Age and Sex as Factors in the Development of the Typhoid Carrier State, and a Method for Estimating Carrier Prevalence*

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AS a result of improvements in environmental sanitation, chronic typhoid carriers have assumed greater relative importance as sources of infection. Changes in typhoid incidence will probably bear a direct relationship to the prevalence of typhoid carriers, so it is of interest to estimate the current and future prevalence of these carriers. Age and sex are believed to be factors of importance in the pathogenesis of the carrier state and will be treated in this paper.

A. CHRONIC CARRIERS

Klinger [1] noted marked differences in the age distribution of what he defined as temporary and chronic carriers. The temporary carriers were predominantly children, the curve of carriers by age paralleling the curve of typhoid cases by age. Chronic carriers were rarely found among children; they were most frequently found among middle-aged adults. Stokes and Clarke,[2] Dean,[3] Lentz,[4] and Ledingham and Arkwright [5] also pointed out the marked preponderance of adults, particularly adult females, among chronic carriers. Möller [6] studied 64 chronic carriers among 7,125 recovered cases, noting that 45 were adult females, 16 were adult males, and only 3 were children. The rate of development of the carrier state in the childhood group was 0.1 per cent as contrasted with 13.5 per cent among adults. Hedrich [7] analyzed the records of approximately 10,000 recovered cases of typhoid fever occurring in New York City between 1916 and 1926. One hundred and seventy-five of these persons had positive stools six months or longer after recovery. The observed rate of development of the carrier state among females was more than twice that among males. Moreover, the probability of developing the carrier state increased sharply with age, being about ten times as high at age 50 as at age 20.

On the other hand, Havens and Dehler [8] attempted to determine whether typhoid carrier genesis varied with age or sex and decided that there were no differences. Similarly, Bigelow and Anderson,[9] as a result of their studies in Massachusetts, concluded that sex differences disappeared when they

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considered only carriers who were derived from convalescent cases.

The records of the New York State Department of Health cover a little more than 10 years' experience relative to fecal release specimens from typhoid fever convalescents. Prior to 1929 release specimens were not required except from individuals regularly engaged in food handling occupations. The Sanitary Code was then amended, effective November 1, 1929, requiring that convalescent typhoid patients submit at least two successive negative specimens of feces before being released from supervision. The specimens must be passed not less than 3 weeks from the date of onset and at an interval of not less than 5 days. Cases among persons regularly engaged in food handling occupations are not released until they submit four successive negative specimens of feces, passed in the manner described. The Code defines a chronic fecal typhoid carrier as one whose feces contain typhoid bacilli, but who does not give a history of typhoid fever within the preceding year. By authority of these two regulations, then, fecal specimens are obtained from all individuals with typhoid fever until the requirements for release are met or until it is determined that the chronic carrier state exists.

Between January 1, 1930, and December 31, 1939, there were 3,750 cases and 433 deaths from typhoid fever reported in New York State, exclusive of New York City and state institutions. This represents a case fatality rate of 11.5 per cent, which indicates that reporting was quite complete. With the exception of 620 cases, all were followed for a sufficient length of time to determine their status according to the foregoing definitions. There were 25 who did not submit a sufficient number of specimens for release because they were not effectively followed up; 142 others who absconded or left New York State before submitting proper release specimens; and 453 who died in the attack of typhoid fever or within 1 year of the illness.

It is generally stated that 2 to 4 per cent of typhoid cases become chronic carriers. Among the 3,130 cases comprising this series, 90, or 2.9 per cent, became chronic carriers.

The rôle played by age in the development of the carrier state is shown in Table 1. Although almost half (48.9 per cent) of the typhoid cases were under 20 years of age, only 5.5 per cent of the carriers resulted from these particular cases. It appears that the probability of becoming a carrier is negligible (0.3 per cent) if typhoid is

