Decline of the Tuberculosis Epidemic in Alaska

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THERE can be little doubt that tuberculosis was epidemic among Alaskan natives during the first half of the present century (*1–4*). Although the pattern of spread will probably never be known, the disease appears to have been introduced by white visitors and immigrants (*5*) and to have followed in their wake as they sailed Alaska's coasts and floated down her rivers. Thus the disease probably came first to the Aleutian Islands, the southern coast, and the southeastern panhandle with the explorers and fur traders some time in the latter part of the 18th century. The search for gold and whales late in the 19th century provided additional opportunities for the introduction of tuberculosis into the interior and along the northwest coast. When the disease arrived in the delta of the Yukon and Kuskokwim Rivers is not known, but it seems likely that the epidemic peak came later in this area than elsewhere in Alaska.

In any event, the first systematic examination of Alaskan natives for tuberculosis, a tuberculin survey conducted from 1948 to 1951, indicated that the tuberculosis problem was most serious along the lower Yukon and Kuskokwim Rivers (*6*). The prevalence of tuberculin reactors among native children, standardized for age, was 32 percent in southeastern Alaska and the Aleutian Islands, 56 percent in the interior and on the northwest coast, and an astounding 75 percent in the Yukon-Kuskokwim delta. In the 1950's, tuberculosis continued to be the major health problem of Alaskan natives and was particularly serious in the delta region. From 1953 to 1956, the average annual tuberculosis mortality rate in that area was 282 per 100,000, and as recently as 1957, 30 percent of adults had X-ray evidence of past or present pulmonary tuberculosis (*7*).

In spite of the severity of the tuberculosis epidemic along the lower Yukon and Kuskokwim Rivers, a situation which has few rivals in medical literature, there is evidence that the disease is at last being brought under control. Not only have tuberculosis mortality and case rates fallen sharply, but even more significant for the future of tuberculosis control, there has been a marked decrease in the risk of acquiring new infections. So dramatic is this reduction that children whose parents were decimated by tuberculosis may well live to see it become a rare disease.

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Materials and Methods

The Yukon-Kuskokwim delta is a roughly triangular area, with the Yukon River along its northern border, the Kuskokwim River along the southeast, and the Bering Sea on the southwest (fig. 1). About 7,000 Eskimos and fewer than 1,000 whites live in an area of approximately 30,000 square miles, making it the area with the densest population of Alaskan natives. The delta has 41 villages, ranging in size from about 30 to 1,000 persons and located, for the most part, on the banks of the two major

rivers. Estimates of the tuberculosis infection rates were based on three tuberculin surveys in this area.

The first, which was part of a BCG vaccination program conducted by the Alaska Department of Health, took place during the years 1949 to 1951, the midpoint for the delta region being May 1950. The tuberculin tests were administered and measured by trained physicians and nurses. A dose of 0.00002 mg. of PPD-S, representing 1 tuberculin unit (T.U.), was given intracutaneously, and persons who had reactions with 8 mm. or more of induration 48 hours later were classified as positive reactors (*6*).

The second survey was done in April 1957 by nurses from the Tuberculosis Branch, Public Health Service, who had had extensive experience in tuberculin testing programs (*7*). The third survey, in January and April 1960, was carried out by the nursing staff of the Arctic Health Research Center after a period of training supervised by the authors. For the last two surveys, 5-T.U. doses of PPD-S were used. The reactions were carefully measured at 48 hours, and those showing 6 mm. or more of induration were classified as positive.

It is unfortunate that the dosage of tuberculin and the criterion for a positive reaction were not the same for the first as for the last two surveys, and that the reactions for the first survey were not recorded in millimeters of induration. However, on the basis of other studies (*8*) and the frequency distribution of reactions in 1957, it is likely that the proportion of positive reactions in the first survey would have been only slightly greater had the procedures of the later two surveys been used.

