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LOCATION AND MOVEMENT OF PHYSICIANS, 1923 AND 1938—CHANGES IN URBAN AND RURAL TOTALS FOR ESTABLISHED PHYSICIANS [1]

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Adjustments in physician totals are discussed in earlier papers of this series according to the number of moves involving the crossing of State boundaries (*1*, *2*). Further material extracted from the Directories of the American Medical Association (*6*) published between 1923 and 1938 not only makes possible a study of changes in physician totals for local communities of different urban character, but also serves as a basis for analysis of the interchange of physicians. Completion of the picture of physician movement, together with location data for new registrants and for physicians leaving the profession, provides a pattern of change that is generally representative and indicates which types of communities benefit and which suffer depletion of professional resources.

In considering the distribution of physicians among local communities as of any given time, locations for a small but important fraction of the total, namely, physicians engaged as interns and residents in hospitals, are determined by the distribution of hospital facilities eligible to provide such training rather than by selection of places for the establishment of practice. Inasmuch as hospitals qualifying for physician training are, for the most part, concentrated in large cities, the inclusion of interns and residents at the time of their first listing with other new registrants results in an overstatement of the number of physicians selecting large cities for their initial establishment of practice. Furthermore, inclusion of training-to-practice changes of location, when such changes are made after initial Directory listing, in the total for practice-to-practice movement exaggerates the apparent migratory trends from large cities to smaller cities and rural areas.

[1] From the States Relations Division. Assistance in the preparation of these materials was furnished by the personnel of the Work Projects Administration Official Project No. 65-2-23-356.

For these reasons physicians who can be distinguished as interns or residents on initial Directory listing are not included, until the time of their second listing, in the total count of established [2] physicians registered during the study period. They are then assumed to have settled in practice. By this means, location changes that may have been executed by these physicians between the hospital in which they received intern or residence training and the community in which practice is initiated are excluded, and, therefore, cannot distort the migration pattern for established physicians. Thus location changes enumerated are essentially adjustments occasioned by physicians in removing from practice in one community and re-establishing practice in another location.

Identification of physicians classified as interns or residents is determined somewhat arbitrarily. Those physicians reflecting hospital employment when first listed and who were graduated from medical school less than 5 years previously are considered in this category at the time that their names first appear in the Directory. These individuals are excluded, therefore, until they receive a second Directory listing. This qualification finally results in the omission from the total of those recently graduated hospital physicians who receive but one listing during the course of the study.

The procedure followed in studying the location and movement of physicians has been explained in the first article of this series. Briefly, a single summary card is prepared for each of the 227,000 physicians whose name was listed in one or more of the American medical directories during the period from 1923 to 1938. Upon an individual physician's card are recorded his year of birth and year of graduation from medical school as well as selected items of information concerning his location for each of 4 index years, namely, the first, second, and last year of his listing, and 1931. These items are described by codes to indicate whether or not he was engaged in hospital practice, the size of the places, in terms of the 1930 census count, where he was located for each of the 4 index years, and supplementary codes to signify in which intervals between index years changes of location occurred. In the coding of these data only listings within the continental United States are considered. Any difference in State, county, or city listing of a physician in consecutive issues of the Directory is interpreted as reflecting a change of location.

When data from these cards are tabulated, it is found that the experience of 218,153 physicians out of the 227,000 total is included in this study. In accordance with the procedure outlined in earlier paragraphs, only those listings concerned in the period of established

[2] "Established" physicians as used in this article refer to physicians who have served their internship or residence and are engaged in medical practice. It is recognized that this group contains retired physicians and those engaged in other pursuits; however, the number is thought too small to affect seriously any of the comparisons presented herein.

practice are taken into account. Of the physicians in the study group, 143,000 were established in practice in 1923, while the corresponding total for 1938 was 162,000. The difference between these figures reflects a gain of about one-eighth in the national total. During the period more than one-fourth of the physicians changed their place of practice one or more times. Such changes account for more than 87,000 moves. Likewise, during this interval 75,000 new physicians were added, and 56,000 established physicians were lost from the profession, presumably through death.[3] Some insight into the effect of this interchange upon the continuity of medical service in the average community is gained when it is realized that for every established physician in 1923 an average of more than two adjustments in practice was effected during the study period.

Distribution of physician totals on the basis of location in large cities, small cities, and rural areas [4] reveals trends which are greatly divergent. As contrasted with a gain of one-eighth in the total for established physicians, large and small cities gained, respectively, three-tenths and two-tenths over the 15-year period. Rural communities, at the other extreme, lost nearly two-tenths from their 1923 total. These changes are of particular significance in light of the fact that estimated population totals for the three types of areas show respective increases of one-fifth, one-fourth, and one-tenth during the same interval.

This tendency toward urbanization of physicians apparently represents a continuation of trends established prior to 1923. The Nation-wide study of Mayers and Harrison (*8*) covering the period from 1906 to 1923, as well as numerous State-wide studies (*9, 10, 11, 12, 13*) including later periods, substantiate the fact that this trend was well established early in the century.

FACTORS AFFECTING TOTALS

Study of material at hand reveals two important factors which continually operate in a community to bring about depletion of medical care resources, namely, losses from the medical profession through death of physicians located in the area and migration from the community. In apposition, these factors are more or less counteracted by physicians entering the profession, and initially establishing practice in the area, and by migration thereto of established physicians from other locations. The extent to which those factors that bring

[3] It is assumed throughout this report that a count of physicians in this study group whose names were not listed at the end of the period provides a reasonably accurate estimate of the number of deaths which occurred throughout the study interval. Final allocation of these physicians to communities of different types is made on the basis of location at the time of last listing in a Directory.

[4] All population classifications used in this paper are based upon 1930 population figures published by the Bureau of the Census (*7*). Throughout the text, designations of "large city," "small city," and "rural area" locations refer, respectively, to urban territory for places of 50,000 or more inhabitants, urban territory for places of 2,500 to 50,000 inhabitants, and rural territory.

about depletion of resources are met or overbalanced by additions of new physicians or migrants from other areas determines the trend in physician totals over a period of time.

Data are found in figure 1 to illustrate the distribution of new physicians and deaths in the profession for areas classified according to population size. The extreme preferential status of larger cities in the extent to which they share in recent graduates is clearly apparent. Over the 15-year period the initial establishment of practice by more than 43,000 young physicians in large cities represents additions equivalent to 66 percent of the total located therein at the onset of the study. Corresponding numbers of new physicians for small cities and for rural communities represent 47 and 34 percent, respectively, of their 1923 physician totals. Conversely, deaths [5] were proportion-

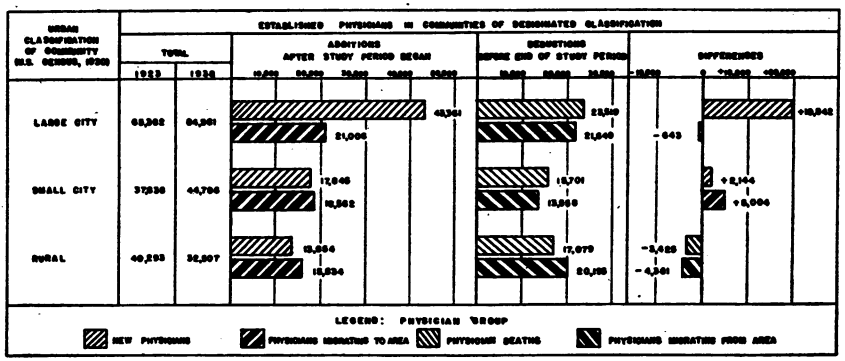

FIGURE 1.—Established physicians in large cities, small cities, and rural areas and changes effected by addition of new physicians, deaths, and migration from one community to another, 1923 to 1938.

ately more numerous in rural areas and small cities than in large urban locations. The 17,000 odd deaths allocated to rural communities are equal to 42 percent of the 1923 total, whereas similar percentages for small and large city locations are 42 and 36.

Comparison of figures representing physicians establishing practice with those representing deaths in the three types of communities over the period demonstrates a high balance in favor of large cities. In such communities the former outnumber the latter by nearly 20,000, whereas in small cities there is a corresponding favorable balance of about 2,100. Only in rural areas does the number of newly established physicians fail to exceed the number dying during the period. In these communities the number of physician deaths actually exceeds the number of physician entries by more than 3,400.

Comparison of place of first with place of last listing for physicians making location changes during the study period indicates that the effect of intercommunity migration upon totals for small cities and

[5] See footnote 3.

rural areas is more important than is that brought about by initial entry into practice and deaths of established physicians. Data presented in figure 1 portray movement patterns for established physicians in the study group over the period of their listing. Moves from one community to another of the same classification are counted both as moves from and moves to an area of that category. Likewise, a move involving more than one location category is enumerated as a move from the type of community where first listed and as a move to the type of community where last listed.

Reference to figure 1 shows that more than 20,000 established physicians first located in rural areas moved during the subsequent period, while of those first located in small and large cities nearly 14,000 and 22,000, respectively, made later changes. The pattern of migration for small cities is unique, however, in that only for this type of community did in-migration more than balance the number of physicians moving away during the period. This favorable balance through migration alone added 5,000 physicians to the total for small cities. For the most part, this trend was established at the expense of rural areas, where the number moving away outnumbered the in-migrants by more than 4,000. However, even in large cities, migration resulted in a small net deduction. The failure of in-migrants to replace losses by physicians moving from rural areas is particularly noteworthy when it is recalled that deaths in such areas outnumber new physicians establishing practice therein by more than 3,000. It seems evident that the acquisition of new physicians in itself, even though that might be possible in considerably larger numbers than prevailed over the study period, would not stem the tide away from rural areas. Unless means are developed to make such areas sufficiently attractive to hold physicians once they are located, rural communities will continue to experience a growing physician deficit. In large cities, on the other hand, the loss of 600 physicians through migration is inconsiderable when compared with the large favorable balance which existed between totals for new physicians establishing practice and deaths over the same period.