TABLE 1

Typhoid Cases and Resulting Chronic Carriers by Age*

New York State, Exclusive of New York City and State Institutions

1930–1939

Age at Time of Typhoid	*Number*		*Per cent of Total*		*Per cent Cases Resulting in Carriers*
	Cases	*Carriers*	*Cases*	*Carriers*	
Under 10	628	2	20.1	2.2	0.3
10–19	902	3	28.8	3.3	0.3
20–29	579	12	18.5	13.3	2.1
30–39	409	18	13.1	20.0	4.4
40–49	295	26	9.4	28.9	8.8
50–59	188	19	6.0	21.1	10.1
60 and over	129	10	4.1	11.1	7.8
All ages	3,130	90	100.0	100.0	2.9

* Includes only those typhoid cases from whom a sufficient number of fecal specimens were obtained to determine carrier status.

contracted while one is less than 20 years of age. This probability increases with advancing age, reaching a maximum of 10.1 per cent among cases in the 50–59 age group.

From Table 2 it will be noted that females make up only 44.3 per cent of the cases, but comprise 58.9 per cent of the carriers. The rate of development of the carrier state at all ages is almost twice as high for females as for males. The most striking sex difference in the age-specific carrier rates occurs in the 40–49 age group in which 16.4 per cent of the female cases and only 3.5 per cent of the male cases resulted in the chronic carrier state.

disease. Cases were entered into the table as of the week in which their first fecal specimen was submitted for examination.

Certain assumptions were necessary because specimens were not submitted from all patients every week. When typhoid bacilli were found in two successive specimens submitted with more than 1 week interval, it was assumed that intervening specimens would also have been positive. Likewise, while realizing the possibility of intermittency of the carrier state, two negative specimens were considered to represent the state of affairs for all weeks between the two negative examinations. When a positive

TABLE 2

Typhoid Cases and Resulting Chronic Carriers by Age and Sex*

New York State, Exclusive of New York City and State Institutions

1930–1939

Age at Time of Typhoid	Number				Per cent of Total				Per cent Cases Resulting in Carriers	
	Cases		Carriers		Cases		Carriers			
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Under 10	347	281	2	..	11.1	9.0	2.2	...	0.6	...
10–19	491	411	2	1	15.7	13.1	2.2	1.1	0.4	0.2
20–29	341	238	7	5	10.9	7.6	7.8	5.6	2.1	2.1
30–39	216	193	6	12	6.9	6.2	6.7	13.3	2.8	6.2
40–49	173	122	6	20	5.5	3.9	6.7	22.2	3.5	16.4
50–59	110	78	10	9	3.5	2.5	11.1	10.0	9.1	11.5
60 and over	65	64	4	6	2.1	2.0	4.4	6.7	6.2	9.4
All ages	1,743	1,387	37	53	55.7	44.3	41.1	58.9	2.1	3.8
Total	3,130		90		100.0		100.0		2.9	

* Includes only those typhoid cases from whom a sufficient number of fecal specimens were obtained to determine carrier status.

B. CONVALESCENT CARRIERS

When these marked age and sex differences among chronic carriers were noted, it was considered desirable to study the relation of these two factors to the average frequency with which typhoid bacilli could be isolated from the feces of convalescent patients. Few such studies are reported in the literature.[3, 9–12] The results of stool cultures for 374 cases reported during 1938 and 1939 were tabulated by sex, broad age groups, and by week after onset of the

was followed a few weeks later by a negative, with no intervening examination, it was assumed that the feces were positive for the first half of the interval and negative for the latter half. The reverse assumption was made when a negative was followed by a positive. No such assumptions were necessary, however, during the first 4 weeks following onset, and in this period the trend of the curve is definitely established.

As seen in Table 3, approximately 61 per cent of the specimens submitted

TABLE 3

Percentage of Typhoid Fever Cases Discharging Typhoid Bacilli in Their Feces by Age and Week After Onset, Based upon 374 Typhoid Cases Reported During 1938–1939 New York State, Exclusive of New York City