Nearly all children living in the selected villages were tested, but the results for non-Eskimo children are excluded from this report. The analysis of the first and third surveys covers an age span of 9 years; the analysis of the second, 9¼ years. Because the second survey was done in April, and only the birth year was recorded, all ages given for the 1957 program are one-fourth of a year greater than stated subsequently.

The villages included in this study were selected without regard to the severity of the tuberculosis problem, although there was a tendency to select the larger villages. Bethel, the largest village and the transportation center for the area, was tested during the first survey. It is not included in the present analysis because in many ways it is not representative of the area. With this one exception, all of the tested villages in the Yukon-Kuskokwim delta are included in this report.

The last two surveys and the analysis of the findings were made possible through the facilities of the Bethel Prophylaxis Study, a co-

Table 1. Distribution of villages by percent of positive tuberculin reactors among Eskimo children for three tuberculin surveys, Yukon-Kuskokwim delta, Alaska

Positive reactions [1] (percent)	Surveys		
	1949–51 (18 villages)	1957 (11 villages)	1960 (13 villages)
0–9			
10–19			3
20–29		1	8
30–39		1	2
40–49		3	
50–59	2	3	
60–69	6	1	
70–79	5	1	
80–89	5		
90 or more		1	

[1] Adjusted to the age distribution of all three survey populations.

Figure 1. Dashed line shows location of Yukon-Kuskokwim delta

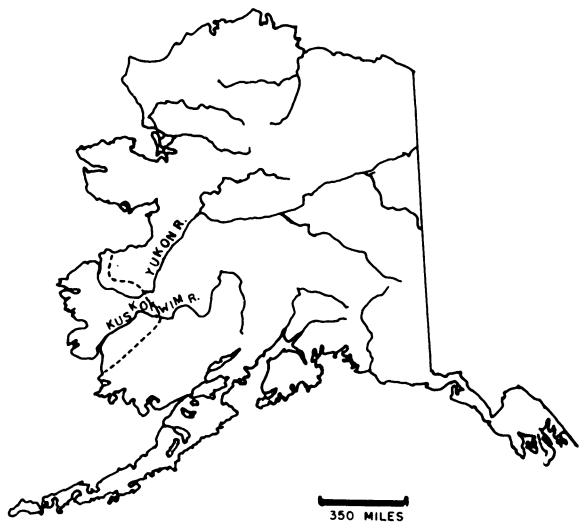


Table 2. Age-adjusted percent[1] of positive tuberculin reactors among Eskimo children in villages of Yukon-Kuskokwim delta, Alaska, by participation in three tuberculin surveys

Surveys in which villages were tested	Number of villages	Surveys		
		1949–51 (percent)	1957 (percent)	1960 (percent)
Total	29	71. 5	52. 2	25. 1
All 3	1	81. 2	44. 5	26. 0
1st and 2d	3	74. 6	56. 0	----
1st and 3d	7	70. 2	----	24. 5
2d and 3d	1	----	56. 2	24. 1
1st	7	70. 1	----	----
2d	6	----	45. 5	----
3d	4	----	----	27. 6

[1] Adjusted to the age distribution of all three survey populations.

operative enterprise established in 1957 to study the usefulness of isoniazid in preventing tuberculosis. The study is supported by three branches of the Public Health Service, Division of Indian Health, Arctic Health Research Center, and Tuberculosis Branch, and by the Alaska Department of Health and Welfare.

Results

Of the 40 villages, 18 were tested in the 1949–51 survey, 11 in 1957, and 13 in 1960. Only 1 village was tested in all three surveys, 11 in two surveys, and 17 in one survey, while 11 have not been tested. This is very close to the distribution which would have resulted from chance alone, given the decision to test the stated number of villages in each survey.

The level of tuberculin sensitivity among children showed some variation from village to village in each time period (table 1). This was most marked for the 1957 survey, perhaps because of the inclusion of a number of small villages. In spite of this variation, the downward trend in tuberculin sensitivity is unmistakable.