Figure 2 traces the migration path of those physicians who made changes between 1923 and 1938 by their location on first and last listings. Of the rural physicians who moved during the period, 43 percent set up practice in other rural areas; 32 percent went to small cities; and 25 percent moved to large cities. This migration pattern appears to lend substance to Maslow's (*14*) hypothesis that there is a "rural type" of practitioner "who has difficulty in maintaining a satisfactory rural practice, and who tries his luck again in another rural area." Yet, if this be true, there must also be a corresponding 'large-city type" of practitioner, since one-half of these physicians who made

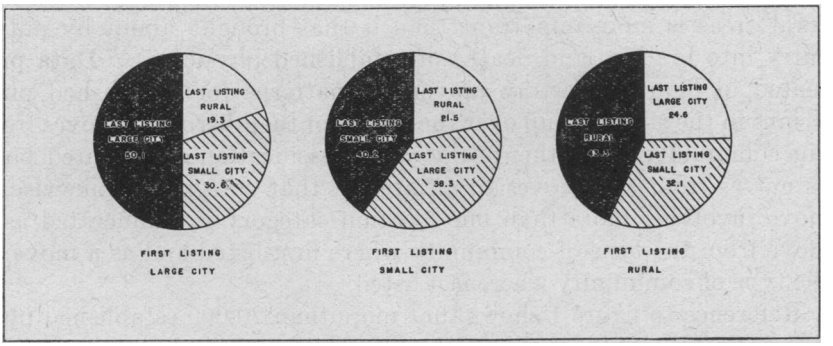

FIGURE 2.—Percentage distribution of migrating physicians first established in large cities, small cities, and rural areas, by location at time of last listing, 1923 to 1938.

changes appeared in other large cities, while 31 percent moved to small cities, and the remaining 19 percent entered practice in rural areas.[6] The course of the physician in small cities also reflects a somewhat similar pattern. In small cities, of the physicians making changes, 40 percent migrated to other small cities, 38 percent to large cities, and 22 percent to rural areas.

COMPARISON OF TRENDS 1923–31 AND 1931–38

Data presented in the previous section indicate that over the 15-year period physician totals were in a constant state of flux. To compare changes over the early years (1923–31) with those for the later years (1931–38) the period is divided into two parts.[7] Figure 3 demonstrates that trends were considerably modified over the total period. During both subperiods large and small cities expanded their physician resources, whereas those in rural communities were reduced. However, the magnitude of net change was generally smaller in the later as contrasted with the earlier years of the study. In large cities, for example, the gain in physicians from 1931 to 1938 was only three-fifths as great as during the first 8 years of the study period, while in rural areas the net loss was only one-tenth of that experienced in the former period. In small cities, conversely, the increase in the physician total was even larger in the second than in the first interval.

[6] Nelson (*15*) found in Minnesota that "there would appear to be a tendency for urban physicians to move to other urban centers or out of the State, while rural doctors tend to restrict their moves to areas within the State, and in larger proportions move to other rural areas."

[7] In processing the data for the 15-year period, the experience of an individual physician is treated as if his listings were continuous from the time that his name first appeared in a Directory until the time of his last listing therein. When the period is divided into two parts, however, it is found that the names of 1,334 physicians, although listed during both subperiods, did not appear in the Directory for 1931. In order to analyze data for the two subperiods each of these physicians was considered as having dropped from the profession during the first and as having reentered during the later interval.

As a result of minor tabulating discrepancies the 1938 totals for small cities and rural areas used in the analysis of subperiods differ slightly from those presented for the analysis covering the period as a whole. Because of the minor character of these differences (representing but 4 for small cities and 3 for rural areas) no attempt has been made to reconcile them.

Inspection of differences between numbers of new physicians and of deaths, as contrasted with differences attributable to migration, indicates that each factor contributed materially to the net changes in physician totals, in the early as well as in the later years of the study. In rural areas deaths outnumbered new registrants during both intervals; however, in the early years the excess was eight times as great as in the later period. Similarly, the unfavorable trend through migration from rural areas was less serious during the later than during the earlier period; losses so accrued from 1931 to 1938 numbered less than one-tenth of those for the earlier years. In large cities, at the other extreme, the advantageous balance of nearly 11,000 more new physicians than deaths in the first subperiod was reduced to about

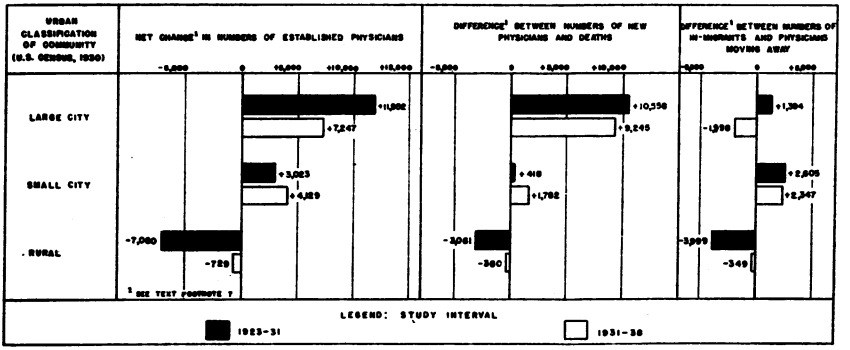

FIGURE 3.—Total net change and difference between new physicians and deaths and between in-migrants and physicians moving away from large cities, small cities, and rural areas, 1923 to 1931 and 1931 to 1938.

9,000 for the last 7 years of the study. Moreover, the migratory trend for the same areas was even reversed over the period, in that the increase of 1,400 physicians through intercommunity changes in the early years was replaced by a loss of nearly 2,000 in the later interval. In terms of all differences for which data are presented, favorable balances are evidenced for small cities.

While changing trends are apparent for all three types of areas, their significance is particularly emphasized when net differences in physician totals are contrasted with estimated population trends. Percentages representing changes in population [8] as well as in physician totals over each interval are indicated in figure 4. Regardless of the location class under consideration there is considerable variation between the two sets of indexes. To illustrate, between 1923 and 1931 the number of physicians in rural areas was reduced more than 17 percent; population, over the same interval, increased 5 percent.

[8] Inasmuch as physicians are tabulated on the basis of location classification as determined by the 1930 U. S. census, population data are also assembled on the same basis. In other words, both physician totals and population estimates for 1923, 1931, and 1938 are tabulated for identical areas on the basis of their urban classification in 1930. Through this procedure, physician figures and those for population are rendered comparable in respect to area classification.

During the next 7 years physician totals lost only 2 percent, while population expanded at a rate slightly accelerated over that for the former period. Trends for small cities diverge somewhat from those for the rural group; in the early interval the rate of population increase was more than twice as great as that for physicians, while for the later interval it was only five-eighths as great. Likewise, the tendencies apparent for the larger urban areas fail to conform to those for either of the preceding types. Specifically, in large cities the 18-percent increase in physician totals between 1923 and 1931 more than

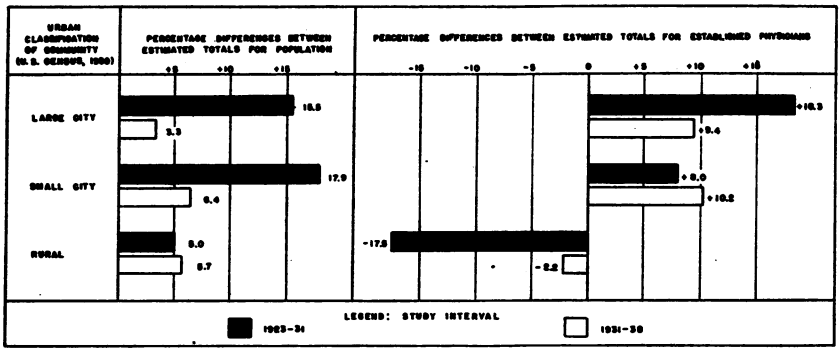

FIGURE 4.—Estimated percentage of change in totals for population and for established physicians in large cities, small cities, and rural areas, 1923 to 1931 and 1931 to 1938.

kept pace with the 16-percent gain in population. Although expansion of the physician total was reduced to about 9 percent during the second interval, the rate of population increase had declined to less than 4 percent.

These data suggest that rural areas, though still gaining population and losing physicians, are not losing doctors so rapidly as they did between 1923 and 1931. Moreover, they are attracting additional new registrants, but not in sufficient numbers to produce a net gain in these areas. Although changes in trend are evident between the two types of urban locations in regard to physician totals, in the final analysis both reflect greater increases in the physician total than in that for the general population.

