What Are the Essentials of Typhoid Fever Control Today?*

GEORGE H. RAMSEY, M.D., DR.P.H., F.A.P.H.A
Director, Division of Communicable Diseases, State Department of Health, Albany, N. Y.

THE question "What are the essentials of typhoid fever control today?" carries with it the implication that these essentials are no longer the same as formerly. Although our fundamental conceptions as to the cause and mode of transmission of typhoid fever remain the same, the problem of control is materially different from that of a generation or even a decade ago because of the changes which have taken place in the prevalence of the disease. Since these changes have a direct relationship to prevention, they will be discussed briefly before reviewing the present status of typhoid control.

TYPHOID PREVALENCE

The trend of typhoid mortality during the past 20 years in 11 states, 6 of them in the northern, and 5 in the southern part of the country, is shown in Table I and in the accompanying graph. The northern states are Connecticut, New Hampshire, Maine, Michigan, Minnesota, and Wisconsin, and the southern states include Kentucky, Maryland, North Carolina, Tennessee, and Virginia.* Populations and deaths for places of less than 10,000 population in North Carolina in 1913, and for the State of Tennessee from 1913 to 1916 inclusive, are not included because data for these areas in the years specified are lacking.

The typhoid death rate in the 11 states fell from 21.9 in 1913, to 4.2 in 1932, a decline of 81 per cent. Similar decreases have been observed throughout the United States and Canada (Howard 1932, *Mon. Epi. Rept. League of Nations, 1933*), and although the term "residual typhoid fever" was in common use 20 years ago, there is little indication that death rates in most states and provinces have ceased to decline or have yet approached stationary levels.

That the downward trend of typhoid mortality has been general, and not limited to any one section of the country or population group, is demonstrated by Table II. In this table are given urban and rural typhoid death rates by 5-year periods from 1913 to 1932 inclusive among the white populations of the 5 southern states, and among the total populations of the 6 northern states previously mentioned. Rates among the white populations of southern states are compared with rates among the total populations of northern states because of the low proportion of negroes

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* According to the 1930 Census, the 6 northern states had a combined population of 13,214,903 persons, and the 5 southern states a combined population of 12,454,798 persons. The density of population for northern states was 56 persons per sq. mi. and that for southern states 69 persons per sq. mi. Fifty-nine per cent of the population of northern states, and 34 per cent of the population of southern states lived in places with 2,500 or more inhabitants in 1930.

TABLE I

TYPHOID FEVER DEATH RATES IN 11 STATES, 1913 TO 1932, INCLUSIVE *

Year	Population	Number of deaths	Death rate per 100,000
1913	16,087,910	3,529	21.9
1914	18,510,750	3,706	20.0
1915	18,784,056	3,159	16.8
1916	19,057,362	3,208	16.8
1917	21,629,131	4,008	18.5
1918	21,918,207	3,222	14.7
1919	22,197,286	2,820	12.7
1920	22,513,653	2,192	9.7
1921	22,837,352	2,681	11.7
1922	23,161,049	2,066	8.9
1923	23,484,746	2,019	8.6
1924	23,808,443	1,888	7.9
1925	24,132,142	2,388	9.9
1926	24,455,838	2,019	8.3
1927	24,779,537	1,696	6.8
1928	25,103,233	1,360	5.4
1929	25,426,932	1,170	4.6
1930	25,750,626	1,343	5.2
1931	26,074,322	1,262	4.8
1932	26,398,018	1,115	4.2

* States included: Connecticut, Kentucky, Maine, Maryland, Michigan, Minnesota, New Hampshire, Virginia, Wisconsin 1913–1932; North Carolina 1914–1932; Tennessee 1917–1932.

in the North. The terms " urban " and " rural " are here used as in *U. S. Mortality Statistics* where places with less than 10,000 population are classified as rural.

Table II shows marked decreases in the urban and rural sections of both northern and southern states. These decreases have been more extensive, and the final rates are considerably lower in the North than in the South. However, although lagging behind northern ratios, the rates in southern states are more than two-thirds lower than they were, the white urban rate in the South having declined 77 per cent, and the rural rate 68 per cent during the 20-year period.

