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# Distribution of Otitis Media Among Four Indian Populations in Arizona

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CONCERTED EFFORTS are being made to reduce the incidence of middle ear disease among American Indians, who experience rates several times those of the general U.S. population (1,2). Hearing loss attributable to ear infections in early life also is considerably higher among Indians. To assure that control programs achieve maximum effectiveness and employ resources to optimum advantage, priority attention must be given to persons at greatest risk of hearing loss and other serious consequences of otitis media.

The analyses reported here were undertaken to characterize the occurrence of otitis media among selected Arizona Indian populations in an effort to define attributes that would help to identify individuals and groups most likely to be adversely affected. Among the factors considered were: (a) the distribution of otitis media with respect to type, season, and the age and sex of affected persons, (b) age of affected persons at the time of first attack, (c) the relation of age to frequency of attacks, and (d) the interval between the initial and subsequent attacks.

## Background Information

Preliminary analyses of data from the same populations observed in this study indicated that a minority, about 30 percent, was severely affected by otitis media during the first year of life (2). Relative risk appeared to be associated with age at the time of first attack

and the frequency of subsequent episodes. These initial observations are consistent with the results from studies among other populations in a variety of environments. Some investigators have considered the significance of age at onset in relation to the frequency of subsequent attacks and the likelihood of hearing loss. Brody and associates (3), for example, found that 38 percent of more than 1,000 Eskimo children near Bethel, Alaska, had at least 1 episode of draining ear by age 1. Since the percentage of children who had a history of draining ear did not increase among older children, the authors suggested that chronic otitis media was established by age 1 or 2. Two-thirds of the people in any age group denied ever having a draining ear; only 3 percent of these were found to have severe hearing loss, but 86 percent of the children with severe hearing loss had a history of draining ear. Brody and associates postulated that the severely affected group was predetermined by reaction to allergenic or infectious stimuli.

In studies of similar Alaskan populations, Maynard (4) observed that 38 percent of Alaskan infants had 1 or more episodes of otorrhea during the first year of life, and 20 percent had 2 or more. The median age at the time of the first episode was 6 months, and 19 percent experienced the first attack before 4 months of age. Johonnott (5) reported about the same incidence among rural and urban Eskimo children; 30 percent had a history of otorrhea before age 2, and 50 percent had no history of otitis media. Of the children with chronic otitis media, 50 percent had a history of otorrhea before the age of 2, and 25 percent without chronic otitis media had such a history.

Kaplan and associates (6) conducted a followup study between September 1969 and July 1971 of a

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cohort of Alaskan Eskimo children born between October 1960 and December 1962. Of the 489 children studied, 59.5 percent had an initial episode of otorrhea during the first year of life and 17 percent during the second year. No episodes were reported or observed for 23.5 percent. The rate of episodes was higher (4.8) for children who experienced their initial episode during the first year of life than for those having an initial attack during the second year (2.2). Results of otoscopic examinations indicated that abnormalities of the tympanic membrane (perforation or scar) were affected more by the number of episodes than by the age at which the first attack occurred. Among children with 4 or more episodes, 70 percent had abnormal tympanic membranes; among children with fewer than 4 attacks, only 29 percent had abnormal tympanic membranes. Children who had the same number of episodes showed no difference in the percentage of tympanic membrane abnormalities, regardless of age at the first attack. Hearing loss, detected in 30 percent of 134 children with abnormal tympanic membranes, was associated with early occurrence of otitis media but was affected most by the number of episodes. Risk of a subsequent episode of otorrhea after the first attack was greatest for children who had their first attack before age 2.

Similar results were reported by Reed and Dunn (7) from a longitudinal study of 641 Eskimo children in 6 villages. Middle ear infections occurred during the first 2 years of life in almost two-thirds of the children. The children so affected were at much higher risk of further episodes of otitis media and of hearing loss than children who were not affected during the first 2 years of life.