AGE OF PHYSICIANS

Not only has there been reduction in physician totals in rural areas during recent years, but age distributions reveal that rural physicians are much older than those in more urban locations. Figure 5 gives the distribution by single years of age for established physicians in each type of community, for both 1923 and 1938. The variation among the age distributions for large cities, small cities, and rural areas is arresting for both years. Throughout the age scale the percentages for physicians in small cities occupy intermediate positions

between those for rural areas and large cities. In 1923 a higher proportion of the physicians located in rural places than of those practicing in large cities was found for each year of age over 44. This tendency for relatively more rural physicians to fall into the older groups was recognized by Pusey (*16*) and Peebles (*17*) in papers on the distribution of physicians for the country as a whole. Similiar trends were reported by Burns (*18*), Hyman (*19*), Mengelberg (*20*), Noyes

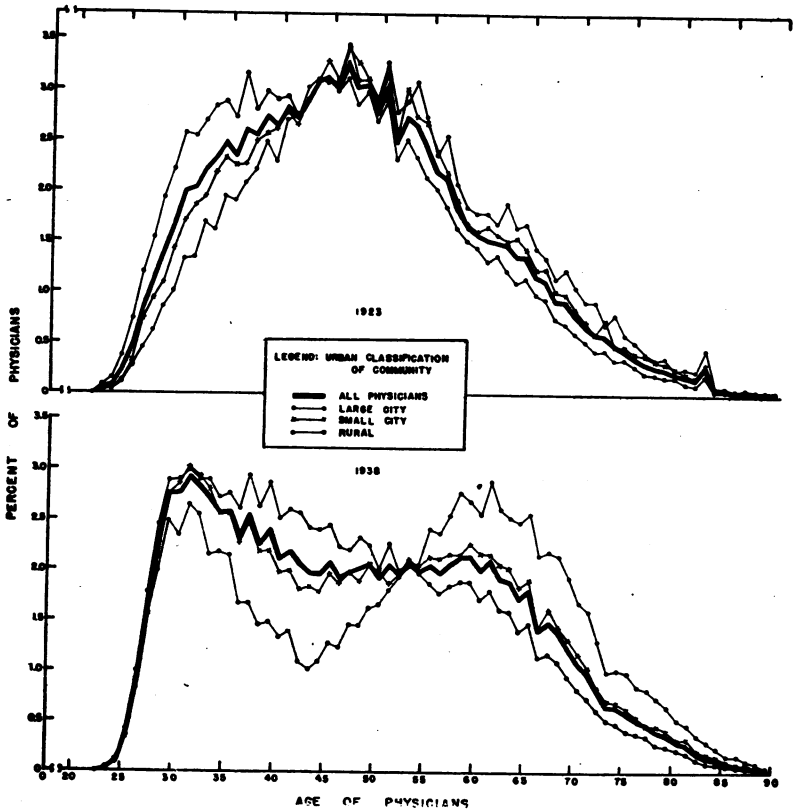

FIGURE 5.—Percentage distribution of all established physicians and of those in large cities, small cities, and rural areas in 1923 and in 1938 by single years of age.

(*21*), and Reinhardt and Schroeder (*22*) in discussion of physician resources in various States.

In 1938 the age curves for all the areas show marked changes. Increased numbers of graduates establishing practice have elevated the percentage of young physicians to the extent that high levels are reached for physicians around 30 years of age. The large number of physicians pictured on the 1923 curve between the ages of 40 and 55 are found 15 years later in the 1938 distributions between the ages of 55 and 70. The concentration at these levels in the 1938 age distribution for physicians in small city and rural areas is so great that the

curves representing these groups are distinctly bimodal. In rural areas, although the fraction under 35 compares rather favorably with those for more urban locations, the proportion of physicians 61 years of age is greater than for any other single year.

Computation of the median age for each of the established physician distributions shows that it has risen from 47 years for 1923 to 48 for 1938, an increase of 1 year. The median age for physicians in each of the location categories varied in relation to the extent to which the area was urbanized. For instance, in 1923 the median ages for physicians in rural areas, small cities, and large cities were 49, 48, and 45, respectively. By 1938 the median age for each of the distributions in identical order was 55, 49, and 45. No one factor can so clearly demonstrate the physician differences between rural communities and large cities as does comparison of these median ages. In 1923 there was a variation of 4 years between the two groups; by 1938 this difference had extended to 10 years.

MORTALITY DIFFERENCES ASSOCIATED WITH AGE

Presented in figure 5 and discussed in preceding paragraphs are age distribution curves for two periods, 15 years apart; one series heavily weighted with middle-aged physicians, the other with bimodal tendencies reflecting concentrations of both young and old physicians. What do these age differences mean in terms of mortality losses from the profession? Obviously, the group most heavily weighted with older physicians may expect to lose more through death than would a group of the same size heavily weighted with young individuals. It follows, therefore, that the proportionate losses from a unit total of physicians distributed as were the physicians in 1938 will, because of the less favorable age distribution, be greater than for a like number distributed according to the ages of the 1923 group. If the age distribution for the 1923 group is more favorable, how much more favorable is it? Is there some quantitative measure which may be used to determine this point?

Mortality rates based upon physician deaths in 1923 and 1938 related to the average physician counts over the same 12-month periods, if available, would serve this purpose. Unfortunately, precise data on physician deaths are not available for those years. It is possible, however, to build up hypothetical mortality rates by using 1930–39 age-specific mortality rates for white males (*23*) and the known age distribution of physicians in large cities, small cities, and rural localities in 1923 and 1938. Inasmuch as the age-specific rates used are identical for all mortality estimates, any differences between annual mortality rates computed on such a hypothetical basis reflect only the influence of physician age in the original totals from which they were prepared. Based upon the 1923 age distributions the estimated

annual mortality rates would be 15 per 1,000 physicians in large cities, in small cities 18, and in rural areas 20.

This unfavorable position of rural locations is more sharply revealed by similar rates based upon 1938 distributions. On these bases expected losses would be 18 per 1,000 for physicians in the large cities, 22 in small cities, and 29 for physicians located in rural areas. These estimates of mortality losses are higher for communities of each type than are those based upon the age distributions for the 1923 physician groups. In no place, however, is the difference so pronounced as in rural areas. Physicians in rural areas are much older than those in

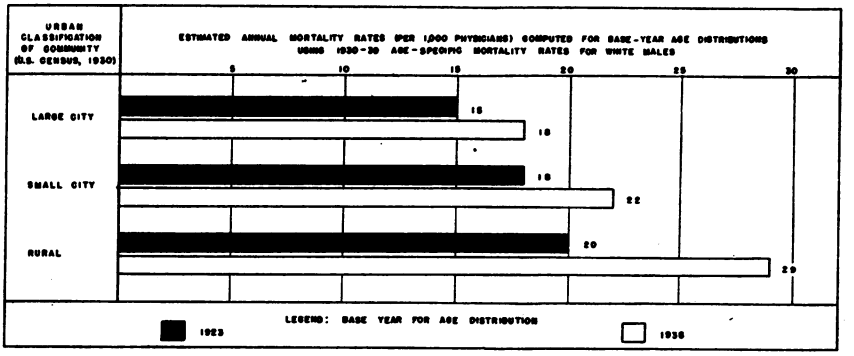

FIGURE 6.—Estimated annual mortality rates for established physicians in large cities, small cities, and rural areas, 1923 and 1938.

other communities, hence, this relatively high rate of loss is to be expected. Two outstanding facts emerge in figure 6. First, proportionately more deaths may be expected from the profession in rural areas than in any other location. Second, because of the progressively more unfavorable age distribution which has developed, the rate of loss may continue to increase for a number of years.

SUMMARY

The combined effect of physician migration, recruitment, and losses from the profession, over the period 1923–38, resulted in gains for both large and small cities and in losses for rural communities. Moreover, comparison of physician totals with population data indicates that the tendency for physicians to concentrate in large urban areas somewhat parallels, but exceeds in magnitude, the trend for the population as a whole.

Failure of rural localities to attract and retain a proportionate share of new registrants has resulted in a distribution heavily weighted with old physicians. Although in 1923 the median age of rural physicians was 4 years above that for those in large cities, by 1938 this difference had extended to 10 years. Such concentration of older practitioners in rural communities implies not only a reduced service capacity for

the average physician in those areas due to advanced age, but also an accelerated rate of loss through retirement and death.

How shall the deficit in the number of rural doctors be met? As physicians on completion of medical training tend to return to their communities of origin, encouragement of young men from these localities to attend medical schools might assist in the solution of the problem. Another and more immediate postwar solution might be to make rural practice more attractive through the construction and improvement of hospitals and related facilities. Because of the adverse economic position of these areas, some means for supplementing the income a physician customarily receives from patients very likely will be necessary in addition to other measures that may be instituted.

REFERENCES

PRECEDING PAPERS IN THIS SERIES

(1) Mountin, Joseph W., Pennell, Elliott H., and Nicolay, Virginia: Location and movement of physicians, 1923 and 1938—general observations. Pub. Health Rep., 57: 1363–1375 (Sept. 11, 1942). Reprint No. 2403.

(2) ————: Location and movement of physicians, 1923 and 1938—turnover as a factor affecting State totals. Pub. Health Rep., 57: 1752–1761 (Nov. 20, 1942). Reprint No. 2422.

(3) ————: Location and movement of physicians, 1923 and 1938—effect of local factors upon location. Pub. Health Rep., 57: 1945–1953 (Dec. 18, 1942). Reprint No. 2434.

(4) ————: Location and movement of physicians, 1923 and 1938—age distribution in relation to county characteristics. Pub. Health Rep., 58: 483–490 (Mar. 19, 1943). Reprint No. 2465.

(5) Pennell, Elliott H.: Location and movement of physicians—methods for estimating physician resources. Pub. Health Rep., 59: 281–305 (Mar. 3, 1944). Reprint No. 2543.

OTHER REFERENCES

(6) American Medical Directory, eighth, ninth, tenth, eleventh, twelfth, thirteenth, fourteenth, and fifteenth editions, 1923, 1925, 1927, 1929, 1931, 1934, 1936, and 1938. American Medical Association, Chicago.

(7) Sixteenth Census of the United States: 1940 Population. First series, number of inhabitants, United States summary. U. S. Bureau of the Census, 1941.

(8) Mayers, Lewis, and Harrison, Leonard A.: The distribution of physicians in the United States. General Education Board, New York, 1924.

(9) Chambers, J., and Lynn, H.: Medical service in Kentucky. Dept. of hygiene and public health, Univ. of Kentucky, Lexington, 1: 1–69 (January 1931).

(10) Lantis, L.: Distribution of physicians in North Dakota. Quar. J. Univ. North Dakota, 21: 337–347 (Summer 1931).

(11) Rice, Thurman B.: The distribution of physicians in Indiana. J. Indiana State Med. Assoc., 25: 157–162 (April 1932).

