

Apparent Decline in Tuberculous Infection Among Household Associates of Sputum-Positive Cases of Tuberculosis

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THERE is evidence that the proportion of the general population with tuberculous infection, as well as tuberculous disease, is now much lower than it was at one time. There is also considerable evidence that the attack rates from tuberculous disease vary among household associates of cases of tuberculosis, depending on several characteristics of the index cases.¹ There is less evidence that tuberculous infection among household associates of known cases of tuberculosis is rarer now than in past years. The purpose of this paper is to present such evidence, and to describe certain changes among index cases which are associated with this apparent drop in tuberculous infection. The tuberculosis control program conducted for many years in Cattaraugus County, New York, and the records of case and contact supervision lend themselves to analyses having a bearing on this problem.

This tuberculosis control program was extensively reorganized in 1928 by Dr. John H. Korns. The reorganization brought into operation the essential features of a modern control program,

even by today's standards. The record-keeping system established at that time has been maintained without significant change. In routine annual tabulations of these records, Korns² noted a drop in the proportion of positive tuberculin tests among contacts of sputum-positive cases of tuberculosis within several years of establishment of the reorganized control program.

METHOD OF STUDY

Because of the consistency of the policies, record-keeping, and performance in the program, it was felt that valid comparisons could be drawn between different time periods. Records were considered sufficiently reliable to begin analyses as of January 1, 1929. The analyses continued through 1946, for a period covering 18 years, which resulted in a natural division into three 6 year periods, 1929 through 1934, 1935 through 1940, and 1941 through 1946.

The Bureau of Tuberculosis supervised all household associates of known cases of tuberculosis, but those who had contact with positive sputum were followed most intensively. Among persons aged 0 through 25 it was customary to use 0.1 mg. of old tuberculin intradermally as a routine procedure to detect tuberculous infection. Older persons

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were not routinely tuberculin tested, receiving a medical history, physical examination, and x-ray of the chest. The vast majority of the tuberculin tests were done by the intradermal method. The Vollmer patch test was rarely used prior to 1943, though about half of the tests done between 1941 and 1946 were patch tests.

Because it was felt that the age of the contacts, age, stage of disease and sex of the index cases, and duration of contact were of importance in determining the frequency of tuberculous infection, all of these were considered.

Variable factors were by definition held as constant as possible throughout the time period covered by the study. Only the immediate household associates of sputum-positive cases of tuberculosis were studied. Non-white persons were excluded. Sputum-positivity was defined as a record of any positive sputum, provided the examination was done by direct smear and microscopic examination. The tuberculin tests were read, in most instances, by three individuals—Dr. John H. Korn, Dr. E. K. Richard, and Dr. Richard Nauen, who were, in succession, the directors of the Bureau of Tuberculosis during the time period covered by this study. Those not read by the directors were read by adequately trained public health nurses who were felt by the directors to be entirely capable of interpreting the tests.* The duration of contact was estimated in months. Contact was defined as beginning when the case of tuberculosis was diagnosed, terminating when the case died or was, from some other reason, completely removed from the household. It was considered to be interrupted during those periods of time when the patient was receiving institutional care for his tuberculosis and was, of course,

terminated when the contact was dropped from observation. This definition of beginning of contact is arbitrary, but it is obviously quite difficult to determine accurately the onset of the average case of tuberculosis since it is so gradual in most instances.

DECLINE IN TUBERCULOUS INFECTION;
VARIATION ACCORDING TO CHARACTERISTICS OF INDEX CASES

Table 1 presents the tuberculin status of the observed contacts as their observation was terminated within the three time periods.

