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Effects of Otitis Media on Language Development in Native Populations: A Review of the Literature

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Senior Honors Thesis

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Problem Statement

From the time a fetus reaches about 20 weeks gestational age, its auditory system is functioning. Before we are ever born, we are exposed to sounds within our environment. With birth, we begin to interact with, experiment with, and learn to interpret the sounds around us. Before learning to speak, we are bombarded by the sounds of our language. An infant's head is known to perk up at the sound of a voice, a sudden noise, music...all the sounds of the environment, which is evidence that children are aware of the sounds around them before they are ever able to imitate them (Strange, 1986). The reception of sounds must play a critical part in the acquisition of speech skills, which includes cognitively processing the sounds, learning that sound has meaning, and learning to differentiate and discriminate between these sounds. Finally, skills in positioning the articulators in a way that will create the sounds used for cmmunication and putting these sounds of language in an order that is appropriate and communicable are also necessary.

Speech is a very important part of the development of language as a whole. Language is the process by which thoughts are communicated, and speech is often the vehicle for expressing the language structures that we form to represent our thoughts. In examining speech and language separately, though they are interrelated, speech can be defined as "a very complex rapidly changing pattern of acoustic energy" (Strange, 1986). The complexity of speech lies in the constantly changing frequencies,

intensities and durational cues in the acoustic pattern that are produced by the articulation of the different sounds or "linguistic elements" of the language (Strange, 1986). There are only subtle changes in these variables between individual linguistic elements. For example, the contrasts between the consonants /b/ and /d/ are signalled by low intensity changes in the frequency pattern during a very brief segment of the entire speech signal. It is the perception of these complex, subtle acoustic changes that is essential to normal speech/language development. During early language acquisition, children learn the complex sound system and begin to learn some of the basic rules which govern language, such as rules of plurals and past tense. In the English language, this requires hearing small differences between words, such as "plays" versus "place," or "help" versus "helped" (Friel-Patti, 1990). If a child experienced even a mild hearing loss, he/she might miss these low intensity signals, possibly leading to difficulty in speech discrimination during the period of loss. In fact, it may be that during the early years of language acquisition, when quality auditory stimuli are so important, a mild loss may be more than a "mild" impairment to a child (Friel-Patti, 1990).

Many children have brief periods of mild to moderate fluctuating hearing loss due to the presence of a commonly occurring childhood disease, otitis media. Otitis media is a condition that is often used as a "blanket term" for several different conditions that may exist, but all consisting of some type of pathology within the middle ear cavity. The type of otitis

media may have an effect on the interpretation of information gained from studies dealing with otitis media and its effect on hearing. It is important to understand the different types of otitis media and to become familiar with the set of terms used to describe them in order to properly interpret the results of the studies reported in this literature review (See Appendix A for Glossary of Terms).

Most children have at least one episode of otitis media and do not experience any adverse effects apart from the sequelae associated with an episode of otitis media. One study shows that in a series of children under 2 years of age, otitis media accounted for 1/4 to 1/3 of physician visits (Margolis, et al, 1992). Additionally, Roland and Brown (1990) report that at least 70% of children will suffer at least one episode of acute otitis media. It is evident that otitis media is not an uncommon occurrence in the general population, nor is it presently so great a threat to life as it was in the past, due to advancement of medical knowledge and technology. Today, otitis media can be treated with medicines, antibiotics, and/or surgery, and the many children that continue to come into the physician's office with complaints of earaches can be treated. Unfortunately, the complication of pain involved in the onset of otitis media is not the only problem. Some children have recurring episodes of otitis media, which raises some concern about the potential problems arising from the hearing loss associated with otitis media. This immediately raises the question of what possible effects the

associated hearing loss of otitis media may have on language development.

Hearing loss is the most common and a very important sequela of otitis media. The hearing loss commonly associated with otitis media with effusion (OME), which is the persistent presence of fluid in the middle ear (Wright, et al, 1991), is a fluctuating loss in the frequencies between 250 and 2000 Hz (Wright, et al, 1991) between 10 and 40 dB HL (Friel-Patti, 1990). This hearing loss is usually conductive and exists at various degrees when there is fluid in the middle ear during an episode of otitis media.