Weeks from Onset to Examination	Under 30 Years			30 Years and Over			All Ages		
	Number Cases	Number Positive	Per cent Positive	Number Cases	Number Positive	Per cent Positive	Number Cases	Number Positive	Per cent Positive
Less than 1	40	24	60.0	24	15	62.5	64	39	60.9
1	108	71	65.7	46	35	76.1	154	106	68.8
2	125	80	64.0	64	42	65.6	189	122	64.6
3	159	73	45.9	78	41	52.6	237	114	48.1
4	193	48	24.9	88	38	43.2	281	86	30.6
5	211	34	16.1	105	33	31.4	316	67	21.2
6	222	19	8.6	109	27	24.8	331	46	13.9
7	232	14	6.0	116	25	21.6	348	39	11.2
8	236	12	5.1	119	23	19.3	355	35	9.9
9	237	5	2.1	121	21	17.4	358	26	7.3
10	239	8	3.3	124	19	15.3	363	27	7.4
11	239	4	1.7	127	15	11.8	366	19	5.2
12	243	3	1.2	129	13	10.1	372	16	4.3
13	244	3	1.2	129	13	10.1	373	16	4.3
14	244	3	1.2	130	11	8.5	374	14	3.7
15	244	3	1.2	130	12	9.2	374	15	4.0
16	244	2	0.8	130	11	8.5	374	13	3.5
17	244	2	0.8	130	12	9.2	374	14	3.7
18	244	2	0.8	129	10	7.8	373	12	3.2
19 and over	244	2	0.8	130	10 *	7.7 †	374	12 *	3.2 †

* One female, over 30 years of age, became negative in the 42nd week.
† Per cent persons over 30 declared chronic carriers was 6.9; and for all ages, the percentage was 2.9.

during the 1st week of illness showed typhoid bacilli, 69 per cent during the 2nd week, and 65 per cent during the 3rd week. From the 3rd week on there was a rapid decline until an almost constant level was reached at the 20th week.

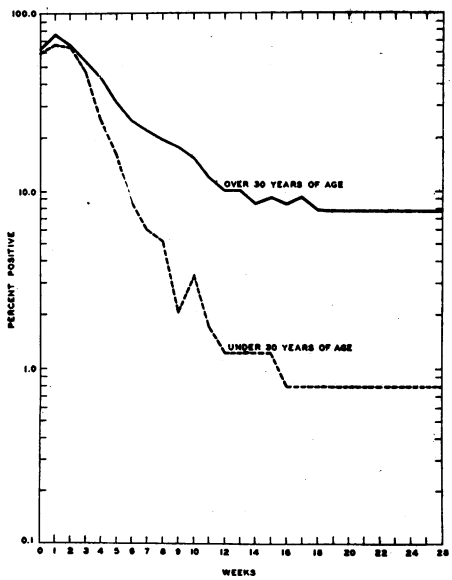

FIGURE 1—Per cent positive fecal specimens by age and week after onset of typhoid fever in New York State exclusive of New York City—374 cases 1938–1939

When the data were analyzed according to sex, differences were observed but they were not statistically significant. The importance of the age factor, however, is striking (Table 3 and Figure 1). At ages 30 and over, 76 per cent of the stools were positive in the 2nd week of the disease, with a decline to 7.7 per cent in the 19th week. At ages under 30 the peak is approximately 66 per cent, also in the 2nd week, followed by a more rapid decline to 0.8 per cent in the 16th week of the disease. Fecal specimens from one female, aged 59, were found to be negative beginning in the 42nd week after the onset of illness.

C. CARRIER PREVALENCE

Estimates of carrier prevalence have recently been made in Massachusetts[13] and Mississippi.[14] In brief, the method employed in Massachusetts was as fol-

lows: The probable number of typhoid cases resulting in recovery was estimated to be equal to nine times the number of reported deaths, and 2 per cent of these survivors were assumed to be chronic carriers; the carrier prevalence in any particular year was represented by those who had become carriers during the preceding 40 years. In Mississippi, the number of persons with a history of having had typhoid fever was determined by means of a field survey of approximately 1 per cent of the population; 3.27 per cent of the persons with a history of typhoid were considered to be chronic carriers. Both methods of estimation admittedly resulted in only rough approximations. The principal deficiency in these methods is that they fail to consider the marked variations in the rates of carrier production among typhoid cases in the several age groups as shown in Table 1. A statistical technic based upon a modified life table procedure is proposed which takes into account the age distribution of carriers resulting from cases, and it may possibly give a more accurate estimate of carrier prevalence than can be obtained with either of the two previously mentioned methods.

