases had occurred. The contagious disease hospital, as well as the infirmary of the Poggioreale prison, which had been one of the primary points of dissemination during the previous winter, was kept under observation.

During the fall of 1944 arrangements were made through the Ministry of the Interior for a series of meetings with the provincial health officers and their representatives throughout liberated Italy. At these gatherings the epidemiological and clinical features of both louse-borne and murine typhus were dis-

cussed, the importance of early diagnosis and reporting was emphasized and the technique of dusting demonstrated. Each provincial representative was required to dust at least 15 or 20 individuals under expert supervision. An emergency supply of powder and of dust guns was left in each province so that the local officers could do immediate spot dusting should typhus or suspected typhus patients appear within their jurisdiction.

These meetings began in October, 1944, and extended to all but two of the southern provinces, both in Sicily. In December a similar instruction tour was undertaken in the liberated provinces to the north. Delegates from the 3 Sardinian provinces met in Cagliari. Also in December, the typhus control service, in cooperation with the Office of Hygiene of the Commune of Rome, supplied and supervised a dusting squad at the Prenestina railway station, where large numbers of refugees from the north were being discharged. This work was discontinued in June, 1945, after dusting operations in the northern camps had been adequately organized.

#### *Postepidemic typhus*

Between June 1st, 1944, and March 31st, 1945, when the Naples headquarters were closed, 24 cases of typhus with two deaths were investigated; only one of these cases occurred in Naples. The patient, a baker, had arrived from Sicily only 10 days before onset, and his serum gave a positive complement-fixation reaction for murine typhus. The epidemiological and serological evidence is strongly suggestive that 17 of the 24 cases were of the murine type. All were either food handlers or closely associated with ration dumps where rats were numerous. In addition to the one case in Naples, 10 of the 24 cases were in the vicinity

of that city, 6 were in Brindisi, 3 in Sardinia, two in Calabria and one each in Sicily and Leghorn. During the months of April through July, 1945, scattered cases were observed in northern Italy in connection with the movement of displaced persons from Germany, Austria and Yugoslavia. Spot dusting about these imported cases was done by the local authorities who had previously been provided with powder and guns.

At Cappizi, Sicily, a series of 39 cases with 9 deaths occurred between March 12th and May 11th, but typhus was not suspected until 26 cases had occurred, when the local authorities initiated contact delousing. As usual, much powder was used after the epidemic was over. At Palermo typhus was recognized in May after 10 or 12 cases had occurred and, in spite of the local activities, some 25 cases and 3 deaths had occurred before the outbreak ended. Figure 8 shows the distribution of cases during this period.

#### RECOMMENDATIONS

*Materials required for dusting.* A motor compressed-air unit with multiple guns is a valuable apparatus for dusting large groups of people quickly, such as those in institutions, travel centers, demobilization points, ports, and hospitals, as well as in labor, refugee and prison camps, where such an apparatus may be installed. With this implement the worker can dust more people with greater efficiency, since he is not fatigued by the operation of the gun. The simple hand-operated gun, however, is inexpensive, portable and enables many workers to operate in a limited space. Dusting units with hand guns can be of any size, and additional dusters can be trained in a few moments from