Truly, in the child who experiences scattered episodes of acute otitis media, there may not be any reason to doubt that the child compensates for the short periods of reduced hearing and may not experience any kind of language delay. In the case of the child who experiences recurring episodes of otitis media in the early years of language development, however, there may be a significant causal relationship between the fluctuating hearing loss and language development. According to Friel-Patti (1990), a fluctuating hearing loss during the early years of life gives the child an inconsistent or distorted speech signal, upon which the child is supposed to base language learning. Speech and language development is a foundation for much of what children will participate in through a normal school day, such as reading, writing, following instructions, peer interactions, and sharing ideas and comments. If speech and language play such a vital role in the academic success of children, it is important to acknowledge

and address problems that may interfere with normal language development.

Professionals in the areas of communication disorders, teaching, special education, and health care should be concerned about the identification of children who are at risk for language problems and problems associated with language delay. Children who have chronic otitis media and thus a possible associated fluctuating hearing loss are "at risk" for developing language problems that may affect academic performance. Some particular populations under study for the prevalence of otitis media are the indigenous peoples of the world, particularly Native North Americans and Australian Aboriginal peoples. These populations have shown a significantly higher prevalence of otitis media and other middle ear diseases than other ethnic populations. According to a study by Maynard (1969), 38% of Alaskan Eskimo infants had one or more episodes of otorrhea (draining ear) in their first year of life. Twenty percent had 2 or more episodes. In a study conducted by Sunderman (1979) with Aborigine children in Australia, only 14% of the ears examined were found to be normal. He found problems such as foreign bodies in the ear canal, perforations, and scarred ear drums. He found cases of mild to severe hearing loss in the remaining subjects. In the general population, only about 20% of children will have repeated bouts of otitis media in all the years of their childhood (Howie, Ploussard, & Sloyer, 1975). It appears that the native populations experience a significantly higher rate of otitis media than what would be considered normal and presents

a concern for those professionals dealing with these populations medically and scholastically. If these populations are more "at risk" for otitis media with effusion and its associated problems, then it may be assumed that they are also more at risk for delayed language development. Unfortunately, according to McShane and Mitchell (1979), many professionals that deal with Native American children and their communities are unaware of the prevalence of otitis media and its possible detrimental effects on the children's language development. Otitis media, as stated before, is a common disease that affects most children to some degree; however, with the medical technology now available and with the increasing interaction of professionals with children in the area of communication due to the enactment of public laws protecting the educational rights of all children, chronic middle ear problems and the possibility of resulting language delays are not inevitable. It is important to turn some of our attention to a population "at risk" for problems that may affect their success in early years of development, thus affecting later years of education and learning.

Purposes and Objectives

Purpose:

The purpose of this literature review was to investigate the potential effects of otitis media on language development and

future academic success in Native Americans and the Australian Aboriginal groups. This was accomplished through examination of the existing literature pertaining to otitis media and hearing, hearing and language development, language and academics, and prevalence of otitis media in Native populations.

Objectives

In order to complete this review of the literature, the following objectives were the focus:

1. To define the relationship between otitis media and hearing loss.
2. To determine the potential effects of hearing loss on language development.
3. To integrate the findings regarding hearing loss, otitis media, and language development.
4. To substantiate the prevalence of otitis media in the native populations of the United States, Canada, and Australia.
5. To investigate the relationship between the prevalence of otitis media and possible effects on language and academic performance in Native populations.

Procedures

Identification of Studies

The search for information for this literature review included searches of several sources. These included:

1) Studies and information extracted through search of ERIC (Educational Resources Information Center) from the years 1960-1992.

2) Literature obtained through Medline search from the years 1980-1992.

3) Sources of information obtained through personal collections of professionals in the field of communicative disorders.

4) Additional sources obtained from relevant studies used as references at the end of the studies reported.

Key words used in searching these sources included: Native Americans and otitis media, otitis media and language, language and academics, ear infections and children, otitis media, American Indians and ear disease, hearing and otitis media, Aborigines and otitis media.

Studies used in this review were obtained from these sources: Alaska Medicine, Annals of Ototorhinolaryngology, American Journal of Public Health, Archives of Otolaryngology, Canadian Journal of Public Health, Clinical Pediatrics, Hearing Instruments, Journal of American Indian Education, Journal of Learning Disabilities,

Journal of Speech and Hearing Disorders, Journal of Speech and Hearing Research, The Laryngoscope, Otitis Media and Child Development, Pediatrics, Pediatric Annals, Public Health Reports, The Journal of Pediatrics, The Volta Review, and Topics in Language Disorders.