An entirely different type of population was followed by Howie and associates (8), who observed 488 private pediatric patients in Alabama. Of this group, 67 percent had otitis media at least once. About half of the initial attacks occurred during the first year of life and more than 60 percent during the first 2 years. Of those who experienced an initial episode before age 1, about 47 percent had otitis media during the second year. Children who had two or more episodes during the first year of life had at least twice as many subsequent episodes as patients who had no attack or only one episode during this period.

In summary, as indicated from the preceding review, the severe effects of otitis media are associated with occurrence of initial attacks in the first year or two of life and with the frequency of subsequent attacks. In the study presented here, we extend previous observations by providing data for additional populations,

analyzing the frequency of attacks of otitis media subsequent to infancy and considering the interval between initial and subsequent attacks.

## Procedures

Observations were made among four populations of Arizona Indians who received health services at facilities of the Indian Health Service, Public Health Service. Comprehensive services were provided through Health Service Units that included a hospital, satellite clinics, and community health services. Complementary programs were operated—under tribal direction—by community health representatives, who conduct educational programs in homes and transport patients to service facilities. The populations included in this study were members of the Hopi and Navajo tribes residing in the vicinity of the Keams Canyon Hospital, residents of selected San Carlos Apache communities near the San Carlos Hospital, and members of the Colorado River Indian tribes served by the Parker Hospital.

As part of a program for surveillance and control of otitis media, information was obtained on all cases of otitis media treated at health facilities in the project areas. The Indian Health Service employs a uniform record system that includes an Ambulatory Patient Care Report for each visit. These reports were examined daily by technicians specially trained for the Otitis Media Project. All visits for ear disease were noted, and data were abstracted from individual records. More detailed accounts of the record systems, data management, and other procedures have been described elsewhere (2). Two subgroups are considered in this report: (a) cohorts of children born since initiation of the project in mid-1974 and (b) persons of all ages treated for ear disease at each Service Unit. Data available for all areas were combined for this report. Preliminary analyses indicated that variances between the study sites were not significantly different from the general trends in the distribution described here. Variation in incidence and the association of environmental and behavioral factors at individual locations were considered in another report (9).

For maximum uniformity of terminology and diagnostic criteria, somewhat arbitrary schemata for classifying otitis media were followed during this study. These criteria were reviewed periodically with the medical staff at each Service Unit to stress the need for consistency and to provide regular reports of project activities. The types of otitis media and the differentiating criteria used in this study were as follows:

*Acute suppurative otitis media (ASOM)* was characterized by a bulging, erythematous tympanic membrane usually associated with pain and fever. The tympanic membrane often was perforated and drainage was present, but perforations usually were small.

*Chronic suppurative otitis media (CSOM)* was determined by the presence of a perforation that had persisted for at least 5 days. Pain or fever usually was not present. Data on the occurrence of active CSOM—with drainage present at the time of the examination—and inactive CSOM—without drainage—were combined in this analysis.

*Serous otitis media (SOM)* was identified by conductive hearing loss and presence of a retracted tympanic membrane or decreased mobility of the tympanic membrane. Observation of these latter characteristics often was difficult. Fever or drainage was not present. Transient pain was sometimes associated with the onset of acute SOM, but usually pain was mild or absent.

*Hearing loss* was recorded for persons who failed the school hearing test or subjectively reported loss of hearing.