Further assurance that the decreasing prevalence of tuberculin reactors is not likely to be the result of selection alone is shown in table 2. For all villages, the prevalence of positive reactors was more than 70 percent in 1949–51, about 50 percent for 1957, and 25 percent for 1960. At each of the three periods, the proportion of reactors was similar for villages tested in one, two, or three surveys.

The percentage of positive reactors by age is shown in table 3 and figure 2 for each of the three surveys. In 1949–51, the proportion of infected children increased very rapidly with age, reaching 92 percent in the age group 7–8 years. In 1957, the increase with age was still marked, but much less so. By 1960, there were no reactors less than 1 year of age, and only a few between 1 and 3, but among older children the proportion of positive reactors again increased rapidly with age. The shapes of the three curves in figure 2 suggest that the infec-

Table 3. Prevalence of tuberculin sensitivity among Eskimo children tested in three successive surveys, by age, Yukon-Kuskokwim delta, Alaska

Age group (years)	1949–51			1957			1960		
	Total tested	Positive reactors		Total tested	Positive reactors		Total tested	Positive reactors	
		Number	Percent		Number	Percent		Number	Percent
Under 1	88	12	13. 6	46	2	4. 3	84	0	0
1–2	168	74	44. 0	100	19	19. 0	203	5	2. 5
3–4	168	132	80. 0	96	47	49. 0	177	15	8. 5
5–6	164	148	90. 2	93	69	74. 2	200	66	33. 0
7–8	159	146	91. 8	90	75	83. 3	179	123	68. 8
0–2	256	86	[1] 34. 4	146	21	[1] 14. 4	287	5	[1] 1. 7

[1] Adjusted to the age distribution of all three survey populations.

tion rate was extremely high during the entire lifetime of individuals tested in 1949–51 and that it had fallen appreciably but was still high among those tested in 1957. For those tested in 1960, it appears that the infection rate in recent years was quite low but had been much higher during the earlier lifetime of the older children.

Because the infection rate was apparently changing rapidly during the period under study, the average rate calculated for the entire 9-year period represented by each of these curves is not very meaningful; in addition, BCG vaccination, done in this area between 1949 and 1956, might have been responsible for some of the reactions in the 1957 and 1960 surveys. To minimize these difficulties, it was decided to utilize only the experience of children less than 3 years of age in estimating the average annual infection rate. The rate over this restricted interval should closely approximate that during the year or so prior to testing. Furthermore, the effect of BCG vaccination is negligible in this age group. Only 10 children had been vaccinated, all of them participants in the 1957 survey.

Figure 2. Prevalence of tuberculin sensitivity among Eskimo children tested in three successive surveys, by age

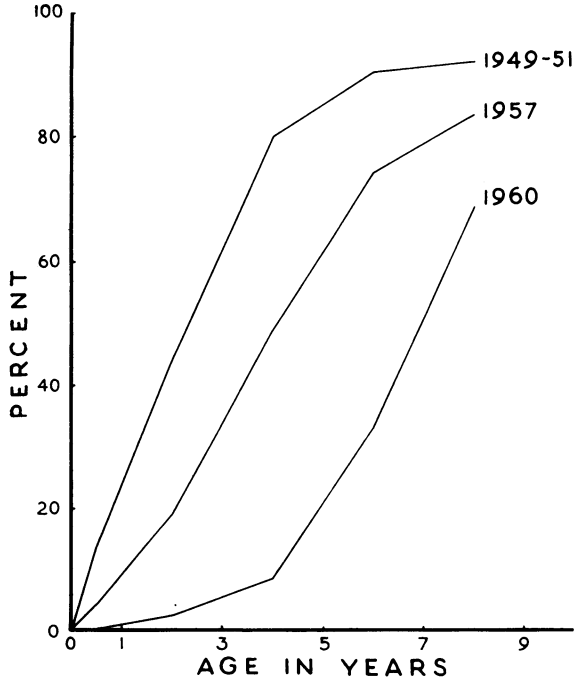


Table 4. Average annual tuberculosis infection rates among Eskimo children 0–3 years of age, in three successive periods, Yukon-Kuskokwim delta, Alaska

Survey	Positive reactors (percent)	Average annual infection rate [1] (percent)
1949–51	34. 4	24. 6
1957	14. 4	8. 5
1960	1. 7	1. 1

[1] During the 3-year period prior to each survey.