Data Collection

A coding instrument was developed in order to effectively analyze the extensive information to be included in this review. Coding the data provided a way to extract the same information from each study in order to make more accurate and conclusive assumptions from the material gathered. This coding instrument can be found in Appendix B.

Results

The purpose of this literature review was to extract information from studies in the existing literature pertaining to otitis media, its possible effects on hearing and language, and its prevalence in native populations. In order to identify trends existing in the literature, similar information from each study was examined and organized on a code sheet. This information has been summarized and can be found in Appendices C-E.

Otitis Media and Hearing

Information in the literature regarding otitis media and hearing is summarized by authors, year, population, age, number of subjects, any environmental factors included as a variable in the study, history or presence of otitis media, type of otitis media and information regarding hearing loss in Appendix C. Eight articles were included that represent the literature supporting a fluctuating hearing loss accompanying otitis media. Due to change in sample size within an article, multiple studies within an article, and changes in dependent and independent variables, the eight selected articles were broken into thirteen studies and will be addressed as separate studies throughout this review. Sample sizes within the 13 studies ranged from 29 to 1609, M=280, SD=374. Ages of the subjects ranged from birth to school age. The types of otitis media that will be referred to throughout the remainder of this review are defined thoroughly in the Glossary of Terms in Appendix A.

Slight Hearing Loss

Six of the thirteen studies reported a hearing loss of 15 dB HL to 26 dB HL, (which will be referred to as a slight hearing loss for the purpose of consistency), or failed hearing screening associated with middle ear problems. Of these six studies, one reported the hearing loss in children with acute otitis media

(Olmstead, et al, 1964). Another study found a hearing loss in some of the subjects with serous otitis media (Nelson & Berry, 1984). A slight hearing loss was reported by Nelson again in 21% of subjects with the presence of otorrhea. Two studies reported a failed screening; Nelson and Berry (1984) found a several cases of a failed screen in the presence of either otorrhea, acute otitis media, serous otitis media, or a perforated tympanic membrane. A final study reported failed hearing screenings with the presence of an irregular tympanogram (Ickes & Kell, 1982). The prevalence of a slight hearing loss within the sample population with the presence of slight hearing loss ranged from 21% to 67%.

Mild Hearing Loss

A mild hearing loss (26 dB to 41 dB) in subjects with some type of otitis media was reported in 11 of the 13 studies. Four of these accompanied a history or presence of otorrhea (Lewis, et al, 1976; Nelson, 1984; Brody, 1965; Reed, 1967). Two studies showed a mild hearing loss within the subjects having a perforated tympanic membrane (Kaplan, et al, 1973; Nelson & Berry, 1984). A mild hearing loss accompanying subjects with serous otitis media was reported in a study by Nelson and Berry (1984). Three studies addressed the presence of a mild hearing loss with the presence of one of several possible middle ear problems. Perkins and Church (1960) found a hearing loss in subjects with otitis media or a perforated ear drum. Similarly, Lewis et al (1976) found a mild hearing loss with the presence of either otorrhea, an ear drum

perforation, or a scarred ear drum. In a study by Nelson and Berry (1984), a mild hearing loss was found in the subjects who had otorrhea, acute otitis media, serous otitis media, or a perforated ear drum. The prevalence of mild hearing loss reported in these studies ranged from 6% to 41% with a mean of 22% and a standard deviation of 15.

Moderate Hearing Loss

Of the thirteen studies, seven reported a moderate hearing loss (41 dB or greater) in subjects with some type of otitis media. In four of these cases, the authors reported the history or presence of otorrhea (Nelson & Berry, 1984; Brody, et al, 1965; Brody, et al, 1965; & Reed & Brody, 1967). Kaplan et al (1973) and Nelson et al (1984) found the presence of a moderate hearing loss in subjects with a perforated tympanic membrane and Nelson and Berry (1984) reported a moderate hearing loss in a group of people with serous otitis media. The prevalence within sample groups of a moderate hearing loss in association with some type of middle ear abnormality ranged from 1% to 32% of the subjects.