In order to apply this method, the following assumptions were made:

1. That a constant relationship has existed during the study period between the number of cases of typhoid fever and the number of deaths from the disease; a case fatality rate of 10 per cent is considered to have been maintained.
2. That the age distribution of recovered typhoid fever cases was the same during past decades as that observed during 1930–1939 (Table 1).
3. That 2.9 per cent of those patients who recover from typhoid fever remain chronic carriers; and that the rate of carrier genesis for each age group was the same in past decades as that observed during 1930–1939. As a corollary of this and the previous assumption, the age distribution of carriers produced in past decades is assumed to be the same as that observed during 1930–1939 (Table 1).
4. That carriers produced during a given decade survive to the beginning of the next decade; and that subsequent to that time they suffer the same age specific mortality risks as the general population.
5. That no carriers have been cured of their carrier condition.

It is believed that errors introduced through these assumptions do not seriously affect the final estimate of carrier

TABLE 4

Number of Typhoid Fever Deaths, Estimated Persons Surviving an Attack of Typhoid Fever and Typhoid Carriers Produced During Each Decade 1860–1939

New York State, Exclusive of New York City

Decade	*Typhoid Deaths*	*Estimated Survivors (col. 2 x 9)*	*Estimated Carriers Produced (col. 3 x 2.9%)*
(1)	(2)	(3)	(4)
1860–69	15,378 *	138,402	4,014
1870–79	13,626 *	122,634	3,556
1880–89	12,288 *	110,592	3,207
1890–99	10,953 *	98,577	2,859
1900–09	9,593	86,337	2,504
1910–19	5,236	47,124	1,367
1920–29	1,713	15,417	447
1930–39	444	3,996	116

* Typhoid deaths for each decade from 1860 to 1899 were estimated on the basis of the following mean annual typhoid death rates:

1860–1869 — 55 per 100,000 population
1870–1879 — 45 per 100,000 population
1880–1889 — 37 per 100,000 population
1890–1899 — 30 per 100,000 population

prevalence in New York State. On the basis of assumptions (2) and (3), the final estimate is believed to be somewhat lowered, whereas assumptions (4) and (5) increase the final estimate.

The number of typhoid fever deaths, the estimate persons recovering from an attack of typhoid fever, and the expected number of carriers produced are shown in Table 4 for each decade since 1860. The first step in the life table procedure was to distribute the carriers according to age group at the time of their attack of typhoid (Table 5). These groups are designated as l_x cohorts.

TABLE 5

Distribution by Age Group of the Estimated Number of Typhoid Carriers Produced During Each Decade (l_x Cohorts)

1860–1939

New York State, Exclusive of New York City

Age Group at Onset of Typhoid Fever	*Per cent Total Carriers*	*Estimated Number Carriers Produced*							
		1860–1869	*1870–1879*	*1880–1889*	*1890–1899*	*1900–1909*	*1910–1919*	*1920–1929*	*1930–1939*
Under 10	2.2	88	78	71	63	56	30	10	3
10–19	3.3	134	118	107	95	83	46	15	4
20–29	13.3	535	474	427	381	234	182	60	15
30–39	20.0	803	711	641	572	501	273	89	23
40–49	28.9	1,160	1,028	927	826	723	395	129	34
50–59	21.1	847	751	677	604	529	289	94	24
60–69	10.0	402	356	321	286	250	137	45	12
70–79	1.1	45	40	36	32	28	15	5	1
All ages	100.0	4,014	3,556	3,207	2,859	2,504	1,367	447	116

If we arbitrarily limit our problem to the determination of the prevalence of carriers under 80 years of age as of January 1, 1940, it becomes unnecessary to follow the life table survivorship of every carrier produced in the past. Hence, of the 4,014 carriers comprising the l_x cohort of 1860–1869, only those carriers who were under 10 years of age on January 1, 1870, are pertinent to our problem since the other carriers from this cohort would necessarily be over 80 years of age on January 1, 1940. If we assume that the carriers in this cohort under 10 years of age were uniformly distributed within the age group and assume that all 88 carriers comprising this sub-cohort survived to January 1, 1870, half of them, or 44 carriers, would still have been under 10 years of age on that date, and 44 carriers would have become 10–19 years of age (Table 6, column L_x for 1870). The latter group of 44 carriers would be over 80 years of age on January 1, 1940, and need not be considered in our further calculations. To determine how many of the 44 carriers under 10 years of age would live to enter the 10–19 age group on January 1, 1880, this number is multiplied by the estimated life table survivorship rate of 0.963.* Thus, it was calculated that 42 of the 44 carriers would have survived (Table 6, column C_x for 1880). The next step was to obtain the L_x cohort as of January 1, 1880. Inasmuch as carriers in this cohort who were over 20 years of age would be over 80 years of age on Janu-