(12) Rice, Thurman B., and Connell, Paul S.: Distribution of physicians in Indiana. J. Indiana State Med. Assoc., 30: 275–281 (June 1937).

(13) Peebles, Allon: A Survey of the Medical Facilities in the State of Vermont. Publication No. 13 of the Committee on the Costs of Medical Care. University of Chicago Press, 1932.

(14) Maslow, Harold: The characteristics and mobility of rural physicians: A study of six Wisconsin counties. Rural Sociology, 3: 267–278 (September 1938).

(15) Nelson, Lowry: Distribution, age, and mobility of Minnesota physicians 1912–1936. Am. Sociol. Rev., 7: 792–801 (December 1942).

(16) Pusey, William Allen: Medical education and medical service. J. Am. Med. Assoc., 86: 1501–1508 (May 15, 1926).
(17) Peebles, Allon: A Survey of Statistical Data on Medical Facilities in the United States. Publication No. 3 of the Committee on the Costs of Medical Care. Washington, D. C., 1929.
(18) Burns, B. I.: The distribution of physicians in Louisiana with special reference to those in private practice. Southern Med. J., 35: 381–387 (April 1942).
(19) Hyman, O. W.: Southern medical colleges must maintain enrollment at least at its present level. J. Assoc. Am. Med. Colleges, 12: 301–304 (September 1937).
(20) Mengelberg, Kaethe: Doctors in two decades. Iowa Farm Economist, Iowa State College, 8: 10 (November 1942).
(21) Noyes, Guy L.: Hospital and medical service in rural Missouri. J. Missouri State Med. Assoc., 18: 430–431 (December 1921).
(22) Reinhardt, James M., and Schroeder, Martin H.: Physicians and hospitals in rural Nebraska. Medical Care, 1: 332–343 (October 1941).
(23) United States life tables 1930–1939 (preliminary); For white and nonwhite by sex. U. S. Bureau of the Census (July 21, 1941).
(24) Lawrence, Joseph S.: A study of the distribution of physicians in the rural districts of New York State. New York State J. Med., 29: 996–1000 (Aug. 15, 1929).
(25) Pearl, R.: Distribution of physicians in the United States, a commentary on the report of the General Education Board. J. Am. Med. Assoc., 84: 1024–1028 (Apr. 4, 1925).
(26) Smith, H., and Warnshuis, F.: Distribution of physicians in relation to population—a statistical survey and study covering 10 years. J. Michigan State Med. Soc., 25: 89–94 (February 1926).

INOCULATION OF CHICK EMBRYOS WITH SPOROZOITES OF *PLASMODIUM GALLINACEUM* BY INDUCING MOSQUITOES TO FEED THROUGH SHELL MEMBRANE [1]

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This note describes a method for inoculating chick embryos with sporozoites of *Plasmodium gallinaceum* by inducing infectious mosquitoes to feed through the shell membrane and the fetal membranes immediately beneath. The insects engorge upon blood from the superficial chorioallantoic vessels, or upon the allantoic fluid, and inject sporozoites from their salivary glands into the tissues of the embryo.

PREPARATION OF CHICK EMBRYOS

Chick embryos which have been incubated at 99° to 100° F. for 10 to 13 days are used. Under the candling light, each egg is examined on the day when the mosquitoes are to be applied, and one of the larger chorioallantoic vessels near the surface is located by inspection. With a pencil, a line about 1.5 cm. long is drawn on the shell, immediately over a portion of the course of the vessel selected.

The dental carbon disc is used to cut through the eggshell along the penciled line, care being taken to expose but not to penetrate the shell membrane, beneath which the chorioallantoic vessel selected

[1] From the Office of Malaria Investigations, National Institute of Health.

lies close to the surface. Only one cut is made, exposing a linear area of shell membrane about 1.5 cm. long and 0.2 cm. wide (the width of the cutting surface of the disc).

APPLICATION OF MOSQUITOES

One or two mosquitoes which have previously fed on a gametocyte-carrying chick, and are presumed to contain sporozoites of *Plasmodium gallinaceum* in their salivary glands, are placed in a small glass lantern globe (5 cm. tall and 3.5 cm. in diameter) or in a plastic cylinder of comparable size, both ends of which are covered with bobbinet. (In our laboratory, *Aedes aegypti* have been the mosquitoes used for inoculating embryos with *P. gallinaceum*.)

One of the embryos prepared as described is selected; the exposed line of shell membrane is moistened with a droplet of saliva carried on an applicator, and the globe or cylinder is applied to the egg over the prepared area.

We have found that best feeding results are obtained if the egg and the globe are held in the hands during the process. During our first attempts we succeeded in getting a few female *A. aegypti* to feed by leaving the cylinders or globes attached to the eggs by rubber bands in such a way that one of the bobbinet-covered ends fitted over the slit made in the eggshell, but subsequently, results secured by actually holding the egg and the cylinder thoughout the procedure have made this the method of choice, in spite of the extra work entailed.

Some care is required to maneuver the mosquito onto the bobbinet covering one or the other of the open ends of the cylinder. When the insect seems to be resting quietly, the end of the cylinder on which she rests is applied gently over the slit in the eggshell. The bobbinet is held firmly against the shell by careful, light pressure. If the mosquito is resting at a point a little distant from the opening in the eggshell, the cylinder is slid cautiously over the surface of the shell until the insect's head is over the exposed shell membrane.

Some patience is required to induce the mosquito to feed in this fashion, and if no success is attained in 5 or 6 minutes, it is well to discontinue the attempt with that particular mosquito and try another one.

Under direct observation, mosquitoes may be seen to engorge upon blood from the vessel lying beneath the shell membrane. The degree of distention of the insect's abdomen, once it has been induced to feed, compares with that seen when the mosquito engorges upon any suitable warm-blooded animal, the red color of the blood being clearly evident. Less frequently, the insect may be seen to fill up with clear, pale fluid, obviously not blood but allantoic fluid.

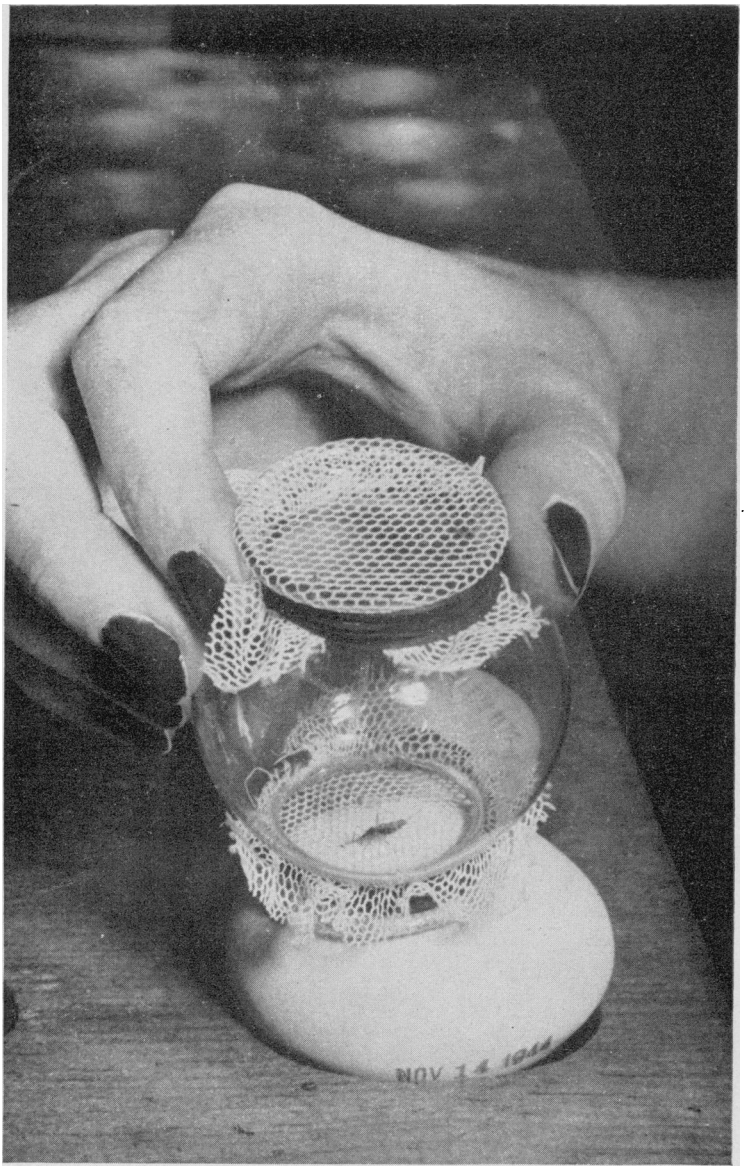

FIGURE 1.—Mosquito resting on bobbinet after feeding through shell membrane. The slit in the eggshell lies alongside the mosquito. (Photograph by Senior Sanitary Engineer H. A. Johnson.)

We have succeeded in feeding over 100 mosquitoes in this fashion. One worker can frequently induce 8 or 10 of the insects to engorge in a half day.

That some mortality is connected with the procedure is apparent from the following observations:

Mosquitoes were observed to engorge on 4 lots, comprising 38 embryos.
Of this total, 21 embryos died before hatching time.
There were 11 eggs which hatched out live chicks.
There were 6 embryos alive and ready to hatch at the time of this writing.

This indicates a provisional mortality of a little over 50 percent, apparently inherent in the method as we have practiced it to date. The hatching of 11 chicks, and the survival of 6 more up to hatching time, may be taken as an indication that sufficient embryos tolerate the procedure to make it worth while. It has been our experience that embryos inoculated by any of the several standard techniques with salivary glands dissected out of mosquitoes show nearly 100-percent mortality, usually within 24 hours. (The statistics on mortality given above do not include the embryos comprising the two lots used for complete passage of *P. gallinaceum*, discussed below, because these lots were done early in our series, before we had adopted the policy of holding each individual cylinder under direct observation; the mortality in these 2 lots was less than in the 4 lots considered above, but since we did not observe the feedings directly, these 2 lots are not comparable with those in which the feeding on each embryo was observed and noted.)