Variables

Type of otitis media

Among the variables to be considered in reporting hearing loss associated with the presence of middle ear abnormalities is the type of abnormality. There is some variability and interchangeability in the terms used to describe the types of

otitis media. With respect to the types described in the problem statement and elaborated on in the Glossary of Terms, twelve of the thirteen studies addressed a specific type of otitis media (Reed, et al, 1967; Reed, et al, 1967; Olmstead, et al, 1964; Brody, et al, 1965; Brody, et al, 1965; Ickes & Kell, 1982; Nelson & Berry, 1984; Nelson & Berry, 1984; Nelson & Berry, 1984; Kaplan, et al, 1973; Lewis, et al, 1976;). On the other hand, one study described a presence of otitis media without any specific reference to the type of otitis media present (Perkins & Church, 1960).

History of otitis media

The history of otitis media within the subjects was coded as either one episode or multiple episodes. Five of the thirteen studies gave information regarding the history of one or more episodes of otitis media. The remaining eight studies gave prevalence information with regard to hearing loss with the presence of middle ear problems.

Variables Not Addressed

Some of the variables that were considered important in drawing conclusions about otitis media and hearing loss and were included on the coding sheet but not addressed in these articles were: (1) the presence of unilateral versus bilateral otitis media; (2) length of effusion or time with fluid in the middle ear; (3) feeding method; and (4) urban versus rural living. Some

factors that were addressed, but not as independent variables were age of onset, socioeconomic status, frequency of health care, day care, and living conditions.

Hearing Loss/Otitis Media and Language

Eleven articles were included in this review representing the existing literature supporting an effect on language tasks with the presence of varying degrees of hearing loss or otitis media. Appendix D summarizes information extracted from the 11 studies by author, age of subjects, number in study, type of hearing loss or otitis media, tests administered, and statistically significant findings. More detailed descriptions of the tests administered can be found in Appendix F. If a test is referred to as statistically significant on the summary table, the scores obtained from the experimental group were significantly different from those obtained from the control group. Some test findings are written as percentages with respect to the number of children below a certain percentile rank.

Sample sizes within the eleven studies ranged from 1 to 323. Subjects in the studies included children from the age of 0 to 7 years.

Hearing loss and language

Five of the eleven studies examine the effects of hearing loss on language performance. Davis (1974) and Matkin (1963) reported the significant difference in language performance as assessed through formal testing between children with normal hearing, children with mild hearing losses, and those with moderate hearing losses. When a test of basic concepts was administered, Davis found that children with greater hearing losses received lower scores. The normal hearing children had 83% scoring above the 80th percentile. 58% of children with a hearing loss of 35-50 dB HL scored below the 10th percentile and 91% of the children with a hearing loss of 51-70 dB HL scored below the 10th percentile. Matkin used an oral language test which screened syntax and articulation skills. The group of children with normal hearing had a failure rate of 11% failed the screening and 11% were labelled "borderline," meaning they did not fail the screening, but did not obtain results indicative of normal hearing. Again, children with a greater hearing loss had a higher failure rate. Children with slight to mild hearing losses had a failure rate ranging from 40% to 36% failed screenings respectively. Borderline scores ranged from 20% to 40%. Only one child represented the effects of a moderate hearing loss with a 100% failure rate.

Three studies compared children with normal hearing to children with documented mild to moderate hearing losses. Blair, Peterson, and Viehweg (1985) reported significantly lower scores in children with mild (20-45 dB HL in better ear) losses than their

peers with normal hearing on a the Iowa Test of Basic Skills (ITBS), a test of vocabulary and language. Updike and Thornburg (1992) found significantly lower test scores in children who had a documented chronic conductive hearing loss than their normal hearing peers on a test of auditory skills. Lower scores appeared in the sound mimicry, sound analysis, and sound blending subtests. In Holm and Kunze's (1969) study examining children with a documented fluctuating hearing loss in comparison to their normal hearing peers, significantly lower scores were obtained from children with a hearing impairment in the areas of receptive vocabulary and the total score of the Illinois Test of Psycholinguistic Abilities (ITPA) as well as the visual decoding , verbal analogies, expression of ideas, use of grammar and syntax, and sequencing subtests. Lower scores also were reported on the Mecham Verbal Language Development Scale.