Moreover, typhoid fever mortality has decreased to a remarkable extent even in the smallest and most scattered population groups. Thus, the mean annual typhoid death rate (based on deaths allocated to place of residence) for New York State unincorporated territory from 1913 to 1917 inclusive was 8.0, and the corresponding rate for the same population group from 1928 to 1932 inclusive was 1.5 per 100,000. This decline of 81 per cent is noteworthy since it occurred for the most part in strictly rural districts without public water supplies, and in New York, a state where only a negligible proportion of the population have received typhoid vaccine.

According to a compilation of communicable disease cases made by the U. S. Public Health Service for the White House Conference (1931), the trend of typhoid morbidity has been the same as that of mortality. Taking both morbidity and mortality data into consideration, it appears that, by and large, typhoid fever has decreased in prevalence more than any other common

acute communicable disease with the possible exception of diphtheria. The extent and continuance of this decline have been stressed for two reasons, one of which is to point out that due caution must be exercised in evaluating the results of preventive measures by means of reductions in morbidity and mortality rates. Typhoid case and death rates are falling so rapidly that reductions in a given area cannot be interpreted as directly resulting from any single preventive measure, unless they are significantly greater than those in similar localities where the same measure has not been employed.

A more important reason for emphasizing changes in typhoid prevalence is to make it clear that control of the disease is no longer the object to be attained. Provided decreases can be made to continue at their present satisfactory rate, the complete eradication of typhoid fever is an actual possibility, and is the goal toward which future preventive efforts should be directed.

ENVIRONMENTAL PREVENTIVE MEASURES

That our present favorable typhoid situation has been arrived at largely because improvements in water, and milk supplies, sewage disposal facilities, and other environmental conditions is seldom, if ever, seriously questioned. Certain recent studies afford confirmatory evidence of the association between environmental factors and typhoid prevalence, and serve to demonstrate that the possibilities for further reductions by means of sanitary improvements have not yet been exhausted.

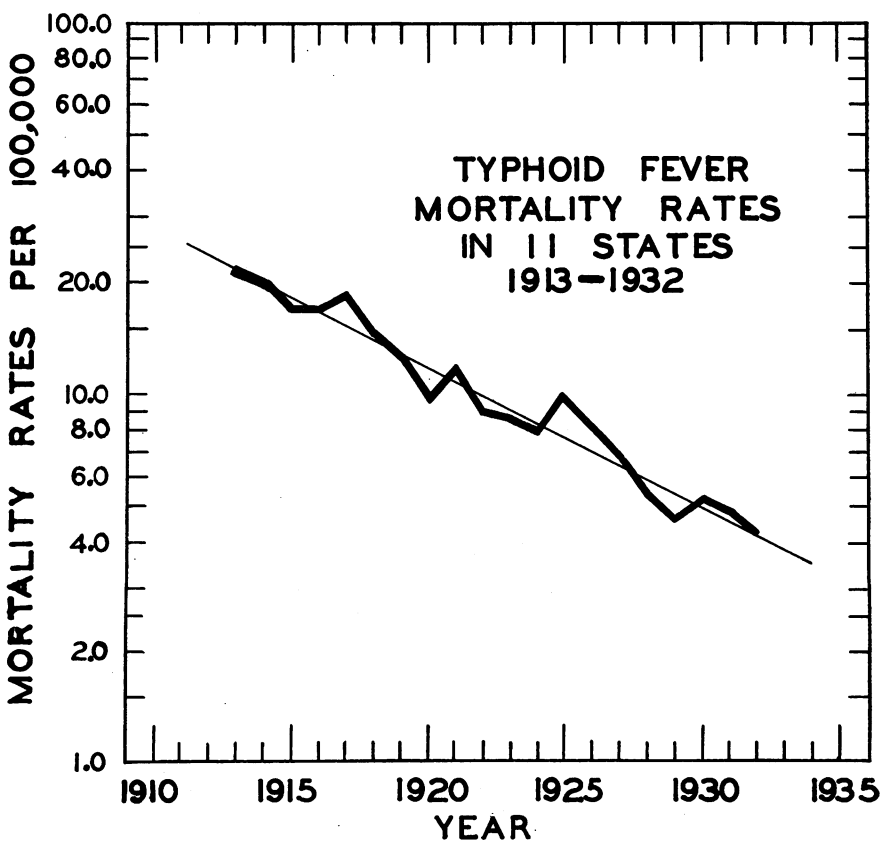

TABLE II

MEAN ANNUAL URBAN AND RURAL TYPHOID FEVER DEATH RATES PER 100,000 IN 6 NORTHERN STATES, AND AMONG THE WHITE POPULATIONS OF 5 SOUTHERN STATES, BY 5-YEAR PERIODS, 1913–1932 INCLUSIVE *