The average annual infection rates estimated in this way from each survey are shown in table 4. For the 3-year period prior to testing in 1949–51, 24.6 percent of the negative reactors would have had to be infected each year to yield a prevalence ratio of 34.4 percent in the age group 0–3 years. Prior to the 1957 survey, the average annual infection rate was 8.5 percent, while prior to the 1960 survey it was only 1.1 percent. The dramatic decrease in the risk of acquiring new infection is illustrated in figure 3, which shows a much greater rate of decline between 1957 and 1960 than between 1950 and 1957. Further assurance that the most recent estimate is not too optimistic is the fact that a tuberculin survey of two villages in 1959 yields an estimated infection rate that falls below the curve shown in figure 3.

Discussion

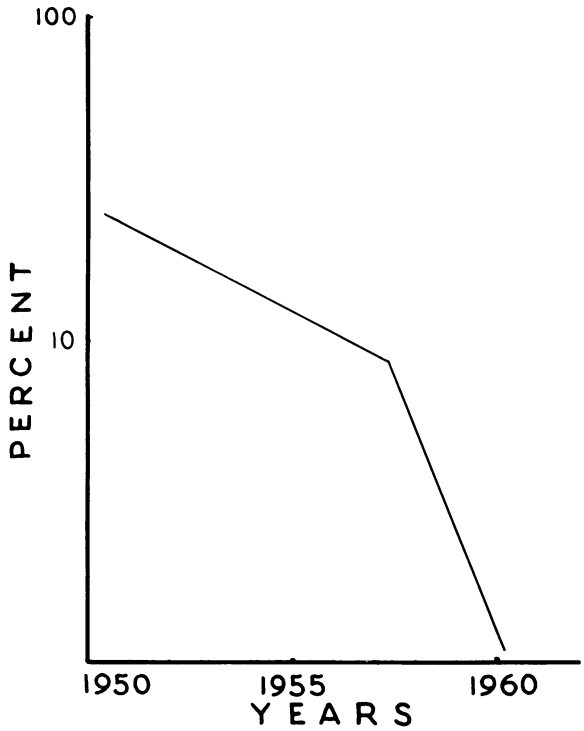
A recent report on public health in Alaska records marked improvement in the tuberculosis problem among Alaskan natives as measured by traditional indices (*9*). The tuberculosis death rate for Aleuts, Eskimos, and Indians was 501 per 100,000 in 1952; in 1959, the provisional rate was 54 (*10*, *11*). At the end of 1955, the year the maximum number of tuberculosis beds was first made available, 1,311 Alaskans were hospitalized for tuberculosis; 3 years later, the number was 444, and there were very few persons at home known to be infectious. Dramatic as these reductions are, the infection rate declined even more sharply in the Yukon-Kuskokwim delta.

There is reason to believe that the infection

rate has also declined markedly in other areas of Alaska suggesting that here, as elsewhere in the United States, the tuberculosis problem is becoming concentrated among those already infected. Preliminary unpublished analysis of an isoniazid prophylaxis study in the Yukon-Kuskokwim delta indicates that tuberculosis in this area, as measured by deaths and active cases, is still further concentrated among persons with previously diagnosed disease. If the current pressure against tuberculosis through casefinding, treatment, and isolation can be maintained and if known cases continue to be carefully followed, it seems likely that the infection rate will soon approach the low level found in the United States as a whole, recently estimated to be less than 0.1 percent per year (*12*).