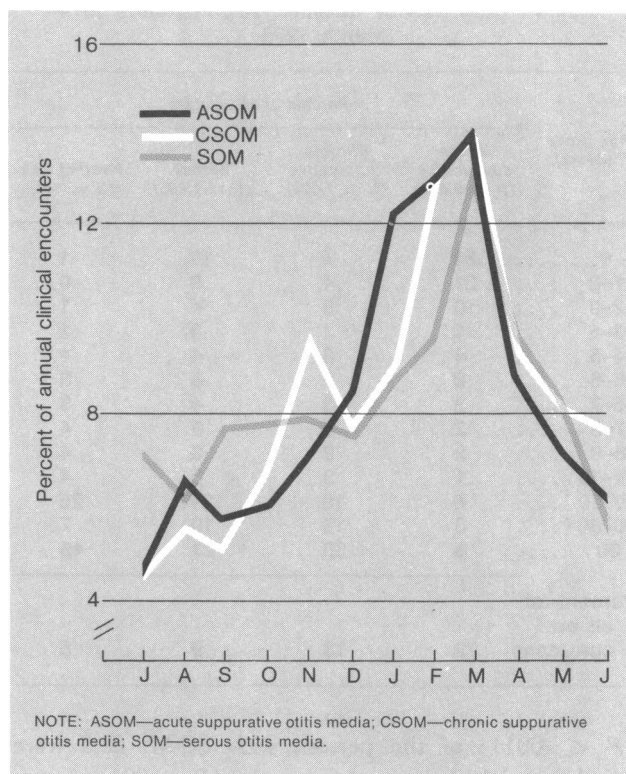
## Observations

These analyses are based on data collected from May 1974 through March 1979. During this period 21,896 visits to Service Units for ear disease were recorded for the 4 populations. Excluding followup visits, persistent episodes, and persons residing outside the designated project areas, data were considered for 13,226 visits. Data concerning frequency of otitis media and age distribution of the children with this disease were derived from observations of cohorts that included children born in each of the four project areas from May 1974 through March 1979. During this period, 2,295 infants were admitted to the cohorts; 245 of these were lost to followup because of death or moving from the area. A total of 1,710 patients were under observation for 12 months or more.

## Results

**Seasonal occurrence.** Figure 1 shows the average monthly distribution of encounters for ASOM, CSOM, and SOM. This distribution is expressed as the percentage of the total number of encounters recorded for each month from July 1974 through June 1978. These calculations were based on 8,001 encounters for ASOM, 1,498 for CSOM, and 983 for SOM. Deviations from the mean number of encounters were 11 to 34 percent for individual years. Comparable variations were observed for individual months. The seasonal dis-

Figure 1. Average monthly distribution of types of otitis media among four Indian populations in Arizona, July 1974–June 1978



tribution of the three types of otitis media was similar, as shown in the figure. The months of maximum occurrence were January, February, and March, although appreciable numbers of encounters were reported during other months.

**Sex distribution.** Table 1 shows the distribution of the prominent types of ear disease by sex of affected persons among the general population, including the cohort members. The percentage distribution of males (47.3) and females (52.7) among persons who had one or more attacks of ASOM was not significantly different. However, the percentage distribution of females among persons with CSOM or SOM was significantly greater than for males. Females accounted for 59.8 percent of the CSOM cases and males for 40.2 percent

Table 1. Percentage distribution of attacks of otitis media among males and females treated at Indian Health Service facilities, Arizona, June 1974–March 1979

| Type of otitis media          | Percent male | Percent female | Number of persons |
|-------------------------------|--------------|----------------|-------------------|
| Acute suppurative . . . . .   | 47.3         | 52.7           | 2,691             |
| Chronic suppurative . . . . . | 40.2         | 59.8           | 458               |
| Serous . . . . .              | 41.4         | 58.6           | 532               |

Table 2. Distribution of types of otitis media, by ages of affected persons and percentage of clinical encounters at Indian Health Service facilities, Arizona, June 1974–March 1979