SUCCESSFUL TRANSMISSION OF SPOROZOITES

To date we have not been interested in carrying a strain in serial passage in this fashion, nor in repeating the inoculations of embryos with *P. gallinaceum*. We are continuing to use the method for other lines of investigation with which this note is not concerned, and therefore the number of successful transfers of the parasite considered here are very few. We carried out only sufficient work along this line to prove that the method was a practicable one for getting infected mosquitoes to engorge on chick embryos, and that *P. gallinaceum* sporozoites can be inoculated in this fashion.

One lot of 24 embryos, 11 days old, was prepared as indicated. Presumably infected *A. aegypti* were applied by fastening plastic cylinders to the eggs, 2 mosquitoes per cylinder. The cylinders were left attached overnight, and the following morning 7 cylinders contained definitely engorged mosquitoes. Probably because the eggs and cylinders had been kept at 100° F. during the overnight period, only 9 mosquitoes were still alive; 3 of these showed light sporozoite infections in their salivary glands. The chick embryos were allowed to

incubate, and on their twenty-first day (the tenth day after the mosquitoes had been placed on the eggs), 21 chicks hatched out from the original 24 eggs. Blood films were made on all these chicks on the day of hatching or on the following day. One was positive, 2 parasites being observed on the day after hatching; on the following day the count was 40 parasitized erythrocytes per 10,000 cells, and the chick died later in the day; autopsy revealed many exo-erythrocytic forms in the brain. A second chick from this lot showed no parasites the day after hatching, but had a count of 1,400 on the fourth day, and a count of 7,300 on the seventh day, at which time it died.

Another lot of 32 embryos, 12 days old, was exposed to mosquitoes in the same manner as just described. Four cylinders were found to contain engorged mosquitoes on the morning after the application had been made; 6 of these mosquitoes (some cylinders contained 2 and some 3 mosquitoes) showed moderate sporozoite infection of the salivary glands. On the ninth day after the mosquito application, 16 chicks hatched from the lot; 2 of these were found to have demonstrable parasitemia on the day after hatching; in one, a single parasite was seen, and this chick died 6 days later, with typical malarial pigmentation of the liver. The other chick had a parasite count of 790, and died 5 days later, showing a pigmented liver. A third chick was not examined on the day of hatching or the next day, but it died on the third day, and a smear of the heart blood showed a parasite count of 5,100, and exo-erythrocytic bodies were seen in the brain.

SUMMARY

Transmission of sporozoites of *P. gallinaceum* to chick embryos by allowing infectious *A. aegypti* to feed through the shell membrane has been accomplished. Having succeeded in inoculating embryos with sporozoites by this method, we have subsequently induced over 100 mosquitoes to engorge on embryonic blood or allantoic fluid in the course of other experiments. The technique is relatively simple and has been quite practicable in our experience. Embryos have survived the procedure sufficiently well to make it a worthwhile method for inoculating sporozoites.

MORTALITY IN LARGE CITIES, 1944

In 1944 a total of 468,773 deaths was reported in a group of 93 large cities in the United States, as compared with 487,931 in 1943, according to provisional figures furnished by the Bureau of the Census. These figures represent a decrease of 3.9 percent in 1944 as compared with an increase of 8.9 percent in 1943. Decreases were recorded for all geographic areas in 1944.

The numbers of deaths reported for each week of 1944 agree fairly closely with the 3-year weekly averages except at the beginning and end of the year. The excess number of deaths during the first 3 weeks in January, due to the influenza epidemic, brought the mortality curve for that period above the 3-year average, while the excess mortality during the last 3 weeks of December 1943 brought the graph for the 3-year average for that period above the 1944 curve. The provisional death rate for the country as a whole for the first 11 months of 1944 was 10.6 as compared with 10.5 for the same period in 1943.

A decrease was also reported in the number of infant deaths recorded in the same cities in 1944, the total being 32,113 as compared with 34,402 in 1943, or a reduction of 6.7 percent. The provisional infant death rate for the country as a whole for the first 11 months of 1944 was 39.1 as compared with 39.9 for the same period in 1943.

These provisional urban mortality figures are based on tabulations made with reference to the place of occurrence and not by place of residence. The total figures, and probably the figures for most, if not all, of the cities, therefore include deaths of nonresidents dying in the city and exclude deaths of residents occurring elsewhere than in the city.

	Provisional		Final 1943
	1944	1943	
Total deaths, 93 cities	468,773	487,931	492,526
Percentage difference from preceding year's total	−3.9	+8.9	
Deaths under 1 year of age	32,113	34,402	35,765
Deaths under 1 year of age, percentage difference from preceding year's total	−6.7	+11.9	

DEATHS DURING WEEK ENDED JANUARY 20, 1945

[From the Weekly Mortality Index, issued by the Bureau of the Census, Department of Commerce]

	Week ended Jan. 20, 1945	Corresponding week, 1944
Data for 93 large cities of the United States:		
Total deaths	9,654	10,461
Average for 3 prior years	10,036	
Total deaths, first 3 weeks of year	29,352	35,596
Deaths under 1 year of age	658	584
Average for 3 prior years	621	
Deaths under 1 year of age, first 3 weeks of year	1,911	1,991
Data from industrial insurance companies:		
Policies in force	66,923,436	66,222,332
Number of death claims	12,968	19,037
Death claims per 1,000 policies in force, annual rate	10.1	15.0
Death claims per 1,000 policies, first 3 weeks of year, annual rate	9.9	12.9

PREVALENCE OF DISEASE

No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

UNITED STATES

REPORTS FROM STATES FOR WEEK ENDED JANUARY 27, 1945

Summary

As compared with the preceding week, slightly increased incidence was recorded currently for influenza, measles, meningococcus meningitis, poliomyelitis, scarlet fever, typhoid fever, and whooping cough. Of 79 reported cases of typhoid fever, 35 occurred in Pennsylvania. Only 3 cases of smallpox were reported for the week. Seven cases of botulism were reported in Utah.

For the first 4 weeks of the year, higher incidence than for the same period last year has been reported for diphtheria, the dysenteries, poliomyelitis, scarlet fever, tularemia, endemic typhus fever, undulant fever, and whooping cough. Of these diseases probably the most significant is the continuation from last year of the rather general unusual prevalence of scarlet fever, of which a total of 18,976 cases has been reported during January as compared with 17,066 for the same period last year. A total of 132 cases of tularemia has been reported as compared with 54 last year, 292 cases of endemic typhus fever as compared with 199 last year, and 267 cases of undulant fever as compared with 146 for the same period last year. For the first 4 weeks of January, 3,603 cases of dysentery (2,766 bacillary) have been reported as compared with 1,328 for the corresponding period last year.

Urban mortality is below that for both last year and the 3-year average. A total of 9,742 deaths was reported for the current week in 93 large cities in the United States as compared with 10,068 for the same week last year and a 3-year (1942–44) average of 9,803. The cumulative total for the first 4 weeks this year is 39,096 as compared with 45,664 for the corresponding period in 1944.

Telegraphic morbidity reports from State health officers for the week ended January 27, 1945, and comparison with corresponding week of 1944 and 5-year median

In these tables a zero indicates a definite report, while leaders imply that, although none was reported, cases may have occurred.