DEATH RATES PER 100,000

Period	Urban		Rural	
	Southern white	Northern	Southern white	Northern
1913—1917	20.8	12.8	27.8	7.5
1918—1922	10.6	5.7	17.6	4.4
1923—1927	6.8	3.0	14.0	2.2
1928—1932	4.7	1.2	8.8	1.3
Per cent decrease	77	91	68	83

* Data 1913–1929 inclusive from U.S. Mortality Statistics
Data 1930–1932 obtained from States by correspondence

Veldee (1931) found that in 6 Ohio river cities typhoid death rates were somewhat reduced by changes from raw water to partially treated supplies, but were not brought down to rates comparable with those in a control group of cities until the water supplies received entirely adequate treatment. It is probable that reductions of the same sort have followed successive water supply improvements in cities generally, these reductions being less striking than those in earlier years, and therefore less commented upon. A large number of New York State water supplies have been improved during the past two decades, particularly in villages and cities of from 2,500 to 25,000 population, the majority of larger cities having had good or fairly good supplies prior to 1913. From 1913 to 1922 inclusive, 24 water-borne epidemics are known to have occurred in the 138 places belonging to the 2,500 to 25,000 population group, whereas during the period 1923 to 1932 inclusive, there were only 6 water-borne outbreaks in places of the same size, no such outbreaks having occurred since 1928. In 1,301 communities with less than 2,500 inhabitants, and with proportionately fewer water supply improvements, there were 14 water-borne outbreaks from 1913 to 1922, and 10 water-borne outbreaks from 1923 to 1932 inclusive.

Doull, Morales, and Haygood (1928) found that in Knoxville, Tenn., typhoid fever was most prevalent among persons who, though living inside the city limits, used privies or outdoor flush closets, and drank water from wells and springs. It is believed that if this survey were repeated in other cities with high typhoid death rates, similar results would be obtained, and that in spite of accessible city water supplies and sewerage systems, large numbers of people drinking spring or well water and using privies would be found.

After an intensive study of recent epidemics, Wolman (1931) gave warning that water-borne typhoid fever is still a menace, and emphasized the necessity for continued efforts to improve the

quality and supervision of water supplies. The same statement should be made with respect to milk supplies, sewage disposal facilities, and other environmental conditions. Environmental preventive measures are still major essentials of typhoid control, and it is certain that these measures have not yet been used to the fullest possible extent, especially in areas where the prevalence of the disease remains strikingly high.

TYPHOID CARRIERS

With the gradual elimination of opportunities for the wide dissemination of the disease by means of polluted water and milk supplies, and other defective environmental factors, typhoid carriers have come into greater and greater prominence, and as sources of infection now occupy, or should occupy, an important place in control programs. The vast majority of carriers are discovered either during investigations of typhoid cases and outbreaks, or as the result of requiring release specimens of feces from convalescent patients.

As regards the discovery of carriers by means of epidemiological investigation, it is clear that success depends upon careful, intelligent case study by qualified personnel. Unfortunately, the ideal of tracing the majority of sporadic cases, and small endemic typhoid foci to carrier infection is scarcely ever realized even in states with the fewest cases and best investigative facilities. Reasons for failure include superficial inquiry as to the circumstances surrounding the case, lack of sufficient numbers of fecal specimens from contacts and suspected carriers, and in some instances poor laboratory examination of the specimens obtained.

As would be expected, more carriers have been discovered in New York State by means of epidemiological investigation in small communities than in large cities. Two-thirds, or 194 of the 288 carriers so discovered in the state, outside of New York City and state institutions, up to the end of 1932 were found in villages of less than 2,500 population or in unincorporated territory.