Otitis media and language

Four studies looked specifically at the difference in language scores between children with a history of otitis media and those with no history of otitis media (1 episode or less). Silva, Chalmers, and Stewart (1986) reported significantly lower scores on the verbal subtests (expressive and receptive) of the Illinois Test of Psycholinguistic Abilities (ITPA) and the Reynell Developmental Language Scales in children with a history of bilateral otitis media. Lower scores on the Sequenced Inventory of Communication Development-Expressive scale were reported by Wallace et al (1988)

in children with a history of recurrent otitis media as opposed to their peers with no history of otitis media. Children with chronic otitis media in a study by Zinkus and Gottlieb (1980) scored lower than their peers with a negative otitis media history on the Carrow Test of Auditory Comprehension (CTACL) and the on auditory sequencing, grammatic closure, and auditory association subtests of the ITPA. In addition, informal assessment of developmental landmarks revealed that the children with a positive history of otitis media were later in reaching the 3-word phrase level and the 10-word vocabulary level. Teele et al (1984) did a study that divided children into three groups according to the duration of otitis media. The first group of children had otitis media for a total of less 30 days. The second group's time with otitis media extended from 30 to 129 days. The third group had otitis media for more than 130 days. Teele found that as the duration of otitis media number of days increased, significant decreases in scores on the Peabody Picture Vocabulary Test (PPVT) and auditory comprehension and verbal ability quotients of the Zimmerman Preschool Language Scale (ZPLS) resulted.

Academics

Several studies looked at the effects of otitis media or hearing loss on academic factors such as intelligence and reading. Two studies looked at the reading skills of children with hearing loss (Blair, et al, 1985; Updike & Thornburg, 1992). Blair found decreased performance on the reading comprehension subtest of the ITBS in children with a mild sensorineural hearing loss. Updike

also compared children with chronic conductive hearing loss associated with recurrent otitis media with normal hearing children using the Classroom Reading Inventory. Scores were significantly lower in the following subtests: word decoding, independent and instructional level, frustration level, comprehension at independent and instructional level, and comprehension frustration level.

Two studies reported decreased reading performance in children with a history of otitis media (Silva, et al, 1986; Zinkus & Gottlieb, 1980). Zinkus found lower scores on the WRAT in 20 children with a history of chronic otitis media in the 3 years before the study. Silva et al (1986) compared children with bilateral otitis media and otitis-free children and found significantly lower scores on the Burt Word Reading Test.

Three studies reported significantly lower intelligence scores. Two of these were in children with a history of otitis media (Silva, et al, 1986; Zinkus & Gottlieb, 1980). One study found increasingly lower intelligence scores in children with increasing hearing loss (Davis, et al, 1986). Davis and Zinkus used the Weschler Intelligence Scale for Children, which measures mental ability with performance tasks as well as verbal tasks. One final study (Kodman, 1963) regarding academic performance in hearing impaired children, found that in a group of 100 mildly hearing impaired children, 57 grades were repeated which is an average of 1 to 2 repeated grades for each child.

A summary of the number of studies in this literature review that found significant differences in the scores between children with normal hearing and children with hearing losses/otitis media with respect to expressive or receptive language, reading, and intelligence tests can be found in Table 1. This table indicated that the majority of studies that tested these skills found significant differences in performance between the subjects in expressive and receptive language, intelligence, and reading skills.

Table 1. Effects of otitis media/hearing loss on language

#/ total	Significantly lower scores in:	Hearing loss	History of OM
7/10	Expressive Language	3	4
7/9	Receptive Language	3	3
4/4	Reading	1	3
3/4	Intelligence	1	2

This table indicates that the majority of studies that tested these skills found significant differences in performance between the subjects with and without normal hearing, ranging from 70% in expressive language findings to 100% in reading findings.

Variables/Factors Not Addressed

Some factors that were considered important and included on the coding sheet, but not addressed in the preceding studies were

bilateral versus unilateral otitis media/hearing loss, length of time with otitis media, early onset of hearing loss/otitis media versus later onset, and types of otitis media. These factors are important to the establishment of any conclusive statements about the effect of otitis media on language, because each of them may effect the degree of hearing loss, the extent to which the disease interferes with normal language stimulus, or the ability for a child to compensate for the language information that may have been missed during episodes of otitis media.