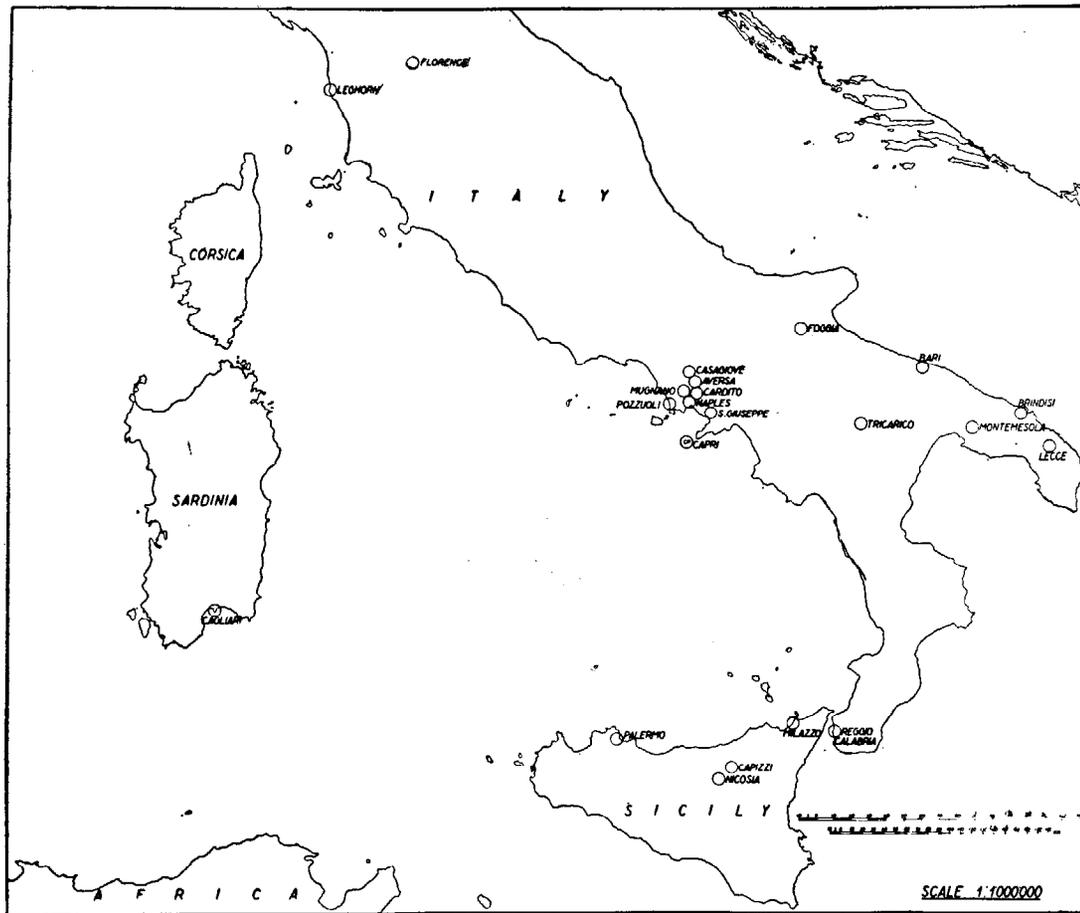


FIGURE 8. Postepidemic distribution of typhus cases in southern Italy, July, 1944, to June, 1945.

*June July*

among the persons to be deloused. One person can easily carry a hand gun and enough powder to dust from 200 to 300 persons, and a pack mule can transport guns and powder sufficient for several thousand dustings. The most satisfactory hand pump used is one with eccentric entry and discharge air tubes to and from the dust chamber, exemplified by the Dobbins "Superbuilt" no. 133 and the Hudson "Admiral" no. 765 (Soper et al., 1945).

The 10 per cent DDT louse powder can be readily blown from the dust guns. It does not kill nits but remains active and kills lice as they hatch for a considerable period, varying with the amount of insecticide used and the thoroughness of its application. In the Naples campaign a pound of powder was sufficient for dusting 20 persons, but in colder countries where more clothing is worn, a conservative estimate would be one pound for 15 persons. No evidence of sensitization or intoxication due to the DDT louse powder was observed during the Naples control activities.

*Instructions for dusting.* Members of dusting squads should be trained to follow a definite routine in dusting so as to reduce the likelihood of missing one or more important points. The operator should bear in mind that the powder should be distributed on the inner surfaces of the inner garments and on the skin itself. Clothing should be removed from the first persons dusted so that the distribution may be observed. If properly done, the inner surface of garments should be covered and powder should be visible on the hairs of the chest, back, thighs, armpits and of the pubic and perineal regions. Since body lice are most often found in the seams of the clothes, those about the neck (figure 9), armpits, waist, shirt tail, and

crotch of the pants should receive particular attention. A definite routine for dusting is as follows:

1. Dust inside the hat (figure 10).
2. Dust the head, pumping the powder against the scalp especially above the back part of the ears (figure 11).
3. With the arms of the treated person extended at shoulder height at the side (not in front) of the body, insert delivery tube first up the right and then up the left sleeve and pump powder in between the skin and the innermost garment (figure 12). Powder should reach the armpit and the gun should be shifted to eject the powder about the shoulder.
4. The delivery tube is next inserted at the back of the neck and a liberal charge of powder shot down the back, care being taken to dust the neckband (figure 13).
5. The tube is next inserted inside the clothing from in front and powder sprayed first on the right side, then on the chest and finally on the left side, special care being taken to reach the armpits again (figure 14).
6. (a) For men: The trousers are loosened and the tube inserted in front next the skin and a good dose of powder delivered to the crotch and pubic area (figure 15). With the tube still in contact with the skin, the underclothing is powdered, with special attention to the waist and side seams.
- (b) For women: The skirt is lifted in front and the body and the inside of the underclothing are powdered as with men.
7. (a) For men: With the trousers still loose, the tube is inserted at the rear of the garment next the skin and the powder distributed over the buttocks and rear of the crotch (figure 16).
- (b) For women: The skirt is lifted