Division and State	Diphtheria			Influenza			Measles			Meningitis, meningococcus		
	Week ended—		Median 1940–44	Week ended—		Median 1940–44	Week ended—		Median 1940–44	Week ended—		Median 1940–44
	Jan. 27, 1945	Jan. 29, 1944		Jan. 27, 1945	Jan. 29, 1944		Jan. 27, 1945	Jan. 29, 1944		Jan. 27, 1945	Jan. 29, 1944	
NEW ENGLAND												
Maine	3	0	0	------	41	34	2	227	154	1	3	1
New Hampshire	1	0	0	------	------	------	0	9	9	0	1	0
Vermont	1	1	1	------	19	------	0	19	22	0	0	0
Massachusetts	3	7	4	------	------	------	60	377	341	3	16	4
Rhode Island	0	0	0	------	24	------	0	279	98	0	5	1
Connecticut	2	3	1	7	53	14	38	185	164	2	8	1
MIDDLE ATLANTIC												
New York	8	8	18	[1] 3	[1] 15	[1] 15	57	928	928	27	56	10
New Jersey	1	4	4	3	24	24	14	913	431	4	25	2
Pennsylvania	12	8	8	1	20	------	42	1,272	1,272	17	41	15
EAST NORTH CENTRAL												
Ohio	8	7	12	7	72	21	22	2,314	152	12	24	3
Indiana	6	7	11	14	134	50	8	267	126	3	6	2
Illinois	3	15	15	1	68	68	45	436	273	16	16	0
Michigan [2]	19	6	6	2	32	12	18	1,132	354	3	29	1
Wisconsin	1	1	3	26	601	93	37	1,099	286	8	12	3
WEST NORTH CENTRAL												
Minnesota	8	7	3	3	------	3	4	710	235	1	2	0
Iowa	4	5	3	------	251	22	22	246	109	1	1	0
Missouri	5	3	3	5	5	6	10	99	55	7	34	2
North Dakota	2	1	1	1	14	23	2	275	42	0	1	0
South Dakota	0	0	0	------	------	1	9	158	39	0	0	0
Nebraska	3	5	4	2	3	3	14	19	28	1	1	1
Kansas	3	7	5	1	54	54	13	153	213	1	9	1
SOUTH ATLANTIC												
Delaware	1	2	1	------	------	------	43	10	10	1	2	1
Maryland [2]	9	10	9	16	267	132	21	217	32	1	7	4
District of Columbia	0	3	1	------	5	5	7	60	11	0	3	3
Virginia	12	8	8	385	2,404	2,107	22	270	168	5	15	6
West Virginia	4	2	8	14	354	53	11	200	54	2	2	1
North Carolina	9	11	11	------	45	66	20	460	87	7	11	2
South Carolina	19	8	8	810	1,878	1,878	17	144	25	1	9	1
Georgia	13	7	7	52	408	408	9	284	63	6	8	0
Florida	1	2	5	2	76	62	35	95	33	7	11	1
EAST SOUTH CENTRAL												
Kentucky	7	8	8	7	845	59	7	97	97	5	12	2
Tennessee	3	7	3	58	419	325	24	357	48	8	37	2
Alabama	12	6	12	266	1,264	900	4	349	62	13	10	3
Mississippi [2]	5	7	7	------	------	------	------	------	------	5	11	1
WEST SOUTH CENTRAL												
Arkansas	6	9	9	121	862	862	90	42	63	25	3	2
Louisiana	9	5	6	12	1,990	[1] 42	10	32	32	4	10	1
Oklahoma	7	2	9	192	661	[1] 373	7	0	5	1	[1] 3	1
Texas	57	30	35	2,138	5,990	2,158	173	340	196	8	28	3
MOUNTAIN												
Montana	1	1	2	38	517	25	5	246	77	0	3	0
Idaho	2	0	0	1	------	1	0	27	27	0	0	0
Wyoming	0	0	0	------	205	43	1	51	20	0	0	0
Colorado	10	8	8	30	298	113	6	226	166	3	3	0
New Mexico	6	3	3	[1] 5	32	19	8	6	21	0	0	0
Arizona	0	4	4	136	543	271	9	112	106	1	2	1
Utah [2]	1	0	0	2	1,115	45	33	5	40	0	0	0
Nevada	0	1	0	------	10	------	1	1	1	0	0	0
PACIFIC												
Washington	10	6	3	------	3	13	49	88	88	6	5	1
Oregon	6	8	4	10	157	125	42	68	147	5	3	1
California	28	41	24	20	705	474	430	499	389	21	39	4
Total	331	294	341	4,391	22,483	13,242	1,501	15,403	10,887	242	527	65
4 weeks	1,384	1,059	1,355	17,103	261,981	47,956	5,362	49,851	36,328	953	2,273	230

[1] New York City only.
[2] Period ended earlier than Saturday.

Telegraphic morbidity reports from State health officers for the week ended January 27, 1945, and comparison with corresponding week of 1944 and 5-year median—Continued

Division and State	Poliomyelitis			Scarlet fever			Smallpox			Typhoid fever and paratyphoid fever [4]		
	Week ended—		Median	Week ended—		Median	Week ended—		Median	Week ended—		Median
	Jan. 27, 1945	Jan. 29, 1944	1940–44	Jan. 27, 1945	Jan. 29, 1944	1940–44	Jan. 27, 1945	Jan. 29, 1944	1940–44	Jan. 27, 1945	Jan. 29, 1944	1940–44
NEW ENGLAND												
Maine	1	0	0	49	33	17	0	0	0	0	2	1
New Hampshire	0	0	0	21	14	11	0	0	0	0	0	0
Vermont	0	0	0	8	11	11	0	0	0	0	0	0
Massachusetts	1	0	0	360	314	314	0	0	0	1	0	1
Rhode Island	0	0	0	13	13	10	0	0	0	0	0	0
Connecticut	0	0	0	85	86	65	0	0	0	0	0	2
MIDDLE ATLANTIC												
New York	6	0	1	465	391	416	0	0	0	2	3	3
New Jersey	0	0	0	135	142	142	0	0	0	2	1	0
Pennsylvania	4	0	0	324	341	341	0	0	0	35	3	5
EAST NORTH CENTRAL												
Ohio	3	0	1	392	314	318	0	2	1	1	8	1
Indiana	1	3	1	177	90	126	0	0	2	5	32	3
Illinois	2	2	1	430	257	257	0	0	0	0	1	1
Michigan [3]	0	0	0	279	236	207	0	0	1	0	0	2
Wisconsin	1	0	0	145	303	214	0	0	1	0	0	1
WEST NORTH CENTRAL												
Minnesota	0	0	0	95	157	93	0	0	1	0	0	0
Iowa	0	0	0	61	96	63	0	1	1	0	1	1
Missouri	0	0	0	143	93	91	0	0	1	0	0	0
North Dakota	0	0	0	7	13	16	0	0	0	1	0	0
South Dakota	0	0	0	24	42	32	0	0	0	1	0	0
Nebraska	0	0	0	67	74	34	0	0	0	0	0	0
Kansas	0	1	1	146	87	87	0	1	1	0	0	0
SOUTH ATLANTIC												
Delaware	0	0	0	6	8	13	0	0	0	0	0	0
Maryland [3]	[3] 0	1	0	157	113	81	0	0	0	0	1	2
District of Columbia	0	0	0	70	131	29	0	0	0	0	0	0
Virginia	0	0	0	86	74	50	0	2	0	2	1	3
West Virginia	2	0	0	75	48	48	0	0	0	0	0	0
North Carolina	1	0	0	74	56	56	0	0	0	2	0	0
South Carolina	1	0	1	6	10	7	0	0	0	3	1	1
Georgia	0	0	0	36	23	25	0	0	0	3	4	4
Florida	2	0	0	11	25	7	0	0	0	2	4	0
EAST SOUTH CENTRAL												
Kentucky	0	0	1	70	64	64	2	0	0	0	0	0
Tennessee	0	3	0	87	41	54	0	0	0	2	3	3
Alabama	0	0	1	25	12	16	0	2	0	0	1	1
Mississippi [3]	0	0	0	10	15	8	0	1	1	1	0	1
WEST SOUTH CENTRAL												
Arkansas	1	0	0	63	4	7	[3] 0	0	1	0	0	2
Louisiana	0	0	0	27	8	10	0	0	0	3	4	4
Oklahoma	0	0	0	22	5	27	0	0	0	0	0	1
Texas	0	4	1	163	65	64	0	1	2	3	3	3
MOUNTAIN												
Montana	0	0	0	17	53	30	0	0	0	0	0	0
Idaho	0	0	0	64	37	4	0	0	0	3	0	0
Wyoming	0	0	0	5	14	14	0	0	0	0	0	0
Colorado	1	2	0	73	68	43	0	0	0	0	0	1
New Mexico	0	0	0	29	6	7	1	0	0	1	2	2
Arizona	0	0	0	16	14	7	0	0	0	0	0	0
Utah [3]	3	0	0	53	199	38	0	0	0	0	0	0
Nevada	0	0	0	7	1	0	0	0	0	0	0	0
PACIFIC												
Washington	3	2	1	76	238	29	0	1	0	4	0	1
Oregon	0	0	0	44	78	20	0	0	0	0	2	0
California	3	11	9	329	419	191	0	1	1	2	2	2
Total	36	29	31	5,127	4,936	3,746	3	12	26	79	79	72
4 weeks	147	119	136	18,976	17,066	14,150	[3] 33	49	127	211	253	308

[2] Period ended earlier than Saturday.

[3] Delayed reports: Maryland, poliomyelitis 1 case, 1944; Arkansas, smallpox 1 case, week ended January 6, 1945.

[4] Including paratyphoid fever reported separately as follows: Massachusetts, 1; New York, 2; South Carolina, 1; Georgia, 2; Tennessee, 1; Texas, 2; California, 1.

Telegraphic morbidity reports from State health officers for the week ended January 27, 1945, and comparison with corresponding week of 1944 and 5-year median—Continued

