Otitis media is a very important cause of morbidity among Eskimos. A group of Eskimo children were followed from birth to four years in order to study otitis media and hearing defect. This report presents the results of the study in relation to frequency of respiratory infections and frequency of episodes of otorrhea.

OTITIS MEDIA AND HEARING DEFICIENCY AMONG ESKIMO CHILDREN: A COHORT STUDY

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OTITIS media is the second highest cause of morbidity among Alaska natives.[1] This and other reports of unusually high rates of hearing deficiency[2,3] have stimulated a series of projects to investigate the natural history and epidemiologic concepts of middle ear disease. In a pilot study which compared the retrospective history of draining ears and the prevalence of hearing deficiency among Eskimo, Aleut, and Caucasian children in Alaska, Eskimo children had the greatest prevalence of pathology.[4]

The present study correlates episodes of otorrhea and hearing deficiency in a cohort of Eskimo children who have been followed since their birth.

Methods and Materials

Cohort Study

In October, 1960, a study of infant morbidity and mortality was begun by the Arctic Health Research Center to obtain data bearing upon birth, death, growth and development, and illness among Eskimo infants.[5] The observations were made in 27 Eskimo villages located in the Yukon and Kuskokwim River Delta areas of southwestern Alaska. The cohort consisted of 643 live births occurring between October, 1960, and December, 1962, divided into those children born the first year (Group I) and the second year (Group II).

A research nurse visited the cohort children in each village four times a year during the first two years of study and at least twice a year subsequently. Additional sources of morbidity information included records of the radio medical traffic, and hospital admission and clinic records from the US Public Health Service Hospital, Bethel, Alaska, and the Alaska Department of Health itinerant nursing records. Information concerning middle ear pathology and upper respiratory illness (URI) was obtained during each nursing visit and by surveillance of medical records between visits. Only episodes of otitis media with known otorrhea were used for analysis. It was possible that an occasional case of otitis externa with otorrhea was included but current investigations showed this entity to be rare.

Audiometric Testing

Pure tone and audiometric testing was undertaken in 24 of the 27 study villages between September and December,

Table 1—Number of children by sex, study group, and number of episodes of otorrhea during study period

		No. at risk	No. of episodes of otorrhea					% with one or more episodes
			0	1	2	3	4+	
Group I	Males	96	29	19	10	15	23	70
	Females	102	36	21	10	14	21	65
	Total	198	65	40	20	29	44	67
Group II	Males	97	38	23	15	9	12	61
	Females	83	40	19	8	12	4	52
	Total	180	78	42	23	21	16	57
Total	Males	193	67	42	25	24	35	65
	Females	185	76	40	18	26	25	59
	Total	378	143	82	43	50	60	62

1965, by one of us (SS). At this time, the study cohort ranged from three to five years of age. Air and bone conduction measurements were made using the Zenith ZA-100-T Diagnostic Portable Audiometer. This audiometer was calibrated to the ISO 1964 standards immediately preceding the project, and was checked daily with a Model RA-106 Rudmose calibration unit. A Beltone NB-101 Narrow Band Masking Generator* was transistorized and attached to the audiometer for use when needed. Testing facilities in each of the villages were located in quiet rooms in the schoolhouse or in a community building.

All children were given a hearing screening test which demonstrated any air conduction hearing deficiency greater than 25 decibels at any frequency from 500 to 4,000 CPS. Any child who failed the screening test was given a complete hearing test at frequencies of 250, 500, 1,000, 2,000, and 4,000 CPS. Air and bone conduction measurements with the use of narrow band masking were included when appropriate. Conditioned play audiometry was used as the technic of testing.

* Kindly provided by the Beltone Electronics Corp., Chicago, Ill.

All hearing threshold levels were plotted on an audiogram form using the ISO 1964 standards. The children were classified according to averages of pure tone air hearing thresholds at the three frequencies, 500, 1,000, and 2,000 CPS, as follows:

0 to 25 dB	range of normal screening test
26 to 40 dB	mild impairment
41 to 70+ dB	moderate to severe impairment.

Results

Due to death and migration only 437 of the 643 children originally in the cohort were available for study. Audiometric tests were completed on 378 (86 per cent) of those available. One hundred and ninety-eight of these children were in Group I with an average age of 4.5 years at audiometric testing, and 180 were in Group II with an average age of 3.4 years. The average number of nurse visits per child during the study period was 10.3 for the children in Group I and 6.4 for the children in Group II.