behind and the body and underwear are powdered.<sup>3</sup>

*Administrative procedures.* *Contact or spot delousing* is of primary importance in the event of a typhus outbreak. By the time a case is discovered, which may be several days after onset, infection may have been transmitted to the contacts, and these, when dusted during the incubation period, may be rendered innocuous at onset. Dusting only the immediate family contacts may not be sufficient to arrest the spread of the disease; hence all persons in the building where the patient's onset occurred as well as others in the neighborhood should be dusted by the spot-delousing squads.

*Station delousing* can be organized on a large scale with a minimum of trained personnel. Persons missed by the mobile units can be referred to a station for treatment. Also, the large-scale dusting reduces the louse burden of the community and for the time being protects those treated both from infestation by infected lice and from uninfected lice. Long continued work at a given station, however, is not economical because it is difficult to avoid redusting applicants, while an appreciable proportion of persons never applies for treatment. When trained workers are available more efficient work can be done by block-dusting squads, which follow a systematic plan that insures more uniform distribution and coverage.

*Institutional delousing.* A minimum of trained personnel is required for this work since persons in the institution can be instructed and pressed into service as dusters.

*Quarantine.* It is virtually impossible to enforce quarantine in circumstances

<sup>3</sup> If more than one layer of clothing is worn; steps 3 to 7 must be repeated for the second layer from the skin.

under which typhus flourishes, since infected persons can always find ways of avoiding barriers on fixed travel routes. On the other hand, infested and panicky citizens welcome dusting and when treated are relatively innocuous as travelers. All wearing apparel carried out of the epidemic area should, however, be dusted.

*Isolation.* Adequate care and hospitalization of the sick is practically impossible during a large typhus epidemic, and the public aversion to isolation hospitals is the chief cause of the concealment of cases. A thorough application of 10 per cent DDT louse powder to the patient, his clothing and bedding, and to the members of his household will greatly reduce the spread of typhus in the community. The patient should be hospitalized only if he requires and can obtain better care there than he would receive at home.

*Vaccination.* In the presence of an epidemic, mass vaccination should be undertaken only if personnel and transportation required cannot be used more profitably for case-finding, and contact- or mass-delousing operations. Vaccination should be available to doctors, nurses, assistants, dusters and others who may be exposed by reason of their occupation to serious risk of infection.

#### SUMMARY

A well-seeded epidemic of typhus fever was revealed in Naples in November, 1943, following the German evacuation and the Allied occupation of that city. The peak of the outbreak was reached in December and the trend reversed in January, 1944. In Naples 1,403 civilian cases were reported with an additional 511 cases from 60 points outside the city. Final cases in Naples occurred in April, 1944, while those in

outlying towns ceased in May, 1944. None of the sporadic cases or small outbreaks observed in other parts of Italy in the following year could be traced to the Naples epidemic.

Delousing services were established in December, 1943, so that an opportunity was afforded to test the efficacy of large-scale dusting with louse powders (MYL and DDT), applied with hand dust-guns without the removal of clothing. Delousing was welcomed by the people and more than 3,000,000 applications of powder were made during the outbreak.

Examination of results revealed that the epidemic potential, i.e., the number of undeclared cases in the population each day, reached its peak 15 days after contact or spot delousing began and before the effect of mass dusting at stations could have become operative. This was true of Naples as a whole and of the

community of Fuorigrotta where a more exact appraisal of the efficacy of dusting was possible.

Spot dusting of the patient's family and of persons otherwise associated with him is believed to have been an important factor in arresting and reversing the trend of the epidemic. Delousing in fixed stations and air-raid shelters and the systematic dusting in areas block by block, through reducing the louse burden of the community, supplemented the work of the spot-dusting squads.

During the winter of 1944 provincial health officers and their representatives were equipped with powder and dust guns to be used should cases of typhus appear in their jurisdictions.

Instructions for dusting with hand guns are given with recommendations as to dusting procedures in the event of an epidemic of louse-borne typhus.

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