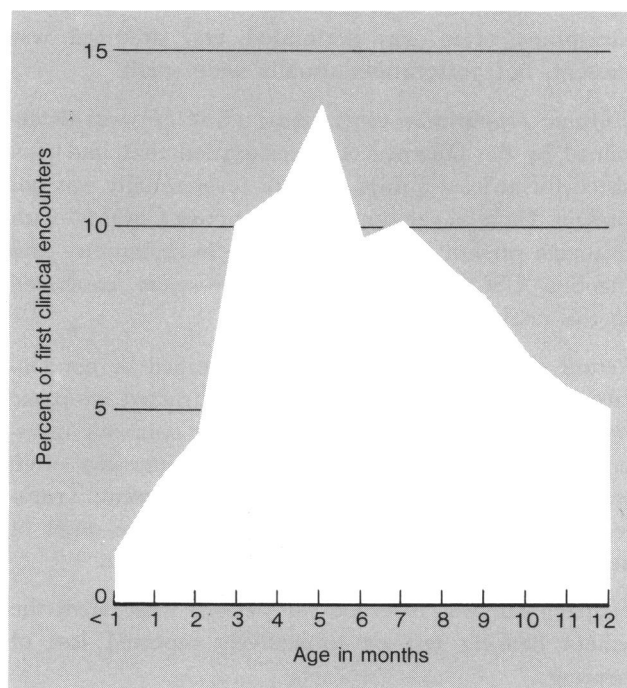
| Age group (years)          | Percent of encounters         |                                 |                    |                        |
|----------------------------|-------------------------------|---------------------------------|--------------------|------------------------|
|                            | Acute suppurative (N = 9,670) | Chronic suppurative (N = 1,693) | Serous (N = 1,225) | Hearing loss (N = 638) |
| 1                          | 34                            | 4                               | 10                 | 1                      |
| 1–2                        | 21                            | 4                               | 9                  | 0                      |
| 2–3                        | 10                            | 3                               | 4                  | 1                      |
| 3–4                        | 6                             | 1                               | 3                  | 1                      |
| 4–5                        | 4                             | 3                               | 4                  | 1                      |
| 5–6                        | 3                             | 3                               | 5                  | 3                      |
| 6–7                        | 3                             | 3                               | 4                  | 3                      |
| 7–8                        | 2                             | 3                               | 3                  | 4                      |
| 8–9                        | 2                             | 3                               | 3                  | 4                      |
| 9–10                       | 1                             | 3                               | 3                  | 4                      |
| 10–20                      | 6                             | 19                              | 21                 | 25                     |
| 20–30                      | 3                             | 13                              | 10                 | 7                      |
| 30                         | 5                             | 38                              | 21                 | 46                     |
| Percent of all occurrences | 73                            | 13                              | 9                  | 5                      |

( $P < .001$ ); of the persons with SOM, 58.6 were females, and 41.4 percent were males ( $P < .001$ ).

Rates could not be calculated for the total population because accurate data on sex composition were not available. Information from cohort members, for whom data were obtained from birth records, indicated that the distribution of males and females among the population was essentially equal, 49.4 percent and 50.6 percent, respectively. The rate of ASOM among males in the cohort, 292 per 100 persons, was not significantly different from the rate among females, 265 per 100 persons. Rates of CSOM and SOM were not significantly different for males and females.

**Age distribution.** Table 2 shows, by age of affected persons, the distribution of the types of ear disease considered in this study. About 73 percent of the encounters were for ASOM, 13 percent for CSOM, 9

Figure 2. Distribution of first encounters for acute suppurative otitis media among 1,052 Indian children during the first year of life, Arizona, June 1974–March 1979



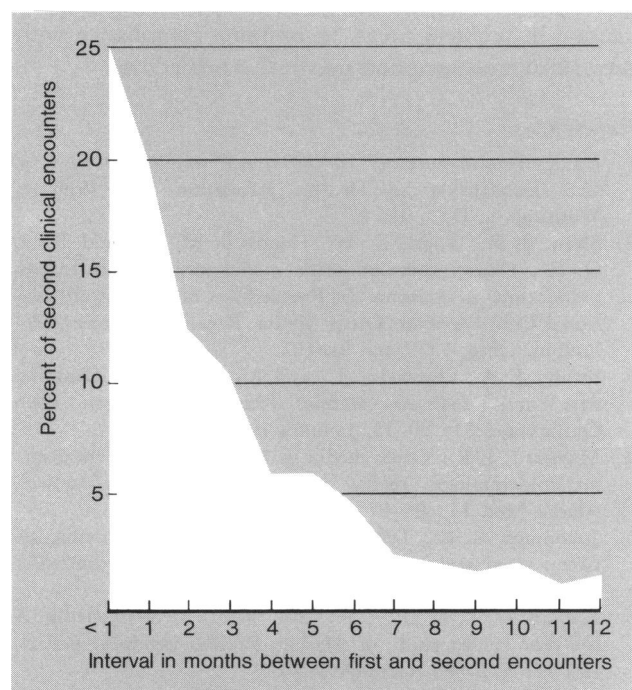
percent for SOM, and 5 percent for hearing loss. Treatment for acute ear disease was sought primarily for preschool children. This age group accounted for more than 75 percent of the attacks recorded for ASOM; more than 50 percent occurred among children under 2 years old. CSOM and SOM also were more prominent among the under-2 age group than among older people.