The number of children in both study groups who experienced various numbers of episodes of otorrhea during the entire study period is shown in Table 1.

Of the 378 children, 235 (62 per cent) experienced 666 episodes of otorrhea, and 65 per cent of the affected children had more than one episode. The higher percentage of affected children in Group I (67 per cent) than in Group II (57 per cent) could be accounted for by the additional year of risk for Group I. The percentage of affected males (65 per cent) was slightly higher than females (59 per cent).

The age at onset of the first episode of otorrhea was tabulated in modified life table form (Table 2). In this table, the number of children at risk in successive age groups decreases by the number of children who have had their first episode of otorrhea and by the number of children who have not completed the next age interval of risk. For both study groups, the first year of age was the year of highest risk for onset of the first episode of otorrhea. Of all children who had episodes of otorrhea during the entire study period, 65 per cent had their first episode before their first birthday and 89 per cent before their second birthday.

The audiometric test results are shown in Table 3. All hearing impairments were of the air conduction type. Of the total 378 children, 116 (31 per cent) had a hearing impairment of 26 decibels or more; 82 (22 per cent) of the children had a unilateral loss only, while 34 (9 per cent) had a bilateral loss. The percentages of children with hearing deficiency were quite similar for both study groups and for males and females.

An age specific proportion (in per cent) of children with one or more episodes of otorrhea was calculated by dividing the number of children with episodes by the number of children at risk during the age intervals (Figure 1). During the first year of life, 40 per cent of the children had one or more episodes. This figure decreased by about 5 per cent each year. When divided into the two categories of those with a 26 decibel or more hearing impairment versus those with normal hearing, 56 per cent of the children in the former compared to 33 per cent of those in the latter group had episodes during their first year of life. The frequency then gradually declined for both groups during the later age intervals. By the end of the study period, 84 per cent of the children with hearing impairment had had one or more episodes compared to 53 per cent of the children with normal hearing.

The correlation between the frequency of episodes of otorrhea and measurable hearing impairment of 26 decibels or more is shown in Table 4. The epi-

Table 2—Risk of having first episode otorrhea by age

	Age in months	No. of children at risk	No. with first episode	No. lost after interval	% of children with first episode
Group I	0-11	198	86	—	43
	12-23	112	31	3	28
	24-35	78	11	35	14
	36-47	32	5	27	16
Group II	0-11	180	66	—	37
	12-23	114	23	22	20
	24-35	69	13	56	22

Table 3—Number of children by sex, study group, and audiometric test findings

	Group I	No. tested	Mild loss (26-40 dB)	Moderate to severe loss (41-70+dB)	% with loss of 26+dB
Males	Unilateral loss only	96	23	2	26
	Bilateral loss only		2	2	4
	Total		25	4	30
Females	Unilateral loss only	102	19	2	21
	Bilateral loss only		4	4	8
	Total		23	6	29
	Group II				
Males	Unilateral loss only	97	21	—	22
	Bilateral loss only		10	1	11
	Total		31	1	33
Females	Unilateral loss only	83	11	4	18
	Bilateral loss only		4	7	13
	Total		15	11	31
Total	Unilateral loss only	378	74	8	22
	Bilateral loss only		20	14	9
	Total		94	22	31

sodes of otorrhea per year of risk was calculated by dividing the number of episodes for any child by the number of years he was followed during the study period. The per cent of children with hearing deficiency rose in proportion to the frequency of episodes per year of risk. This association was statistically significant ($\chi^2_2=33.19$, $P<0.001$). Separate analysis showed no increased risk of hearing deficiency with onset of otorrhea before one year of age compared with later onset.

As upper respiratory illnesses (URI's) are commonly considered to be a predisposing factor in the development of otitis media, the children were grouped according to the number of episodes of URI and otorrhea during the most intensely observed period, the first two years of life (Table 5). The association was statistically significant ($\chi^2_4=19.8$, $P<0.01$).

In agreement with Table 4, the per cent of children with 26 decibels or more hearing impairment increased with a higher number of episodes of otorrhea during the first two years of life. There was no such rise with an increase in number of URI episodes.