TABLE 1
Tuberculin Status of 432 Household Associates of Sputum-Positive Cases of Tuberculosis in Three Time Periods

Date	Number Observed	Tuberculin-Positive	Per cent Positive
1929-34	144	113	78.5
1935-40	170	98	57.7
1941-46	118	60	50.9
Totals	432	271	62.7

It is apparent that, in the 6 year period 1929 through 1934, approximately 78 per cent of the household associates of sputum-positive cases of tuberculosis were infected as indicated by the tuberculin test, but only slightly more than half of the household associates were similarly infected in the 6 year period 1941 through 1946.† The proportion of the general population of similar age in Cattaraugus County having a positive tuberculin test is much lower than the proportion shown in Table 1. There is no evidence of a similar decline in the infection rate in the general population, either on a relative or on an absolute scale, so there is little reason to believe that such a decline

* It should be mentioned that a few persons who developed manifest tuberculous disease while under observation were classified among the tuberculin-positive.

† A slightly younger group was tuberculin tested in the more recent years. This would tend to make the 1941-1946 figure artificially low, but on standardization for age the proportions positive for the three time periods are changed very little, the proportions positive becoming 77.8, 57.7, and 52.8 per cent respectively. Since the observed differences are many times greater than can be accounted for by age alone, age standardization was not done in subsequent tabulations.

plays a considerable part in the change described above among the household associates of sputum-positive cases of tuberculosis. In other words, a drop in the number of sources of tuberculous infection outside of the household is believed to be of little significance in this group.

Tables 2 through 5 indicate the importance of age of index cases, stage of disease, sex of index cases, and duration of exposure of contacts to index cases.

TABLE 2

Tuberculin Status of 432 Household Associates of Sputum-Positive Cases of Tuberculosis According to Age Group of Index Cases

Cases Age Group	Number Observed	Tuberculin-Positive	Per cent Positive
0-24	143	101	70.6
25-54	228	146	64.0
55+	61	24	39.3
Totals	432	271	62.7

TABLE 3

Tuberculin Status of 432 Household Associates of Sputum-Positive Cases of Tuberculosis According to Stage of Disease of Index Cases

Cases Stage	Number Observed	Tuberculin-Positive	Per cent Positive
Minimal	94	49	52.1
Moderately Advanced	189	126	66.7
Far Advanced	149	96	64.4
Totals	432	271	62.7

It will be noted in Table 2 that associates of relatively young (age 0-24) cases of tuberculosis have a rather high ratio of tuberculin positivity, whereas contacts

TABLE 4

Tuberculin Status of 432 Household Associates of Sputum-Positive Tuberculosis According to Sex of Index Cases

Cases Sex	Number Observed	Tuberculin-Positive	Per cent Positive
Male	189	110	58.2
Female	243	161	66.3
Totals	432	271	62.7

TABLE 5

Tuberculin Status of 432 Household Associates of Sputum-Positive Tuberculosis According to Duration of Exposure in Months to Index Cases

Months Exposure	Number Observed	Tuberculin-Positive	Per cent Positive
0-1	217	134	61.8
2-23	125	71	56.8
24+	90	66	73.3
Totals	432	271	62.7

of cases of tuberculosis 55 years of age and over show evidence of infection less frequently. As might be expected, Table 3 shows that the infections of household contacts occurred with less frequency when the index case was in the minimal stage of disease. There appears to be no difference between contacts of moderately and far advanced cases of pulmonary tuberculosis as far as the probability of infection is concerned. Table 4 indicates that women apparently cause infections among their household associates more frequently than do men.

The effect of duration of exposure (Table 5) on the probability of infection is less obvious. The household associates who had exposure to source cases for

TABLE 6

Tuberculin Status of 432 Household Associates of Sputum-Positive Tuberculosis According to Age and Sex of Index Cases

