原　　著

Mortality of Children in Familial Contact with Pulmonary Tuberculosis.

By

Hiroto Yosioka, M. D.

(Institute of Hygiene, Faculty of Medicine, Tokyo Imperial University.
Director; Prof. Dr. T. Tamiya.)

As Dr. Frost[4] pointed out in his paper, for the acute communicable diseases, such as diphtheria, scarlet fever and measles, measurement of the morbidity risk of familial contacts is a simple procedure, because the excess risk is concentrated within the few weeks following invasion of the household. Collection of the data is simple because, for any family, the required period of observation is brief; and compilation is simple because the period to which the attack rate refers may be taken as the same for all families.

For tuberculosis the requirements are essentially the same, but are more difficult to meet, chiefly because the disease is of slow evolution. This explanation can be applied to the mortality. Furthermore, observation of the exposed group must extend over a sufficient number of years to define the rates of mortality prevailing in successive periods throughout the usual span of life. It goes without saying that to keep a sufficiently large group of people under systematic, exact observation for such length of time is a difficult task. However, such simple facts as lie within the knowledge and memory of the average householder may be obtained by retrospective investigation, tracing familial histories backward into the past.

The available records which serve the purpose of my investigation are from those of Hermann M. Biggs Memorial Hospital, Ithaca, New York, which has surveyed eight counties, such as Cayuga, Cortland, Schuyler, Seneca, Tioga, Tompkins, Wayne and Yates during about two years.

The survey covered 764 white persons. The records relate to children born in families known to include whether an adult case of "advanced"* pulmonary tuberculosis or one child suffered from that illness.

The study of each family has included among other items: —

* The word "advanced" in this paper means that this hospital classifies pulmonary tuberculosis as three grades — P 1, P 2, and P 3, so I adopted P 2 and P 3 as "advanced" However, even if the case is P 1, I adopted it, if the sputum is positive.

1 Inquiry into the diagnosis and history of the adult case or case reported, with special reference to probable date of onset and to circumstances of subsequent contact with each child.

2. Careful inquiry in the home to ascertain the date of birth of every child born in the family since establishment of the household, with the date and cause of death of any that had died.

3. Continued observation of each family subsequent to registration in clinic to ascertain year by year, the occurrence of births, deaths, and various manifestations of tuberculosis.

From the histories obtained, it is probable that the deaths ascribed to pulmonary tuberculosis were due to that cause; but it is by no means that these were all the deaths attributable to tuberculosis, and as to non-fatal cases of this disease the histories, both negative and positive, obviously are subject to considerable error. Also, the early history of former members, who were born outside of the households in which they were recorded, must often be unknown. In addition to this, the period since the opening of the hospital has not been long enough to complete the data However, in general, the facts are simple and, for the period since establishment of each household, presumably within the knowledge of the informant. Also, the results of this investigation are quite natural and reasonable in the light of the medical science of to-day.

For specific methods of treating these questions, Dr. Frost[4] wrote in his paper in detail, so I don't think it is necessary to repeat them here.

The whole group of 764 persons, classified as follows:

	Contacts		Non-contacts	Total
Age contact began / Living or dead	Birth	Later		
Living	69	571	64	704
Dead	18	18	24	60
Total	87	589	88	764

TABLE I.

Life-Experience and Mortality between the Age-limit 0–29 years among Individuals while free from Known Familial Contact with Pulmonary Tuberculosis.

Age	Person-years of life-experience	Deaths all causes	Annual death rates per 1,000	Mean death rates per 1,000 1929–1931 (New York State exclusive of New York City)	Expected deaths in New York State
Under 1	669.5	6	8.96	60.9	40.8
1	646.5	6	9.28	8.2	5.3

2	616.0	3	4.87	4.8	3.0
3	584.0	3	5.14	3.7	2.1
4	553.0	0	0	2.6	1.4
5- 9	2382.0	1	0.42	1.9	4.5
10-14	1770.5	0	0	1.5	2.7
15-19	1132.0	2	1.77	2.4	2.7
20-24	563.5	2	3.55	3.4	1.9
25-29	251.0	0	0	3.8	1.0
Total	9168.0	23	2.51		65.4

The aggregate is 9,168.0 person-years; and in each age class, the experience comprises several hundred person-years. Opposite each age-group are set the deaths which occurred at that age, and the next column gives the annual death rate per 1,000 in the age class, calculated as the ratio of deaths to person-years. The next column shows the mean annual death rates at corresponding ages in the population of New York State exclusive of New York City in 1929-1931. The last column shows, for comparison, the expected deaths at the rates of mortality prevailing in the proportion of New York State in each age group.

The number of deaths in this group is very much lower than the New York's number under one year old, which cannot be explained easily. It more probably reflects the selective character of the life-table experience. The deaths of this group is approximately equal to the latter in the age-group 1-4 years. In the age group 15-24 years, also both groups are approximately equal. However, the number of expected deaths is about twice that of the real deaths in the age-group 5-29 years. If the both numbers under one year old be eliminated, the rest of deaths of both groups become pretty closer, though still the expected number is slightly higher than the other, but the difference is not significant. This indicates that the familial records are not grossly erroneous.

TABLE II.

Mortality subsequent to the Establishment of Known Familial Contact.

Age periods	Person-years of life-experience	Deaths		Expected Number of Deaths	
		from all causes	from Tbc.	from all causes	from Tbc.**
Under 1	84.0	1	3	5.1	.029
1- 2	86.5	6	5	.7	.035
2- 3	97.0	2	2	.5	.026
3- 4	113.0	0	0	.4	.020
4- 5	132.5	0	0	.3	.021
5-10	760.5	0	0	1.1	.061

10–15	853.5	3	3	1.3	.094
15–20	740.5	6	6	1.8	.348
20–25	459.0	11	11	1.6	.399
25–30	225.5	0	0	.9	.228
Totals	3552.0	32	30	14.0	1.261

* Based on the same as that in the foregoing table.