Division and State	Whooping cough			Week ended January 27, 1945							
	Week ended—		Median 1940–44	Dysentery			Encephalitis, infectious	Rocky Mt. spotted fever	Tularemia	Typhus fever	Undulant fever
	Jan. 27, 1945	Jan. 29, 1944		Amebic	Bacillary	Unspecified					
NEW ENGLAND											
Maine	70	6	47	0	0	0	0	0	0	0	1
New Hampshire	4	9	9	1	0	0	0	0	0	0	0
Vermont	54	10	34	0	0	0	0	0	0	0	2
Massachusetts	171	99	173	0	3	0	1	0	0	0	1
Rhode Island	28	2	6	0	0	0	0	0	0	0	0
Connecticut	67	17	78	0	0	0	0	0	0	0	2
MIDDLE ATLANTIC											
New York	219	166	388	2	11	0	0	0	0	0	7
New Jersey	106	56	126	1	0	0	0	0	0	0	1
Pennsylvania	138	114	349	0	0	0	0	0	0	0	1
EAST NORTH CENTRAL											
Ohio	169	114	277	0	0	0	0	0	0	0	0
Indiana	20	20	22	0	0	0	1	0	0	0	5
Illinois	83	91	108	4	1	0	1	0	3	0	5
Michigan [2]	85	142	262	0	0	0	0	0	0	0	2
Wisconsin	85	97	149	0	0	0	0	0	0	0	1
WEST NORTH CENTRAL											
Minnesota	40	37	49	1	0	0	0	0	0	0	5
Iowa	2	14	15	0	0	0	0	0	0	0	0
Missouri	1	14	14	0	0	0	0	0	1	0	0
North Dakota	0	4	11	0	0	0	0	0	0	0	1
South Dakota	15	5	3	0	0	0	0	0	0	0	3
Nebraska	3	0	3	0	0	0	0	0	0	0	0
Kansas	67	36	43	0	0	0	0	0	2	0	2
SOUTH ATLANTIC											
Delaware	2	0	7	0	0	0	0	0	0	0	0
Maryland [2]	49	29	73	0	0	0	0	0	0	0	1
District of Columbia	6	5	7	0	0	0	0	0	0	0	0
Virginia	45	58	56	0	0	102	0	0	0	1	2
West Virginia	9	30	49	0	0	0	1	0	0	0	0
North Carolina	108	162	162	0	0	0	0	0	0	2	0
South Carolina	53	72	72	3	8	0	0	0	0	2	0
Georgia	14	14	26	0	3	0	0	0	2	15	2
Florida	9	16	16	1	0	2	0	0	0	4	2
EAST SOUTH CENTRAL											
Kentucky	30	84	84	0	0	0	0	0	0	0	0
Tennessee	38	31	31	0	0	0	0	0	3	1	1
Alabama	38	12	26	0	0	0	0	0	1	8	2
Mississippi [2]	----	----	----	0	0	0	0	0	0	1	1
WEST SOUTH CENTRAL											
Arkansas	17	17	17	1	1	0	0	0	0	1	0
Louisiana	3	16	7	1	0	0	0	0	1	2	1
Oklahoma	21	1	7	5	1	0	0	0	0	0	0
Texas	241	133	139	1	492	28	0	0	0	9	11
MOUNTAIN											
Montana	19	19	15	0	0	0	0	0	0	0	0
Idaho	0	5	6	0	0	0	0	0	0	0	0
Wyoming	9	13	10	0	0	10	0	0	0	0	0
Colorado	20	38	32	0	0	0	0	0	0	0	1
New Mexico	4	3	39	0	1	1	0	0	0	0	0
Arizona	15	31	14	1	0	24	0	0	0	0	0
Utah [2]	23	13	37	0	0	0	0	0	0	0	1
Nevada	0	0	0	0	0	0	0	0	0	0	0
PACIFIC											
Washington	28	49	49	0	0	12	0	0	0	0	0
Oregon	7	34	29	0	0	0	0	0	0	0	1
California	224	80	202	2	15	0	2	0	1	3	3
Total	2,459	2,018	3,846	24	536	179	6	0	14	49	68
Same week, 1944	2,018	----	----	18	205	55	4	0	12	43	38
Average, 1942–44	3,564	----	----	17	137	49	7	[3] 0	19	[3] 43	34
4 weeks: 1945	8,985	----	----	113	2,766	736	23	1	133	202	268
1944	7,069	----	----	99	1,015	214	34	0	54	199	146
Average, 1942–44	13,442	----	[3] 15,883	79	611	169	31	[3] 0	91	[3] 199	123

[2] Period ended earlier than Saturday.
[3] 5-year median, 1940–44.

Anthrax: Massachusetts, 1; Pennsylvania, 1. *Leprosy:* California, 3. *Botulism:* Utah, 7.

WEEKLY REPORTS FROM CITIES

City reports for week ended January 20, 1945

This table lists the reports from 86 cities of more than 10,000 population distributed throughout the United States, and represents a cross section of the current urban incidence of the diseases included in the table.

	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
NEW ENGLAND												
Maine:												
Portland	0	1	------	0	1	1	1	0	4	0	0	0
New Hampshire:												
Concord	0	0	------	0	0	0	1	0	2	0	0	0
Massachusetts:												
Boston	1	2	------	0	22	3	14	0	61	0	0	25
Springfield	0	0	------	0	0	0	0	0	13	0	0	0
Worcester	0	0	------	0	2	0	13	0	19	0	0	8
Rhode Island:												
Providence	0	0	------	1	0	1	2	0	10	0	0	25
Connecticut:												
Bridgeport	0	0	1	0	0	0	0	0	1	0	0	0
Hartford	0	0	1	0	39	0	1	0	12	0	0	1
New Haven	0	0	------	1	0	1	1	0	6	0	0	12
MIDDLE ATLANTIC												
New York:												
Buffalo	0	0	------	0	0	1	2	1	10	0	0	0
New York	12	0	3	0	10	21	80	1	308	0	1	83
Rochester	0	0	------	1	0	3	0	1	3	0	0	23
Syracuse	0	0	------	0	0	1	1	0	8	0	0	17
New Jersey:												
Camden	0	0	------	0	1	0	4	0	3	0	0	0
Newark	0	0	------	0	1	5	6	0	10	0	0	3
Trenton	0	0	------	0	0	1	0	0	5	0	0	0
Pennsylvania:												
Philadelphia	1	0	4	2	14	2	17	0	93	0	2	40
Pittsburgh	0	0	------	1	0	5	5	0	17	0	0	6
Reading	0	0	------	0	2	0	3	0	1	0	0	0
EAST NORTH CENTRAL												
Ohio:												
Cincinnati	1	0	------	0	0	5	12	0	23	0	0	10
Cleveland	0	0	5	0	2	1	10	0	57	0	0	42
Columbus	1	0	------	0	0	1	4	0	8	0	0	14
Indiana:												
Fort Wayne	0	0	------	0	0	0	4	0	3	0	0	0
Indianapolis	1	0	------	2	0	3	14	0	35	0	0	0
South Bend	0	0	------	0	3	0	0	0	3	0	0	0
Terre Haute	0	0	------	0	1	0	2	0	4	0	0	0
Illinois:												
Chicago	0	0	4	2	20	8	25	1	120	0	0	35
Springfield	0	0	------	0	2	0	3	0	3	0	3	2
Michigan:												
Detroit	8	0	------	2	5	4	8	0	80	0	0	23
Flint	1	0	------	0	1	0	4	0	6	0	0	1
Grand Rapids	0	0	------	0	0	0	0	0	5	0	0	1
Wisconsin:												
Kenosha	0	0	------	0	0	0	0	0	2	0	0	8
Milwaukee	0	0	------	0	4	2	1	0	41	0	0	3
Racine	0	0	------	0	7	2	0	0	2	0	0	8
Superior	0	0	------	0	0	0	0	0	1	0	0	1
WEST NORTH CENTRAL												
Minnesota:												
Duluth	1	0	------	0	0	0	0	0	4	0	0	0
Minneapolis	5	0	------	1	2	1	3	0	15	0	0	3
St. Paul	1	0	------	0	2	1	1	0	14	0	0	20

City reports for week ended January 20, 1945—Continued

	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
WEST NORTH CENTRAL—continued												
Missouri:												
Kansas City	1	0	------	2	3	1	14	0	38	0	0	5
St. Joseph	0	0	------	0	0	0	0	0	10	0	1	0
St. Louis	0	0	1	0	0	8	12	1	24	0	0	7
Nebraska:												
Omaha	3	0	------	0	3	1	3	0	11	0	0	0
Kansas:												
Topeka	0	0	------	0	1	1	0	0	6	0	0	3
Wichita	0	0	1	0	0	0	2	0	15	0	0	3
SOUTH ATLANTIC												
Delaware:												
Wilmington	0	0	------	0	0	0	5	0	0	0	0	0
Maryland:												
Baltimore	10	0	4	3	5	4	17	0	65	0	0	53
Cumberland	0	0	------	0	1	0	0	0	2	0	0	0
Federick	0	0	------	0	0	0	0	0	0	0	0	0
District of Columbia:												
Washington	0	0	2	0	2	2	7	0	59	0	0	6
Virginia:												
Lynchburg	0	0	------	0	0	0	1	0	10	0	0	0
Richmond	0	0	------	0	1	0	3	0	12	0	0	0
Roanoke	0	0	------	0	0	1	0	0	0	0	0	2
West Virginia:												
Charleston	0	0	------	0	0	1	0	0	2	0	0	0
Wheeling	0	0	------	0	12	0	1	0	5	0	0	0
North Carolina:												
Raleigh	0	0	------	0	0	0	2	0	0	0	0	2
Wilmington	0	0	------	1	0	0	1	0	0	0	0	9
Winston-Salem	0	0	------	0	1	0	3	0	6	0	0	10
South Carolina:												
Charleston	0	0	102	1	0	1	5	0	3	0	0	0
Georgia:												
Atlanta	1	0	3	3	0	3	4	0	8	0	1	2
Brunswick	0	0	------	0	1	1	1	0	1	0	0	0
Florida:												
Tampa	2	0	------	0	1	0	3	0	0	0	0	1
EAST SOUTH CENTRAL												
Tennessee:												
Memphis	0	0	6	2	39	0	16	0	6	0	0	4
Nashville	0	0	------	0	0	0	1	0	1	0	0	0
Alabama:												
Birmingham	0	0	28	2	0	1	3	0	5	0	0	2
Mobile	0	0	1	0	0	2	3	0	0	0	0	0
WEST SOUTH CENTRAL												
Arkansas:												
Little Rock	0	0	------	0	0	0	0	0	0	0	0	1
Louisiana:												
New Orleans	3	0	------	0	8	4	9	0	11	0	2	0
Shreveport	0	0	------	0	0	0	9	0	2	0	0	0
Texas:												
Dallas	2	0	1	1	0	0	2	0	7	0	0	1
Galveston	1	0	------	0	0	0	0	0	0	0	0	0
Houston	5	0	------	0	0	0	7	1	6	0	0	0
San Antonio	1	0	2	0	0	1	8	0	7	0	0	0
MOUNTAIN												
Montana:												
Billings	0	0	------	0	1	0	0	0	1	0	0	0
Great Falls	0	0	------	0	0	0	1	0	0	0	0	0
Helena	0	0	------	0	0	0	0	0	0	0	0	1
Missoula	0	0	------	0	0	0	0	0	1	0	0	0
Idaho:												
Boise	0	0	------	0	0	0	0	0	0	0	0	0
Colorado:												
Denver	0	0	3	1	9	0	7	0	15	0	0	7
Pueblo	0	0	------	0	0	0	0	0	7	0	0	0
Utah:												
Salt Lake City	1	0	------	1	7	1	3	0	8	0	0	0

City reports for week ended January 20, 1945—Continued

	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
PACIFIC												
Washington:												
Seattle	1	0	------	1	12	0	13	0	9	0	0	2
Spokane	0	0	------	0	1	0	2	0	8	0	0	0
Tacoma	0	0	------	0	4	1	3	0	1	0	0	0
California:												
Los Angeles	4	0	5	2	14	2	7	0	62	0	0	22
Sacramento	0	0	------	0	3	0	0	0	17	0	0	13
San Francisco	1	0	------	0	23	1	11	2	27	0	1	25
Total	69	3	177	33	293	110	431	8	1,490	0	11	595
Corresponding week, 1944	62	------	1,589	185	2,563	------	658	------	1,402	0	10	416
Average, 1940–44	77	------	2,220	[1] 102	[2] 2,720	------	[1] 611	------	1,205	3	14	960

[1] 3-year average, 1942–44.
[2] 5-year median, 1940–44.