Index Cases Age Group	Index Cases Male			Index Cases Female			Index Cases both Sexes		
	Number Observed	Tuberculin-Positive	Per cent Positive	Number Observed	Tuberculin-Positive	Per cent Positive	Number Observed	Tuberculin-Positive	Per cent Positive
0-24	39	24	61.5	104	77	74.0	143	101	70.6
25-54	113	72	63.7	115	74	64.4	228	146	64.0
55+	37	14	37.8	24	10	41.7	61	24	39.3
Totals	189	110	58.2	243	161	66.2	432	271	62.7

one month or less were found to be approximately 62 per cent tuberculin-positive. When the duration of exposure was 2 to 23 months approximately 57 per cent were positive, and when the duration of exposure was 2 years or more, slightly over 73 per cent were found to be positive. It should be recalled, however, that our arbitrary definition of exposure would tend to distort these figures somewhat. Since exposure was considered to begin at the time of diagnosis, and since, in the early years covered by this study, diagnoses were sometimes made only shortly before death, it is believed that deaths occurring soon after diagnosis contribute to the high proportion of infections in the group that had exposure for one month or less.

Table 6 results from combining the factors of age and sex of index cases. It is of interest that whereas on the average approximately 63 per cent of the contacts of sputum-positive cases of tuberculosis had positive tuberculin tests, 74 per cent of the contacts of women age 0 through 24 had positive tests, but only 38 per cent of the contacts of men aged 55 and over had such positive tuberculin tests.

COMMENT; CHANGES CONTRIBUTING TO DECLINE IN TUBERCULOUS INFECTION

From the data summarized in Tables 2 through 6, it is fairly obvious that differences in age of index case, stage of disease, sex of index case, and duration of exposure to sputum-positive tuberculosis all are associated with differences in the probability of infection among household contacts of such cases.* It is equally obvious that any shift in one or more of these factors will have

an influence on the average probability of infection among the contacts. It is a matter of record that in Cattaraugus County, as well as in other areas,³ a greater proportion of minimal cases has been diagnosed in recent years and their contacts have been placed under observation. Similarly, there has been a shift in the age and sex distribution of the diagnosed and recorded cases of tuberculosis, and deaths from the disease,³⁻⁵ with a greater proportion of elderly men and a smaller proportion of young women being discovered when we compare recent with more remote experience. In addition, considerable effort has been expended, not only to secure earlier diagnosis, but to secure earlier and more prolonged hospitalization, especially for sputum-positive cases of tuberculosis. All of these factors, namely a greater proportion of minimal cases, elderly males, and promptly hospitalized cases may have been of importance in producing the apparent reduction in tuberculous infection in this group. The tables which follow may serve to illustrate the changes in the distribution of the contacts according to these characteristics as they have occurred with the passage of time.

Table 7 in the total columns repeats the point made in Table 2; that contacts of young persons with tuberculosis have a much higher probability of being tuberculin-positive than do contacts of older persons with tuberculosis. It illustrates also that, in our observed group of contacts at least, the probability of being in contact with young cases of tuberculosis was greater a number of years ago than more recently. The inevitable result of this combination of circumstances is a drop in the proportion of tuberculin-positive contacts with the passage of time. Reasoning from these data to the general situation, it appears not unlikely that, as the age distribution of our cases of tuberculosis in the general population has changed,

* If it is considered that the patch tests used to a certain extent in the years 1943-1946 are less sensitive than the intradermal type of test, it could be inferred that a part of the apparent decrease in tuberculin sensitivity may be due to the type of test used. However, it cannot be inferred that the type of test used is responsible for different ratios of tuberculin sensitivity among the various classes of contacts.

TABLE 7

Number, Per cent Distribution and Tuberculin Status of 432 Household Associates of Sputum-Positive Tuberculosis According to Age Group of Index Cases for Three Time Periods

Cases Age Group	1929-34			1935-40			1941-46			Totals		
	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive
0-24	52	36.1	42	57	33.5	38	34	28.8	21	61.8	143	101
25-54	85	59.0	66	91	53.5	49	52	44.1	31	59.6	228	146
55+	7	4.9	5	22	12.9	11	32	27.1	8	25.0	61	24
Totals	144	100.0	113	170	99.9	98	118	100.0	60	50.9	432	271