* Life table survivorship rates by age group for 1910–1919, 1920–1929, and 1930–1939 were calculated from abridged life tables for New York State, exclusive of New York City. The life tables were constructed in accordance with the procedure proposed by Reed and Merrill.[15] The survivorship rates obtained for 1910–1919 were used for the decades prior to 1910.

TABLE 6

Computation by a Modified Life Table Procedure of the Probable Number of Typhoid Carriers by Age Group (L_x Cohorts) as of January 1 of Each Decade, 1870–1900

New York State, Exclusive of New York City

Age Group (x)	$l_{\bar{x}}$ (1860–1869)	L_x (1870)	$_{10}p_x$ † (1870–1879)	C_x (1880)	$l_{\bar{x}}$ (1870–1879)	L_x (1880)	$_{10}p_x$ † (1880–1889)
Under 10	88	44	0.963	..	78	39	0.963
10–19	*	(44)*		42	118	140	0.957
20–29	*	*		*	*	(59)*	
30–39	*	*		*	*	*	
40–49	*	*		*	*	*	
50–59	*	*		*	*	*	
60–69	*	*		*	*	*	
70–79	*	*		*	*	*	
Total	88	88		42	196	238	
All ages	4,014				3,556		

Age Group (x)	C_x (1890)	$l_{\bar{x}}$ (1880–1889)	L_x (1890)	$_{10}p_x$ † (1890–1899)	C_x (1900)	$l_{\bar{x}}$ (1890–1899)	L_x (1900)
Under 10	..	71	35	0.963	..	63	31
10–19	38	107	127	0.957	34	95	113
20–29	134	427	401	0.937	122	381	360
30–39	*	*	(214)*		376	572	853
40–49	*	*	*		*	*	(286)*
50–59	*	*	*		*	*	*
60–69	*	*	*		*	*	*
70–79	*	*	*		*	*	*
Total	172	605	777		532	1,111	1,643
All ages		3,207				2,859	

* Carriers are not included who would be over 80 years of age as of January 1, 1940.

† Values of $_{10}p_x$ are assumed to be the same as those calculated for the decade 1910–1919.

$l_{\bar{x}}$ represents a cohort of typhoid carriers produced during a decade according to age groups x at the time of their attack of typhoid.

L_x represents a cohort of typhoid carriers according to age groups x as of January 1 of a given year.

$_{10}p_x$ designates the probability of persons in the general population at age group x surviving to age group x + 10.

C_x represents a cohort of typhoid carriers, according to age groups x as of January 1 of a given year, who are the survivors from a preceding L_x cohort.

ary 1, 1940, only the carriers in the two sub-groups under 20 years of age are of interest. These groups were constituted as follows: the 39 carriers comprising the L_x sub-cohort under 10 years of age were derived from half the 78 carriers under 10 years of age produced between 1870 and 1879; the 140 carriers comprising the L_x sub-cohort 10–19 years of age were obtained by the addition of three groups of carriers: 39 were the other half of the 78 carriers under 10 years of age produced between 1870 and 1879; 59 were half of the 118 carriers 10–19 years of age produced between 1870–1879; and 42 were the aforementioned survivors 10–19 years of age.