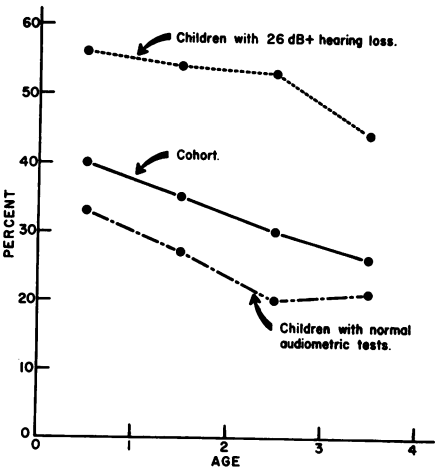

Figure 1—Per cent of cohort with otorrhea per year of risk

Table 4—Number and per cent of children with 26+ dB hearing deficiency by frequency of episodes of otorrhea per year of risk

Frequency of episodes	No. at risk	Hearing deficiency No.	Hearing deficiency %
None	143	21	15
Less than one per year of risk	139	48	35
One or more per year of risk	96	47	49
Total	378	116	31

Discussion

Annual "attack" rates of otitis media in England have been estimated at 2.8 per cent with rates of 10 to 15 per cent in children under age ten.[6,7] Hearing loss in one or both ears has been reported as 1.2 per cent for preschool children[8] and 5 to 7 per cent for school children.[9,10] The occurrence of otitis media and hearing loss among Eskimo children is startling in comparison. Two-thirds of the study children had otorrhea and one-third had a hearing impairment of 26 decibels or more by the average age of four years. Early onset of otorrhea during the first year of life and frequent recurrences were common. It appeared that the frequency of episodes of otorrhea was a more important factor associated with hearing impairment than the age of onset of the first episode.

Middle ear disease and hearing loss are problems of native groups other than Eskimos. Otitis media has been the second most commonly reported disease for US Indians (excluding Eskimos),[1] and was the most prevalent problem requiring medical follow-up in a survey of Indian children in Wyoming.[11] A hearing deficit of 20 decibels or more was found in 26 per cent of Aleut children,[4] and in 23 per cent of a group of Alaskan Indians of all ages.[2] A recent survey of Indians in British Columbia revealed that 45 per cent had a history of otorrhea at one time in their lives, and that 31 per cent of those whose hearing could be tested had a hearing deficit of 15 decibels or more.[12]

Respiratory infections have been implicated as a predisposing factor in otitis media[6,7] and were positively associated with episodes of otorrhea in the present study. While a reduction in frequency of attacks of otorrhea would be expected to follow significant reductions in acute respiratory morbidity, any practical attempt to reduce this morbidity would be difficult until immunization methods can be perfected, considering the depressed socioeconomic condition of the western Alaskan Eskimo.

As with many infectious diseases, there is a strong relationship between otitis media and poor living conditions.[9,12,13] The Eskimos live at a subsistence level in isolated villages. The average household consists of six persons residing in one or two small rooms. Medical care is available only through village aides, radio medical traffic, and visits by Alaska State and US Public Health Service personnel. Appropriate medications are often not available and medical care is not necessarily sought.

Adenotonsillectomy, which may help prevent otitis media in older children,

Table 5—Number of children by episodes of URI and otorrhea during the first two years of life

Otorrhea episodes	URI episodes 0	1-2	3 or more	Total
0	21	67	84	172
1-2	6	55	80	141
3 or more	1	15	49	65
Total	28	137	213	378

has been considered as a solution to the problem in the Eskimos. The present data, however, indicate that frequent episodes of otorrhea and hearing impairment occur long before the children reach an age for safe operation. An effective method of treatment or prevention of otitis media in these children will have to be applicable before they reach the age of two.

Summary

A cohort of 378 Eskimo children followed from birth to an average age of four years was given audiometric tests to detect the relationship between episodes of otitis media, manifested by otorrhea and hearing deficiency. Sixty-two per cent of the children had one or more episodes of otorrhea during the study period. Sixty-five per cent of the affected children had their first episode before their first birthday and 89 per cent before their second birthday. Thirty-one per cent of the study group had a hearing deficit of 26 decibels or more (1964 ISO standards).

The per cent of children with hearing impairment rose in proportion to the number of episodes of otorrhea per year of risk and to the actual number of episodes during the first two years of life. Hearing loss could not be shown to be associated with age of onset of the first episode or with the number of episodes of respiratory infection. There was, however, a statistical association between the frequency of episodes of otorrhea and the frequency of respiratory infections.

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