TABLE 8

Number, Per cent Distribution and Tuberculin Status of 432 Household Associates of Sputum-Positive Tuberculosis According to Stage of Disease of Index Cases for Three Time Periods

Index Cases Stage	1929-34			1935-40			1941-46			Totals		
	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive
Minimal	21	14.6	13	36	21.2	21	37	31.4	15	40.5	94	49
Moderately Advanced	71	49.3	58	76	44.7	41	42	35.6	27	64.3	189	126
Far Advanced	52	36.1	42	58	34.1	36	39	33.0	18	46.2	149	96
Totals	144	100.0	113	170	100.0	98	118	100.0	60	50.9	432	271

TABLE 9
 Number, Per cent Distribution and Tuberculin Status of 432 Household Associates of Sputum-Positive Tuberculosis According to Sex of Index Cases for Three Time Periods

Index Cases Sex	1929-34			1935-40			1941-46			Totals						
	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive				
Male	60	41.7	42	70.0	63	37.1	41	65.1	66	55.9	27	40.9	189	43.8	110	58.2
Female	84	58.3	71	84.5	107	62.9	57	53.3	52	44.1	33	63.5	243	56.2	161	66.3
Totals	144	100.0	113	78.5	170	100.0	98	57.7	118	100.0	60	50.9	432	100.0	271	62.7

TABLE 10
 Number, Per cent Distribution and Tuberculin Status of 432 Household Associates of Sputum-Positive Tuberculosis According to Duration of Exposure in Months to Index Cases, for Three Time Periods

Exposure in Months to Index Cases	1929-34			1935-40			1941-46			Totals						
	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive	Number Observed	Per cent	Tuberculin-Positive				
0-1	74	51.4	57	77.0	83	48.8	48	57.8	60	50.9	29	48.3	217	50.2	134	61.8
1-23	37	25.7	28	75.7	54	31.8	28	51.9	34	28.8	15	44.1	125	28.9	71	56.8
24+	33	22.9	28	84.9	33	19.4	22	66.7	24	20.3	16	66.7	90	20.8	66	73.3
Totals	144	100.0	113	78.5	170	100.0	98	57.7	118	100.0	60	50.9	432	99.9	271	62.7

so has the probability of infection among the contacts of these cases.

The number and proportion of persons under observation exposed to sputum-positive minimal tuberculosis increased between 1929 and 1946. This is shown in Table 8. During the period 1929-1934, 14.6 per cent of the associates were exposed to minimal cases, while in the period 1941-1946 this proportion had increased to 31.4 per cent. The proportion exposed to far advanced tuberculosis remained about constant, the shift being due largely to a reduction in exposure to moderately advanced cases of tuberculosis. The moderately advanced cases, however, were shown in Table 3 and again here, to be at least as potent in producing positive tuberculin among their associates as are the far advanced. Here again we note that an increasing proportion of contacts of minimal tuberculosis cases who have less probability of being tuberculin-positive than do contacts of persons with advanced disease results in an overall decline in the proportion positive to the tuberculin test.

As was shown in Table 6, household associates of women with sputum-positive tuberculosis are more frequently tuberculin-positive than contacts of men. In Table 9 it is shown that with what amounts to a reversal in the proportion of contacts exposed to the two sexes there has, as a natural result, been a drop in the proportion of tuberculin-positive contacts. Thus the change in the sex distribution of tuberculosis cases has played a part in the apparent reduction in tuberculous infection among the observed contacts.

From Table 10 it appears that, in spite of the effort expended in attempts to secure earlier and more prolonged hospitalization of open tuberculosis cases, there has not been a measurable reduction in exposure among their associates who were observed in this study. A consistent upward trend in tuberculin-

positivity with increasing exposure is not demonstrable. This differs from Brailey's⁶ experience in Baltimore. It thus appears that our arbitrary definition of the beginning of exposure as synonymous with the date of diagnosis is not sufficiently critical to detect diagnoses made more promptly after the onset of symptoms. Earlier diagnosis is perhaps better shown in Table 8, where the increase in the proportion of associates exposed to minimal disease is presented. From Table 10 we can conclude only that prolonged exposure, especially if it has continued for 2 years or more, is more hazardous than brief exposure.