This encouraging reduction in the infection rate has occurred in an area of Alaska long considered to have one of the worst tuberculosis problems in the world. Nor was the magnitude of the tuberculosis problem the only handicap encountered when a systematic tuberculosis control program, already in effect in other parts of Alaska, was initiated in the Yukon-Kuskokwim delta only 6 years ago. The estimated 7,000 native inhabitants of the delta live in about 40 villages scattered over an area roughly the size of the State of South Carolina. Personnel, patients, and supplies are usually transported by small bush planes; for shorter trips, dogsleds, snowplanes, and boats are used. But all travel can be and often is delayed by adverse weather conditions. Even now, the bulk of the population lives close to the subsistence level and many adults speak only Eskimo.

Figure 3. Average rate of decline in tuberculosis infection rates among Eskimo children 0–3 years of age in two periods: 1949–57 and 1957–60



Nevertheless, conditions are better than they were 10 years ago, and as a result, the control of tuberculosis has become less difficult. For without the facilities brought by an improved standard of living, without the increased understanding afforded by education, and without the high degree of cooperation of the people in all phases of the tuberculosis control program, it is unlikely that the efforts of public health personnel, dedicated as they have been, could have accomplished so much so quickly.

Some mention of BCG vaccination should also be made, especially since the tuberculin testing of 1949–51 was done as part of a mass vaccination campaign. During the ensuing 5 or 6 years vaccination was continued sporadically. It was then discontinued, largely because it was not possible to produce satisfactory tuberculin conversions under existing conditions. In any event, since only a small proportion of the population was vaccinated, no significant part of the reduction in tuberculosis can be attributed to BCG. Nor does it seem reasonable to anticipate that BCG will play an important role in the future, since its usefulness varies directly with the infection rate (*13*). This rate is already low, and appears to be rapidly diminishing, so that the principal source of future tuberculosis cases will undoubtedly be the persons who are already infected and for whom BCG has nothing to offer.

Because of the likelihood that previously infected persons will provide the tuberculosis cases of tomorrow, controlled cooperative trials of isoniazid prophylaxis have been initiated by the Tuberculosis Branch of the Public Health Service in the hope that a method for reducing

the risk of disease among infected persons may be found. More than 6,000 inhabitants of the Yukon-Kuskokwim delta are participating in these trials. If with their help isoniazid is shown to be an effective prophylactic agent, this finding could signal the end of the tuberculosis epidemic among Alaskan natives.

Summary

Between 1949 and 1960, three tuberculin surveys have been done among the Eskimo population living in the Yukon-Kuskokwim delta of Alaska. The results of tuberculin tests among children less than 3 years of age were utilized to obtain an estimate of the tuberculosis infection rates. In 1949–51, the average annual infection rate was 24.6 percent; in 1957, it was 8.5 percent; and in 1960, it was only 1.1 percent. This dramatic decline appears to have resulted not only from improvements in social and economic conditions but particularly from a vigorous antituberculosis campaign with emphasis on casefinding, isolation, and treatment.

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Surgeon General Urges Polio Vaccination of Infants

By September 1960, about 93 million people, or 60 percent of the population under 60 years of age, had at least one dose of polio vaccine compared with 85 million people, or 56 percent of the population under 60, in September 1959, according to sample surveys conducted by the Bureau of the Census. About 25 percent had four or more doses in 1960 compared with 14.2 percent in 1959.

Surgeon General Leroy E. Burney of the Public Health Service reports the trend has been the same in each of the 4 years the survey has been conducted.

"People who start their polio shots usually follow through with the recommended doses. This is encouraging because it is the third and fourth doses that give the greatest protection," Dr. Burney said.

"We all should be greatly disturbed, however, that so many babies and preschool children remain unvaccinated. To date, we have analyzed 1,300 paralytic cases that occurred this year and we have found that 597 of them were children under 5. Such tragedies will continue unless we begin, routinely, to start each new baby on his polio shots when he is 2 to 4 months old."