**Age at time of early attacks.** The data in table 3 indicate that by far the majority of first attacks of ASOM occurred during the first year of life. These data were obtained for 1,330 children admitted to the study at birth and subsequently followed for 12 to 60 months. Among 375 children observed for 2 years, 82 percent of the first attacks of ASOM occurred by age 1. The same pattern of distribution is apparent for persons observed

Table 3. Age distribution of first encounters for acute suppurative otitis media among 1,330 children treated at Indian Health Service facilities, Arizona, June 1974–March 1979

| Length of observation (years) | Number of children | Percent of children, by age in months |       |       |       |       |
|-------------------------------|--------------------|---------------------------------------|-------|-------|-------|-------|
|                               |                    | 0–12                                  | 12–24 | 24–36 | 36–48 | 48–60 |
| 1–2                           | 375                | 82                                    | 18    |       |       |       |
| 2–3                           | 339                | 77                                    | 18    | 5     |       |       |
| 3–4                           | 324                | 73                                    | 16    | 8     | 3     |       |
| 4–5                           | 292                | 73                                    | 15    | 6     | 4     | 3     |

Figure 3. Interval between first and second encounters for acute suppurative otitis media among 872 Indian children, Arizona, June 1974–March 1979



for longer periods. About 73 percent of 616 children observed for 3 to 5 years had an initial attack by age 1, and almost 90 percent of first attacks occurred before age 2.

Figure 2 shows the distribution of first encounters by month of age among 1,052 children who had initial attacks of ASOM during the first year of life; about 75 percent of these attacks occurred among those aged 3 to 9 months.

To determine the interval between the first and second attacks of ASOM, data were examined for 872 children who experienced a second attack within 12 months of the first attack. As shown in figure 3, about 75 percent of the second attacks occurred within 4 months of the first.

**Frequency of attacks.** Data concerning the frequency distribution of encounters for ASOM during the first 4 years of life are summarized in table 4. About 60 percent of the children observed during the year after birth had an attack of ASOM, and 34 percent experienced more than one attack. The percentage of children for whom attacks were recorded declined sharply to 26 percent after age 2; the percentage who experienced multiple attacks declined to 8 percent. However, by age 2, 47 percent of the children had experienced 2 or more attacks.

Clearly, the majority of encounters were observed during the first 2 years of life. The relation between age

Table 4. Frequency distribution of encounters for acute suppurative otitis media in relation to age of children treated at Indian Health Service facilities, Arizona, June 1974–March 1979

| Number of encounters | Percent of children, by age in months |                      |                    |                    |
|----------------------|---------------------------------------|----------------------|--------------------|--------------------|
|                      | 0–12<br>(N = 1,710)                   | 12–24<br>(N = 1,206) | 24–36<br>(N = 772) | 36–48<br>(N = 364) |
| 0                    | 40.4                                  | 56.9                 | 74.0               | 85.4               |
| 1                    | 25.9                                  | 23.8                 | 18.5               | 12.1               |
| 2                    | 14.2                                  | 10.2                 | 4.9                | 2.2                |
| 3                    | 8.8                                   | 5.4                  | 1.7                | 0.3                |
| 4                    | 4.0                                   | 2.0                  | 0.9                |                    |
| 5                    | 3.0                                   | 1.2                  |                    |                    |
| 6                    | 1.8                                   | 0.3                  |                    |                    |
| 7                    | 0.7                                   | 0.2                  |                    |                    |
| 8                    | 0.5                                   |                      |                    |                    |
| 9                    | 0.3                                   |                      |                    |                    |
| 10                   | 0.3                                   |                      |                    |                    |
| 11                   | 0.1                                   |                      |                    |                    |
| 12                   | 0.1                                   |                      |                    |                    |

at the time of the initial episode and the occurrence of subsequent attacks also was determined. As shown in table 5, initial attacks during the first year of life were more likely to be followed by attacks within the following 12 months than were initial attacks that occurred among older children. More than 70 percent of the initial attacks that occurred before the first birthday were followed by one or more attacks, but only half as many subsequent attacks were observed after initial encounters during the second year of life. The frequency of attacks also appeared to be influenced strongly by the age at which the initial attack occurred. More than 50 percent of the children who had an initial attack of ASOM before age 1 had 2 or more subsequent attacks