Otitis Media and Native Populations

Sixteen articles were included in this literature review regarding the prevalence of otitis media within Native populations. Due to changes within studies in number of subjects or independent variables, these have been coded as nineteen separate studies and will be addressed as such throughout the paper. Appendix E summarizes the information extracted from the selected articles according to author, year of publication, population, age of subjects, number of subjects, and environmental factors that have a possible effect on the outcome of the study such as age of first attack, hearing loss, and living conditions. Also included in the summary table is prevalence of ear disease, and history of ear disease.

Sample sizes within the 19 studies ranged from 29 to 3318 and subject age ranged from 0 to 4+. The populations included in the study are Alaskan Eskimo, Navajo, Aborigine, Shoshone, Arapaho, Colorado River Tribes, Hopi, Apache, and Canadian Eskimo. Populations included as control groups are Alaskan Caucasians and North American Caucasians. Types of ear disease addressed by the studies included otitis media, acute otitis media, chronic otitis media, otorrhea, and serous otitis media. Also addressed was irregular tympanograms and scarred or perforated ear drums. These terms are those used by the authors in the studies and may indeed describe the same ear condition. These terms are all defined in the glossary of terms in Appendix A.

Otitis Media

Four studies addressed the prevalence of otitis media in the Alaskan Eskimo, Shoshone, and Arapaho populations. One study addressed otitis media in a group of Alaskan Caucasian children and their siblings. Otitis media was the general term used by the authors of the studies and represented a variety of pathological middle ear (see Appendix A). Sample sizes ranged from 29 to 503 and ages of subjects ranged from 0 years to school age. Three studies reported prevalence of otitis media history in their subjects, one reporting both incidence of single episodes and multiple episodes (Reed & Brody, 1966; Johonnot, 1973; Kaplan, et al, 1973). One study reported prevalence of otitis media in

Shoshone and Arapaho children at the time of study (Perkins & Church, 1960).

Reed and Brody (1966) reported the history of otitis media in a group of Alaskan Caucasian children and their siblings. Reed did not differentiate between the incidence of single versus multiple episodes. History of otitis media was found in 68% of the subjects and 50% of the siblings. Johonnot (1973) also reported the history of otitis media in her study of Alaskan Eskimo children. 50% of the children in this study had a history of otitis media; again single episode versus multiple episodes were not delineated in this study. Kaplan et al (1973) reported a single episode of otitis media in 18% of Alaskan Eskimo children in his study. Multiple episodes were found in 57% of the children.

Acute Otitis Media

Acute otitis media is reported in five studies. Sample sizes ranged from 221 to 1710 and age of subjects ranged from 0 to 4+ years. Again, one study gave figures representing the prevalence of the disease at the time the subjects were examined (Nelson & Berry, 1984). Four other studies looked at the history of acute otitis media in the subject, including the history of one episode and history of multiple episodes (Shaw, et al, 1981; Shaw, et al, 1981; Goodwin, et al, 1980; Shaw, et al, 1979). The populations reported on are the Hopi, Navajo, Apache, and Colorado River tribes as well as a mixture of other Native American groups.

The prevalence of a single episode of acute otitis media in the children's medical histories ranged from 16% in a group of Navajo, Hopi, Apache, and Colorado River Indian children from the age of 2 to 4 yrs (Goodwin, et al, 1980) to 26% found in another sample of children from the ages of 0 to 1 years within this same study by Goodwin and among Colorado River Tribe children in a study by Shaw et al (1981).

Multiple episodes of acute otitis media 18% n a group of Hopi, Navajo, Apache, and Colorado River tribe children (Goodwin, et al, 1980) to 52% in a group of Apache children (Shaw, et al, 1981).

Nelson and Berry (1984) conducted a study of 1609 Navajo children in which he found the prevalence of acute otitis media to be .04% or 64 children.

Chronic Otitis Media

Two studies reported the prevalence of chronic otitis media in Alaskan Eskimo children (Johonnot, 1973) and Canadian Eskimo children (Schaefer, 1971). Johonnot found the presence of chronic otitis media in 4% of 136 subjects from an urban background and 18% in 300 children from a rural background. History of chronic otitis media in Schaefer's subjects ranged from 3.5% in breast-fed Canadian Eskimo children to 62% in bottle-fed children of the same ethnic background.

Otorrhea

Nine of the nineteen studies reported the prevalence of otorrhea. Sample size ranged from 71 to 2000 and age of subjects ranged from 0 to 4+. Some of the studies gave figures representing the percentage of cases they found at the time of examination while others examined the history of otorrhea in its subjects. Five studies looked at the history of otorrhea, including percentages of subjects who experienced one episode of otorrhea and percentages of those who experienced multiple episodes. Four reported on the prevalence of the disease at the time of examination.