Dysentery, amebic.—Cases: Boston, 1; Los Angeles, 1; San Francisco, 1.
Dysentery, bacillary.—Cases: New York, 4; Rochester, 1; St. Louis, 1; Charleston, S. C., 10; Los Angeles, 1.
Dysentery, unspecified.—Cases: San Antonio, 2.
Tularemia.—Cases: St. Louis, 2; Memphis, 2.
Typhus fever, endemic.—Cases: Wilmington, N. C., 3; Tampa, 1; Nashville, 2; Birmingham, 2; Little Rock, 2; Shreveport, 1; Galveston, 1; San Antonio, 3.

Rates (annual basis) per 100,000 population, by geographic groups, for the 86 cities in the preceding table (estimated population, 1943, 34,129,000)

	Diphtheria case rates	Encephalitis, infectious, case rates	Influenza		Measles case rates	Meningitis, meningococcus, case rates	Pneumonia death rates	Poliomyelitis case rates	Scarlet fever case rates	Smallpox case rates	Typhoid and paratyphoid fever case rates	Whooping cough case rates
			Case rates	Death rates								
New England	2.8	8.3	5.6	5.6	178	16.7	91.6	0.0	355	0.0	0.0	197
Middle Atlantic	6.0	0.0	3.2	1.9	13	18.1	54.6	1.4	212	0.0	1.4	80
East North Central	7.3	0.0	5.5	3.6	27	15.8	52.9	0.6	239	0.0	1.8	90
West North Central	22.1	0.0	4.0	6.0	22	26.1	70.4	2.0	276	0.0	2.0	82
South Atlantic	22.0	0.0	188.5	13.6	41	22.1	90.0	0.0	294	0.0	1.7	144
East South Central	0.0	0.0	206.6	23.6	230	17.7	135.7	0.0	71	0.0	0.0	35
West South Central	34.4	0.0	8.6	2.9	23	14.3	100.4	2.9	95	0.0	5.7	6
Mountain	7.9	0.0	23.8	15.9	135	7.9	87.4	0.0	254	0.0	0.0	64
Pacific	9.5	0.0	7.9	4.7	90	6.3	56.9	3.2	196	0.0	1.6	98
Total	10.6	0.5	27.1	5.1	45	16.9	66.0	1.2	228	0.0	1.7	91

TERRITORIES AND POSSESSIONS

Virgin Islands of the United States

Notifiable diseases—October–December 1944.—During the months of October, November, and December 1944, cases of certain notifiable diseases were reported in the Virgin Islands as follows:

Disease	October	November	December	Disease	October	November	December
Chickenpox	1			Mumps	1		
Filariasis	9	4	3	Schistosomiasis		1	1
Gonorrhea	8	7	8	Syphilis	9	23	16
Hookworm disease	1	3	1	Trachoma	3		
Leprosy		1		Tuberculosis (respiratory)	1	2	3
Lymphogranuloma inguinale			1	Typhus fever, murine			1
Malaria	2						

FOREIGN REPORTS

CANADA

Provinces—Communicable diseases—Week ended January 6, 1945.—During the week ended January 6, 1945, cases of certain communicable diseases were reported by the Dominion Bureau of Statistics of Canada as follows:

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Chickenpox		15		121	383	62	25	78	83	767
Diphtheria	1	4	6	26	5	4		1		47
German measles				1	20		6	10	4	41
Influenza		65			33					98
Measles		2	1	32	61	13	36	8	66	219
Meningitis, meningococcus				1	2			1	2	6
Mumps				127	99	16	16	58	5	321
Poliomyelitis					1					1
Scarlet fever	5	7	9	66	100	7	14	42	24	274
Tuberculosis (all forms)		8	2	70	61	1		19	38	199
Typhoid and paratyphoid fever				6						6
Undulant fever				3						3
Venereal diseases:										
Gonorrhea		32	15	80	163	15	9	40	38	392
Syphilis	1	3	9	116	88	8	7	8	27	267
Whooping cough		29		83	88	4	5	9	3	221

REPORTS OF CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER RECEIVED DURING THE CURRENT WEEK

NOTE.—Except in cases of unusual incidence, only those places are included which had not previously reported any of the above-mentioned diseases, except yellow fever, during the current year. All reports of yellow fever are published currently.

A table showing the accumulated figures for these diseases for the year to date is published in the PUBLIC HEALTH REPORTS for the last Friday in each month.

(Few reports are available from the invaded countries of Europe and other nations in war zones.)

Plague

Algeria.—For the period December 11–20, 1944, 4 cases of plague were reported in Algiers, Algeria. Information dated January 19, 1945, states that 1 death from pneumonic plague occurred in Oran, Algeria, on January 18, 1945; 3 other suspected deaths from plague and 3 additional cases of suspected plague were also reported in Oran.

British East Africa—Kenya—Fort Hall District.—On January 1, 1945, 2 fatal cases of plague were reported in Fort Hall District, Kenya, British East Africa.

Morocco (French).—For the period January 1–10, 1945, 21 cases of plague were reported in Casablanca region, French Morocco.

Senegal.—For the period January 1–10, 1945, 14 cases of plague were reported in Senegal.

Typhus Fever

Algeria.—For the period December 11–20, 1944, 89 cases of typhus fever were reported in Algeria.

Morocco (French).—For the period January 1–10, 1945, 99 cases of typhus fever were reported in French Morocco.

Turkey.—For the week ended January 20, 1945, 100 cases of typhus fever were reported in Turkey.

Yellow Fever

Colombia—Santander del Norte Department—Petrolea.—Yellow fever has been reported in Petrolea, Santander del Norte Department, Colombia, as follows: December 1944, 2 deaths; January 1945, 2 deaths. Petrolea is approximately 50 miles north of Cucuta, the area being in the vicinity of the outbreak in Venezuela.

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COURT DECISION ON PUBLIC HEALTH

Pork containing trichinae—sale—statutes construed.—(Ohio Supreme Court; *Leonardi* v. *A. Habermann Provision Co.* (3 cases), *Sanguedolce* v. *A. Habermann Provision Co.* (3 cases), 56 N.E.2d 232; decided July 26, 1944.) Actions were brought by the plaintiffs to recover damages for illness alleged to have resulted from eating pork. It was claimed that such pork was purchased from the defendant and, when so purchased in a raw or fresh condition, was infected with trichinae. The pertinent sections of the Ohio General Code (a) prohibited the sale of an adulterated article of food; (b) declared food to be adulterated if it consisted wholly or in part of a diseased, decomposed, putrid, infected, tainted, or rotten animal substance; and (c) made punishable the sale of diseased, corrupted, adulterated, or unwholesome provisions unless the condition thereof was made known to the buyer.

Before discussing what liability the Ohio laws cast upon the seller of raw pork, the State supreme court made the following observations: From 2 to 3 percent of all live hogs are infested with *Trichinae spiralis;* these parasites cannot be seen with the naked eye but are discoverable only with a microscope; since their presence or absence in only a small area is not a test as to their presence or absence in the entire carcass, all the tissues must be examined microscopically in order to make sure that the carcass is not infested and, obviously, this renders this

method of inspection impracticable; the United States Government, in connection with its meat inspection program, has discontinued the practice of making microscopic examination of carcasses of hogs to discover the trichinae; trichinae in pork can be destroyed by cooking at 137° F. or by refrigeration for 20 days at a temperature of 5° above zero.

Proceeding to the question of the liability of the seller of raw pork, the supreme court said that, under the plain wording of section 5778, the selling of infected animal substance constituted an unlawful act and that it could not well be denied that meat containing trichinae was infected. The fact that the seller was unable to make an inspection did not relieve him. With respect to the statutory inhibition against the sale of unwholesome food or infected meat, the court stated that this meant that only wholesome food or uninfected meat could be lawfully sold. After defining the terms "wholesome" and "uninfected," it was stated that trichinae-infected meat did not qualify under the definitions. According to the court the statute was passed for the purpose of protecting and safeguarding the lives and health of the people and, in harmony with that purpose, the court took the view that absolute liability was cast upon the defendant as the seller of meat infested with trichinae, without regard to knowledge of its presence. Any other rule said the court, would generally leave the injured purchaser, in his effort to place responsibility, without any practical remedy. "This places a heavy burden upon the seller, but he may require a warranty from the person who sells the meat to him and is in a position to know whether the meat has been made safe by refrigeration." The seller also had a measure of protection in the obligation of the purchaser and the consumer not to eat pork in an uncooked state. "One who eats pork with the knowledge or means of knowledge that it has not been properly cooked is guilty of contributory negligence precluding a recovery from the seller of such meat."

In the instant cases the defendant denied that it sold the meat in question and, also, contributory negligence on the part of the plaintiffs became an issue during the trial. In the trial court the judgments were for the defendant, these were affirmed by the court of appeals, and the judgments of the latter court were affirmed by the supreme court.

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