Table 5. Relation between age at occurrence of the initial attack of acute suppurative otitis media and the frequency of encounters during the following 12 months among children treated at Indian Health Service facilities, Arizona, June 1974–March 1979

| Number of encounters during 12 months after initial attack | Percent with subsequent encounters, by age in months when initial attack occurred |                    |                   |                  |
|--|---|--------------------|-------------------|------------------|
|  | 0–12<br>(N = 860)   | 12–24<br>(N = 122) | 24–36<br>(N = 29) | 36–48<br>(N = 5) |
| 0  | 27.7  | 64.1               | 79.3              | 80.0             |
| 1  | 21.5  | 24.2               | 10.3              | 20.0             |
| 2  | 20.3  | 6.3                | 6.9               |                  |
| 3  | 11.5  | 3.9                | 3.4               |                  |
| 4  | 7.6   | 1.6                |                   |                  |
| 5  | 3.8   |                    |                   |                  |
| 6  | 3.5   |                    |                   |                  |
| 7  | 1.9   |                    |                   |                  |
| 8–12   | 2.2   |                    |                   |                  |

during the following 12 months. Two or more subsequent attacks were observed in fewer than 12 percent of the children who had an initial attack during the second year of life.

## Discussion

Evidence that hearing loss is associated with the frequency of acute otitis media before age 2 has been provided by several investigators (4,6). The early identification of persons at greatest risk of frequent attacks of ASOM, and presumably hearing loss, is especially important in the operation of programs for preventing serious complications of middle ear disease. As indicated by the data in this report, the majority of initial attacks of ASOM occur in the first year of life, and second episodes are most likely within 4 months of the first. The frequency of subsequent attacks is significantly higher among children who experience their initial attack before age 1. These observations indicate that high-risk children are characterized by the occurrence of ASOM before their first birthday and the occurrence of a second attack within 4 months of the first.

The ability to identify high-risk persons has important implications for preventive programs in the context of the system of medical services available to the populations considered in this study. Births usually occur in Service Unit facilities, and pediatric services are provided within the same organizational structure. Individual records generally are adequate and accessible. Records for high-risk persons could be identified conspicuously, as are records for persons with antibiotic sensitiv-

ity, to alert those who provide clinical or preventive services. Intensive efforts then could be made, through existing programs that provide followup and special education in problem areas, to promote compliance with prescribed treatment and preventive procedures.

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## SYNOPSIS

GOODWIN, MELVIN H. (College of Medicine, University of Arizona), SHAW, JAMES R., and FELDMAN, CLYDE M.: *Distribution of otitis media among four Indian populations in Arizona. Public Health Reports, Vol. 95, November-December 1980, pp. 589-594.*

More than 75 percent of the cases of acute suppurative otitis media (ASOM) among Indian children observed from May 1974 through March 1979 were experienced by preschool children. About 60 percent of the

children observed during the first year of life had one or more attacks of ASOM, and 34 percent had two or more. Among those who had ASOM before their first birthday, 75 percent of the attacks occurred between 3 and 9 months of age. About 73 percent of the initial attacks were recorded during the first year of life among children observed from 3 to 5 years; almost 90 percent occurred before the second birthday. Approximately 75 percent of the second attacks occurred within 4 months of the first.

More than 70 percent of the initial

attacks before age 1 were followed by 1 or more subsequent attacks during the next 12 months. When the initial attack occurred during the second year of life, subsequent attacks were experienced by less than half as many children.

Children at high risk of serious ear disease, including hearing loss, are characterized by having an attack of ASOM before their first birthday followed by a second attack within 4 months of the first. Efforts to control and prevent ASOM should selectively be directed toward this group.