The procedure described above was continued for successive decades until the L_x cohort for January 1, 1940, was obtained; the detailed computations are shown in Tables 6 and 6-A. Thus, it was estimated that 2,490 typhoid carriers under 80 years of age were living in New York State, exclusive of New York City, on January 1, 1940. The carrier prevalence rate is calculated to be 42 carriers for each 100,000 persons under 80 years of age. While no strict comparisons are justified, it is interesting to note that the carrier prevalence

TABLE 6-A

Computation by a Modified Life Table Procedure of the Probable Number of Typhoid Carriers by Age Group (L_x Cohorts) as of January 1 of Each Decade, 1900–1940

New York State, Exclusive of New York City

Age Group (x)	L_x (1900)	$_{10}p_x$ † (1900–1909)	C_x (1910)	$l_{\bar{x}}$ (1900–1909)	L_x (1910)	$_{10}p_x$ † (1910–1919)	C_x (1920)	$l_{\bar{x}}$ (1910–1919)
Under 10	31	0.963	..	56	28	0.963	..	30
10–19	113	0.957	30	83	99	0.957	27	46
20–29	360	0.937	108	234	267	0.933	95	182
30–39	853	0.920	337	501	704	0.920	249	273
40–49	(286)*		785	723	1,397	0.877	648	395
50–59	*		*	*	(362)*		1,225	289
60–69	*		*	*	*		*	*
70–79	*		*	*	*		*	*
80 and over	*		*	*	*		*	*
Total	1,643		1,260	1,597	2,857		2,244	1,215
All ages				2,504				1,367

Age Group (x)	L_x (1920)	$_{10}p_x$ † (1920–1929)	C_x (1930)	$l_{\bar{x}}$ (1920–1929)	L_x (1930)	$_{10}p_x$ † (1930–1939)	C_x (1940)	$l_{\bar{x}}$ (1930–1939)	L_x (1940)
Under 10	15	0.973	..	10	5	0.984	..	3	1
10–19	65	0.964	15	15	27	0.979	5	4	9
20–29	209	0.947	63	60	101	0.969	26	15	35
30–39	476	0.930	198	89	272	0.948	98	23	117
40–49	982	0.883	443	129	552	0.893	258	34	287
50–59	1,567	0.774	867	94	979	0.780	493	24	522
60–69	(145)*		1,213	45	1,282	0.570	764	12	782
70–79	*		*	*	(23)*		731	1	737
80 and over	*		*	*	*		*	*	(1)*
Total	3,459		2,799	442	3,241		2,375	116	2,491
All ages				447				116	

* Carriers are not included who would be over 80 years of age as of January 1, 1940.
† Values of $_{10}p_x$ for the decade, 1900–1909, are assumed to be the same as those calculated for 1910–1919. For explanation of symbols, see footnote of Table 6.

rates for Massachusetts and Mississippi in 1935 were estimated to be 48 and 288 per 100,000 population, respectively.

At this point, it should be recalled that one of the basic assumptions made in calculating the New York State carrier prevalence was that 2.9 per cent of patients who recover from typhoid fever remain chronic carriers. It is realized that the true rate of carrier genesis may be higher than 2.9 per cent. The estimate may therefore be considered to be a minimum.

In Table 7 the estimated carriers are shown distributed according to age group and are related to the estimated population and to the number of carriers under supervision as of January 1, 1940. The age-specific carrier prevalence rates are observed to increase with advancing age group. The rate among children under 10 years of age was less than 1 per 100,000, whereas the rate among persons 70–79 years of age was 340 per 100,000. Of the 2,490 estimated carriers 419,* or 17 per cent, were under supervision. This percentage is shown to vary considerably with age. While only 14 per cent of the carriers over 50 years of age were known to the health authorities, the proportion of carriers under 50 years of age who were under supervision averaged 28 per cent.

Further examination of the age dis-

* Nineteen carriers under supervision are excluded who were over 80 years of age on January 1, 1940.