Percentage of subjects that experienced one attack or less of otorrhea ranged from 7% (Brody, et al, 1865) to 22% (Reed & Brody, 1967). One study (Kaplan, et al, 1973) reported a history of otorrhea in 76% of the subjects who had all suffered from at least one attack of otitis media. Kaplan et al (1973) also reported that among a two groups of children who were referred with otorrhea, 54% had a history of one episode of otorrhea in the first group and 15% in the second group. The subjects of this study were not randomly selected from the population, but were children that were chosen for the study because of the presence of otorrhea. For the purposes of the study, their medical histories were examined for the prevalence of otorrhea in their past. The percentages reported would most probably be lower if the samples had been randomly selected from the population so the percentages were not included in the range. Multiple attacks of otorrhea ranged from 5% (Brody, et al, 1965) to 40% (Reed & Brody, 1967) within the studies. In

the study by Kaplan et al (1973), children in the first group who had otorrhea at the time of the study had a history of otorrhea in 46% of the cases and 85% of the cases in the second group. These elevated percentages were not included in the range because, again, they are not representative of a random sample.

The prevalence of otorrhea in the populations in the four studies that addressed prevalence ranged from .8% in a study of the Navajo people (Nelson & Berry, 1984) to 12% obtained in a sample of Aboriginal children.

Serous Otitis Media

Nelson and Berry (1984) reported a prevalence of serous otitis media of 2% in a study of 1609 Navajo children who lived on a reservation.

Irregular Tympanogram; Scarred/Perforated Tympanic Membrane

Three studies reported the prevalence of an irregular tympanogram obtained through immitance testing (Lewis, et al, 1976; Ickes & Kell, 1982; Nelson & Berry, 1984). Lewis et al (1976) found irregular tympanograms in 53% of Aboriginal children studied. In a study by Nelson and Berry (1984), presence of an irregular tympanogram was reported in 8% of Navajo subjects. Prevalence of irregular tympanograms in a group of children of mixed Native American background was 39% (Ickes & Kell, 1982). Ickes compared this group to a group of non Native children, who had irregular tympanograms in 38% of the cases.

Four studies reported the prevalence of scarred and perforated tympanic membranes, often indicative of fluid in the middle ear cavity (Jaffe, 1968; Kaplan, 1973; Lewis, 1976; Johnson, 1967). Two studies looked at the prevalence of perforated tympanic membranes only (Perkins & Church, 1960; Nelson & Berry, 1984). Figures regarding the prevalence of scarred ear drums ranged from 8% in a group of Navajo children (Johnson, 1967) to 16% both in a group of Aboriginal children (Lewis, et al, 1976) and in a group of Alaskan Eskimo children (Kaplan, et al, 1973). Prevalence of Tympanic membrane perforation ranged from 3% in a group of Shoshone and Arapaho children (Perkins & Church, 1960) to 20% in Alaskan Eskimo children (Kaplan, et al, 1973).

Variables

Independent variables within the nineteen studies besides population included living conditions, feeding method, presence of illness before onset of otitis media, age of onset, otitis media history, urban versus rural dwelling, and time observed for study. Shaw et al (1981) reported prevalence of acute otitis media in the Hopi, Navajo, Apache, and Colorado River tribes with information about each population's living conditions with respect to electricity, crowding, and plumbing. There was no apparent difference in prevalence as a result of living conditions as the Apache population had the highest prevalence of acute otitis media, but relatively better living conditions, 100% having electricity, 53% with crowded living conditions, and 11% without plumbing as

compared to the other populations. In these groups no electricity ranged from 10% (Colorado River tribes) to 91% (Navajo), crowding living conditions ranged from 10% (Colorado River tribes) to 88% (Navajo), and no plumbing ranged from 1% (Colorado River tribes) to 90% (Navajo).

Feeding method is addressed as a variable in a study by Schaefer (1971) who looked at the feeding method of Canadian Eskimo children. Schaefer reported that breast-fed children had a lower prevalence (3.5% to 11%) than children who were bottle fed (27% to 62%). Shaw et al (1981) suggested feeding method as a possible variable in the prevalence of acute otitis media and reported than 85% of the subjects had been bottle-fed while the remainder were breast-fed or the feeding method was unknown; however, Shaw did not include feeding method as an independent variable.