Excluding all those in known epidemics, 1,354 typhoid cases were reported in New York State places with more than 2,500 population outside of New York City and state institutions from 1928 to 1932, inclusive. During the same period, 1,325 non-epidemic cases were reported in places of less than 2,500 population and unincorporated territory. Thirty-five carriers were discovered from 1928 to 1932 inclusive, in the investigation of non-epidemic cases in places of more than 2,500 population, and 65 carriers were discovered in places of less than 2,500 population and unincorporated territory by means of the investigation of cases not occurring in outbreaks. Thus, a carrier was discovered for every 20 sporadic cases in places of less than 2,500 population and unincorporated territory, whereas the ratio of non-epidemic cases to carriers epidemiologically discovered in places with more than 2,500 population was 39 to 1.

Since this control measure has been used in New York State, 88 typhoid carriers have been added to the register as a result of making the release of convalescent patients conditional upon the submission of negative fecal specimens. Records have been kept since January 1, 1930, showing the number of fecal specimens obtained from each case, and the results of each examination. Between January 1, 1930, and September 1, 1932, complete records for 1,599 cases were obtained. Of this group of patients, 191 died, and 43 absconded or left the state. Two or more fecal specimens were obtained at intervals of at least 5 days and 3 weeks or more after date of onset from all but 47 of the remaining patients. Thirty-three,

or 2.5 per cent, of these 1,318 individuals remained positive for typhoid bacilli and have been, or will be declared carriers, this proportion being almost identical with that for Massachusetts reported by Bigelow and Anderson (1933).

Methods for supervising typhoid carriers, and the results of gall bladder operations for their cure have recently been described by Senftner and Coughlin (1933), and Bigelow and Anderson (1933). A few states and cities already have well developed facilities for handling the typhoid carrier problem; but looking toward the eradication of the disease there is great need for the extension of this service in all parts of the country. Granting that the administrative machinery for these purposes is of necessity cumbersome, the discovery and supervision of carriers are essential preventive measures, not to be neglected because of the difficulties incident to carrying them out.

INDIVIDUAL CASES AND CONTACTS

At the present time, some communities go through an entire year without a single typhoid case and, excluding epidemics, there are few cities and counties in which more than 75 or 100 cases are reported annually. Typhoid fever now belongs to the group of uncommon diseases, demanding confirmation of diagnosis, and active health department participation in the management of each individual case.

The dearth of typhoid cases in teaching hospitals has been mentioned on various occasions, and since clinicians in practice see cases rather seldom, other febrile conditions, notably tuberculosis and undulant fever, are not infrequently erroneously diagnosed typhoid fever. Of the 3,561 typhoid and paratyphoid cases reported in New York State, outside of New York City, from 1928 to 1932 inclusive, 114 were later removed from the register because of wrong diagnosis. This number takes into account only cases in which the clinician went so far as to commit himself definitely to the local health officer, there having been an unknown but probably considerable number of instances where the diagnosis was changed before a report card had been filled out.

The advantages to the typhoid patient of hospital care have long been realized. Certain data are now available suggesting that the hospitalization of cases is also of value as a means for preventing the occurrence of subsequent cases among household contacts.

According to New York State records for the years 1930 to 1932 inclusive, in families where the primary case was hospitalized, 85 subsequent typhoid cases occurred among the 1,221 household contacts who had not been immunized or had typhoid fever previously, the subsequent attack rate being 7.0 per cent. Of 1,035 contacts of similar status with respect to previous attacks and immunization, but who lived where the primary case remained at home, 110, or 10.6 per cent, were attacked. Thus, the incidence of subsequent cases was more than a third lower when the primary case was hospitalized than would have been expected if this patient had remained at home.

Further, considering individual patients and members of the same families, it is possible to show indirectly that the incidence of secondary cases is related to the environmental status of the household. Subsequent attack rates among familial contacts of typhoid patients in places of 10,000 and over, and in places of less than 10,000 population in New York State, exclusive of New York City, are presented in Table III, the incidence of secondary cases being shown for two periods, namely, during the first 14 days after the onset of the primary case, and 15 or more days after this. In the preparation of this table,

all cases and contacts in known epidemics have been omitted; cases and contacts in families where a known carrier existed prior to the date of onset of the initial case have also been omitted; contacts giving histories of typhoid vaccination or previous attacks of typhoid fever have been left out.