** Based on Mean Annual Mortality Rate of 1928–1932 in New York State, exclusive of New York City.

The number of deaths from all causes is approximately equal to the number expected at the rate of mortality in New York State in the age-group 0–1 year, but is much over the expected deaths in the age group 1–24 years, except the age-group 3–9 years. As stated above, comparing the number of deaths of the one group with the other at all ages (0–29) from all causes, I found the difference significant. That is, deaths from all causes subsequent to the establishment of known familial contact is higher than the expected deaths prevailing at the rates of mortality in New York State in 1929–1931. This conclusion is also, I think, very appropriate from the point of view of biostatistics. In other words, this group suffers from the known familial contact with the disease.

TABLE III.

Mortality in Relation to History of Familial Contact with Pulmonary Tuberculosis.

Age periods	Lx_1	Lx_2	Lx_1+Lx_2	Mx_1	Mx_2	dx_1	dx_2
0– 1	669.5	84.0	753.5	8.96	47.62	6.8	35.9
1– 2	646.5	86.5	733.0	9.28	69.36	6.8	50.8
2– 3	616.0	97.0	713.0	4.87	20.62	3.5	14.7
3– 4	584.0	113.0	697.0	5.14	0	3.6	0
4– 5	553.0	132.5	685.5	0	0	0	0
5–10	2382.0	760.5	3142.5	0.42	0	1.3	0
10–15	1770.5	853.5	2624.0	0	3.51	0	9.2
15–20	1132.0	740.5	1872.5	1.77	8.10	3.3	15.2
20–25	563.5	459.0	1022.5	3.55	23.97	3.6	24.5
25–30	251.0	225.5	476.5	0	0	0	0
Totals	9168.0	3552.0	12750.0			28.9	150.3

Lx_1 — Person-year experience in the group while free from contact.

Lx_2 — Person-year experience of the group subsequent to the establishment of contact with familial tuberculosis.

Mx_1 — Annual mortality rate per 1,000 in the group Lx_1.

Mx_2 — Annual mortality rate per 1,000 in the group Lx_2.

dx_1 — Corrected number dying during year in the group Lx_1.

dx_2 — ,, ,, ,, ,, ,, ,, ,, Lx_2.

Next, when I compare the number of deaths from tuberculosis with the numbers expected, the expected number is so small compared with the observed deaths in this group within each age period. Also, as N=3,552 is pretty large, and np=m=1.261 is small, I use the Poisson's Law, so that I can get the probability P=.0093, when we would get 5 and more deaths. So, we might obviously conclude that the difference between observed and expected numbers is significant. These are also probably due to the fact that this group suffers from the establishment of known familial contact with pulmonary tuberculosis.

We come now to the question of comparison of mortality among individuals while free from familial contact, with their mortality during the period of familial contact with pulmonary tuberculosis (see Table III).

Therefore, I have the corrected death rates of the both groups as follows:

$$Rco_1 = 2.27 -- Lx_1 \text{ group}$$

$$Rco_2 = 11.79 — Lx_2 \text{ group}$$

Thus, I have significant difference between the two corrected death rates. In other words, the mortality of the group while free from contact is significantly lower than that of group subsequent to the establishment of contact.

The figures given above show only the annual mortality risk for all familial contacts in this group of families, as measured by comparing their mortality rates with those of a control drawn from the same universe. Given sufficiently extensive and exact data, it would be quite possible, by similar processes, to measure the variations in the risk as related to numerous circumstances which presumably are of importance, as, for instance, the age at which the individual was exposed, its duration, the sex, etc. The number of persons included in this particular set of records is too small for such sub-divisions as these more detailed studies would require. However, though this method has several shortcomings, the advantages of comparing these two groups rather than comparing the post-contact group with the general population in considering the association of mortality with familial contact with tuberulosis are as follows: (a) same people, (b) same families and (c) same economical status.

It should perhaps be added, though it is sufficiently obvious, that in the procedure applied here, no attempt is made to distinguish between the risk resulting directly from exposure and that which may be due to constitutional weakness or generally unfavorable environment.

Generally speaking, we may conclude the hazards of familial contact with tuberculosis in the light of the evidence of this problem.

Furthermore, as Dr. Frost[5] pointed out, the conditions which limit the propagation of the tubercle bacillus are — (1) that in order to escape from its host it must cause a lesion which breaks through the surface — in general, an extensive lesion which severely

damage the host—and (2) that it succeeds in producing such lesions in only a limited proportion of infected persons. The combination of these two limiting conditions is the peculiarity of the tubercle bacillus which makes it more amenable to control by case-isolation than are diseases such as diphtheria, scarlet fever and measles. Thus, only the relatively small proportion of infections which progress to the stage of open lesion are successful in spreading the infection to others, and it is only these sputum-positive cases that need to be isolated in order to prevent the spread of infection.

If the view which has been presented above is substantially correct, it carries the implication of the risk of persons in familial contact with pulmonary tuberculosis and of a much more vigorous program of case-finding and isolation, with the definite objective of hastening eradication of the disease rather than merely maintaining partial control.

However, as Dr. Georg Wolff[9] successfully wrote, any short critical examination of the statistics shows that of all the factors having influence upon the epidemic march of tuberculosis, it is the socio-economic and socio-biological factor together combined with industrialization changes in the standard of living which are decisive. The goal of a rational campaign against tuberculosis is still further to improve the social environment so that those infected by tuberculosis will not become the victims of the frank disease. So that it should be probably added, that the case isolation be not only one method to eradicate the disease, but still, I suppose, is particularly effective.

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