TABLE 7

Estimated Prevalence of Typhoid Carriers and Known Typhoid Carriers Under Supervision According to Certain Age Groups as of January 1, 1940

New York State, Exclusive of New York City

Age Group	Census Population as of April 1, 1940	Estimated Number of Carriers	Carrier Prevalence Rate per 100,000	Number of Carriers under Supervision	Per cent of Estimated Carriers under Supervision
Under 10	826,514	1	0.1	1	100.0
10–19	1,002,712	9	0.9	4	44.4
20–29	992,718	35	3.5	8	22.9
30–39	918,260	117	12.7	28	23.9
40–49	861,065	287	33.3	84	29.3
50–59	678,305	522	77.0	95	18.2
60–69	455,795	782	171.6	119	15.2
70–79	216,584	737	340.3	80	10.9
Total	5,951,953	2,490	41.8	419	16.8

TABLE 8

Computation by a Modified Life Table Procedure of the Probable Number of Typhoid Carriers by Age Group (L_x Cohorts) as of January 1 of Each Decade, 1900–1980

New York State, Exclusive of New York City

Age Group (x)	L_x (1940)	${}_{10}p_x$ † (1940–1949)	C_x (1950)	$l_{\bar{x}}$ (1940–1949)	L_x (1950)	${}_{10}p_x$ † (1950–1959)	C_x (1960)	$l_{\bar{x}}$ (1950–1959)
Under 10	1	0.989	..	2	1	0.989	..	1
10–19	9	0.986	1	3	3	0.986	1	2
20–29	35	0.979	9	11	16	0.979	3	8
30–39	117	0.958	34	16	48	0.958	16	11
40–49	287	0.903	112	23	131	0.903	46	16
50–59	522	0.789	259	17	279	0.789	118	12
60–69	782	0.575	412	8	425	0.575	220	6
70–79	737		450	1	454		244	1
80 and over	*		*		(1)*		*	
Total	2,490		1,277	81	1,358		648	57

Age Group (x)	L_x (1960)	${}_{10}p_x$ † (1960–1969)	C_x (1970)	$l_{\bar{x}}$ (1960–1969)	L_x (1970)	${}_{10}p_x$ † (1970–1979)	C_x (1980)	$l_{\bar{x}}$ (1970–1979)	L_x (1980)
Under 10	..	0.989	..	1	..	0.989	..	1	..
10–19	3	0.986	..	1	1	0.986	..	1	1
20–29	8	0.979	3	5	6	0.979	1	4	4
30–39	25	0.958	8	8	15	0.958	6	5	10
40–49	60	0.903	24	12	34	0.903	14	8	21
50–59	132	0.789	54	8	64	0.789	31	6	38
60–69	229	0.575	104	4	110	0.575	50	3	54
70–79	247		132	1	134		63	..	65
80 and over	(1)*		*		(1)*		*		
Total	705		325	40	365		165	28	193

* Carriers are not included who would be over 80 years of age.
† Values of ${}_{10}p_x$ are assumed to be the same as those calculated for 1940.
For explanation of symbols, see footnote of Table 6.

tribution of the estimated carriers shows that 61 per cent were between 60 and 80 years of age. In view of their advanced age, a large number of these carriers may be expected to die annually. Using the proposed life table procedure, the future prevalence of carriers was calculated to January 1, 1980

(Table 8).* Thus, it is estimated that in that year the number of carriers under 80 years of age will have decreased from 2,490 to 193.

CONCLUSIONS

1. The data presented indicate that age and sex are of importance in the development of the typhoid carrier state.

2. Typhoid patients over 30 years of age became chronic carriers nine times as frequently as did younger patients.

3. The rate of development of the carrier state at all ages was 2.1 per cent among male cases, as compared with 3.8 per cent among female cases.

4. Approximately 16 per cent of the females who developed typhoid between ages 40 and 49 became chronic carriers.

5. The rate of bacteriological cure varied inversely with age.

6. A modified life table method was applied to the typhoid experience of New York State, exclusive of New York City, and resulted in an estimated carrier prevalence on January 1, 1940, of approximately 2,500 carriers under 80 years of age, or 42 carriers per 100,000 population.

7. It is highly probable that there will be a rapid decline in carrier prevalence. In 40 years it is estimated that the carrier prevalence will decrease to about 200.

8. Four hundred and nineteen, or 17 per cent, of the estimated carriers in the state were under supervision on January 1, 1940.

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* The number of carriers produced annually between 1940 and 1949 was estimated as equal to the mean number produced between 1935 and 1939. The estimated number of carriers produced in each subsequent decade was obtained by assuming that the rate of decrease between 1930–1939 and 1940–1949 continued.

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