The subsequent attack rates in both periods were significantly higher in places with less than 10,000 population, than in places with more than 10,000 inhabitants. Some of the cases during the first 14 days may not have been secondary, but may have arisen from the same source as the primary case. However, few original sources would be expected 15 or more days after the primary case, so that most of the cases in the latter period were probably contracted as the result of familial exposure.

Household contacts in communities of 10,000 or more population were apparently exposed to less risk than contacts in smaller communities. This finding may be interpreted as being due to the fact that houses in places of 10,000 or more population are generally equipped with running water and indoor flush closets, conditions under which the observance of case prophylaxis would be much easier than in homes without such conveniences.

TYPHOID VACCINATION

Of the preventive measures which have been widely used, vaccination remains to be considered. There is no doubt as to the efficacy of this procedure as a method for protecting contacts and individuals apt to be unduly exposed by reason of occupation or travel, and its usefulness as an emergency measure in civil population groups has likewise been proved. For example, Mustard (1930) reported the occurrence in Rutherford Co., Tenn., of 29 secondary typhoid cases among 695 non-immunized household contacts, but observed no secondary cases among 776 household contacts who had been immunized 1 month or more prior to exposure.

Although of demonstrable worth under special and emergency conditions,

TABLE III

SUBSEQUENT ATTACK RATES FROM TYPHOID FEVER AMONG CONTACTS IN FAMILIES WHERE THE PRIMARY CASE REMAINED AT HOME, ACCORDING TO LOCALITY AND DATE OF ONSET OF PRIMARY CASE, NEW YORK STATE, 1930–1932, INCLUSIVE *

Size of Locality	Days after onset of primary case				Subsequent attack rates per cent	
	1–14		15 and over		Days after onset of primary case	
	Number exposed	Number of subsequent cases	Number exposed	Number of subsequent cases	1–14	15 and over
10,000 and over	290	8	282	4	2.8	1.4
Under 10,000 and unincorporated territory	557	41	516	29	7.4	5.6
Total	847	49	798	33	5.8	4.1

* Exclusive of New York City and State Institutions, and exclusive of cases and contacts in known epidemics; contacts with histories of vaccination and previous attacks; cases and contacts in families with known carriers.

there are valid objections to the vaccination of civil population groups as a permanent, or semi-permanent control measure. In the first place, the argument used in advocating smallpox and diphtheria immunization as permanent measures to the effect that infection may be acquired from hidden sources even when there are no known cases in the community does not hold in typhoid fever. Unlike the other two diseases, sources of infection in typhoid fever are more or less stationary in character, and of such a nature they can eventually be eliminated.

The highest typhoid death rate observed during the period 1928 to 1932 inclusive, in any population group in the 11 states previously mentioned, was that for negroes in the rural sections of southern states, among whom deaths occurred at a rate of 13.4 per 100,000. At this expectancy, it would be necessary to immunize 7,400 people to prevent a single death, and about 740 people to prevent a single typhoid case. Taking into consideration the brief duration of the protection conferred by typhoid vaccine, the wisdom of spending time and money on a procedure which gives promise of such meager results may well be questioned.

SUMMARY

Typhoid fever has decreased in prevalence to a remarkable extent in all sections of the country, even during very recent years. Because of the low levels already reached, and since typhoid case and death rates are continuing to fall rapidly, eradication of the disease rather than control is the goal toward which future efforts should be directed.

Examining various preventive measures with the possibility of typhoid eradication in mind, it has been concluded that measures for the improvement of environmental sanitation are of major importance, and that these measures have not yet been used to the fullest possible extent.

Among the preventive measures which have come into greater prominence with the decline of the disease are procedures for the discovery and supervision of typhoid carriers. There is great need throughout all sections of this country and Canada for more intensive case investigation, and for the development of facilities for the supervision of carriers.

Typhoid fever now belongs to the group of rather uncommon diseases in which the diagnosis must be confirmed and the health officer must participate in the management of individual cases. It appears that other members of the household are less apt to contract typhoid fever when the primary case is removed to a hospital, and that when the patient remains at home fewer secondary cases occur in large than in small communities.

Under special and emergency conditions, typhoid vaccination is a useful and necessary procedure, but its employment as a permanent control measure in civil population groups is of doubtful value.

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