SUMMARY AND CONCLUSIONS

A group of 432 household associates of sputum-positive cases of tuberculosis was studied over an 18 year period in Cattaraugus County, New York.

There is evidence that the proportion positive to the tuberculin test has declined from 78.5 to 50.9 per cent.

The proportion of household associates positive to the tuberculin test varies with certain characteristics of the index cases, being higher for associates of women, young persons, cases with advanced disease, and in situations where exposure is prolonged.

The distribution of the household associates of cases of tuberculosis has changed over the 18 year period. With the exception of the "prolonged exposure" group, association with each of the above categories of cases was less frequent in the latter part of the 18 years.

It is suggested that this group of associates of sputum-positive cases is a fairly representative group, and that a general decline in tuberculous infection may have taken place among such associates largely because of changes in the characteristics of the tuberculosis cases themselves.

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A National Recruitment Program for Public Health

Remarkable as have been the accomplishments of preventive medicine and public health in the United States during the past fifty years, tremendous new advances in the preservation of health and life are possible in a short period of time if all present knowledge in the field could be fully utilized. All of us can point to many reasons why progress is not more rapid. But underlying most of these obstacles is a basic difficulty—the shortage of trained personnel.

The qualitative and quantitative shortage in public health personnel of all categories is neither a recent development nor one unique to public health. It is perhaps more acute in public health than in many other scientific disciplines because of the great expansion in demand for public health services in the war and post-war years.

Dean Simmons points out . . . there are now 35,800 individuals engaged in full-time public health work in the United States. An adequate national health program will require about 68,000 health specialists in 1960. Of these, about 20,000, or 2,300 per year, will require formal advanced training. In 1947-48, only 655 students were registered in the nine accredited schools of public health.

Attacks on this fundamental recruitment problem have been sporadic, localized, short-lived, and often unsuccessful. Now, for the first time, a logical solution to this pressing problem has been proposed by the American Public Health Association—a nation-wide project under the auspices of the Association's Committee on Professional Education. The report outlining the project stresses the need for liaison with other national agencies such as the State and Territorial Health Officers Association, the Federal Health Agencies, the American Medical Association, the Association of American Medical Colleges, the Conference of Professors of Preventive Medicine, the Association of Schools of Public Health, the National Health Council, and social scientists

of all types with "know-how" and experience in recruitment.

The American Public Health Association has formulated and put into action many far-reaching programs reflecting the wisdom of its leadership and the "public-good-first" attitude of its broad and varied membership. We believe no past project, however essential, has been so basic and necessary to future progress in public health as this proposed recruitment program.

The recruitment project, recently submitted to the State and Territorial Health Officers, points out that "it is recognized that this is indeed a difficult problem and that the suggested remedies are many and diverse. . . . In this instance there may be basic underlying problems involved as, for example, the attitude of the public toward government, toward employment in public health service, and toward the respect in which career service is held."

"The Association proposes to apply scientific methods to discover the underlying causes of this shortage and to adapt a program to whatever the findings may be. This study will include: (1) Research and planning; (2) Active recruitment at the service level."

A great deal of thoughtful planning has obviously preceded the report of the American Public Health Association on this vital problem. If its tentative proposals become operative (as seems probable from the resolution adopted by the State and Territorial Health Officers and the acceptance by the Federal Agencies) many active health workers will be involved in the program. The project has obvious advantages for the Schools of Public Health. Underlying all planning and expansion at Harvard are the harassing questions of numbers and abilities of its future students. We applaud the American Public Health Association for its proposed program and leadership. Cooperation of the School and its Alumni serving in key positions in public health seems assured.—*Harvard Public Health Alumni Bulletin*, Nov., 1949.