Upper respiratory illness as a precursor to otitis media was addressed as a variable in a study by Reed and Brody (1966). There was a higher history prevalence of otitis media (68%) in a sample of children of whom the majority had an upper respiratory illness prior to the onset of otitis media as compared to the children without prior illness, with a prevalence of 50%.

Kaplan et al (1973) compared the history of otorrhea in two groups differing by age of onset. The age of onset refers to the age at which the child experienced his/her first episode of otorrhea. In the group of Alaskan Eskimo children whose age of onset ranged from 0 to 1 year, 15% had a history of one episode and 85% had a history of multiple episodes. In the second group whose

age of onset was 1 year or older, 54% experienced one episode of otorrhea and 46% experienced several episodes. It appears that in this study, the children whose age of onset was lower, had a higher history of multiple episodes of otorrhea, while more in the group with a higher age of onset had a history a single episode. In a study on the Hopi, Navajo, Apache, and Colorado River tribes Goodwin et al (1980) compared the history of acute otitis media between children of different age groups. 26% of the children between the ages of 0 and 1 had a history of a single episode of acute otitis media and 34% had a history of multiple episodes. The prevalence of single and multiple episodes decreased as the age of the children increased, with 24% of 1 to 2 year old children experiencing one episode and 19% experiencing multiple episodes. 16% of children from the age of 2 to 4 yrs had a history of a single episode of acute otitis media and 18% had a history of multiple episodes.

One study addressed the history of otitis media as a variable that possible effected the prevalence of middle ear disease in its subjects (Kaplan, et al, 1973). Alaskan Eskimo children with a history otitis media consistently had higher prevalence of middle ear abnormalities than children without a history of otitis media. Of the children with a positive otitis media history 10% had otorrhea, 20% had perforated ear drums, and 16% had scarred ear drums as opposed to the group which had a negative history of otitis media. 5% of these children had otorrhea, 10% had perforated ear drums, and 7% had scarred ear drums.

Urban versus rural dwelling was a variable addressed by two studies (Schaefer, 1971; Johonnot, 1973). Johonnot (1973) found a higher prevalence (18%) of chronic otitis media in subjects from a rural background than those from an urban setting (4%). Schaefer (1971) also conducted a study with urban versus rural background as a variable possibly effecting prevalence of chronic otitis media. The results were not consistent, with a higher prevalence in breast-fed, urbanized subjects than their rural counterparts and a lower prevalence in bottle-fed urbanized subjects than their rural counterparts. These results are not conclusive with respect to the effects of rural versus urban background due to the presence of a second variable (feeding method).

A final independent variable that was addressed by Shaw et al (1979) was time spent in observation of the subjects. 23% of children observed for one year after birth had a history of a single episode of acute otitis media and 31% had multiple episodes. In the children observed through their second year of life, 25% had a history of one episode and 36% had a history of multiple episodes. This shows a slight increase in number of episodes in children observed after the first year of life.

The variables addressed by the authors of the studies, the number of studies that addressed the variable, and their possible effects on the prevalence or history of middle ear disease are summarized in Table 2.

Table 2. Summary of reported effects of variables on prevalence/history of ear disease

#	Variables	# studies	otitis media higher?	no difference
1	Higher level of living conditions	1		X
	Lower level of living conditions			
2	Breast-fed	1		
	Bottle-fed		X	
3	Upper respiratory illness prior to onset of otitis media	1	X	
	no illness prior to otitis media			
4	Age of onset: 0 to 1 year	2	X	
	Age of onset: 1+ years			
5	History of otitis media	1	X	
	No history of otitis media			
6	Urban background	2		
	Rural background		X	
7	Subjects observed 1 year	1		
	Subjects observed 2 years		X**	

**significance of difference between the two groups is questionable

Discussion

The overall purpose of this paper was to investigate the potential effects of otitis media on language development in Native populations. Various studies have addressed the hearing loss associated with otitis media; others have explored the effects of hearing loss on language development. Still others have addressed the prevalence of otitis media in native populations. This

literature review attempted to integrate these factors and suggest a link between otitis media, language development, and academic success in Native populations.

The first objective of this literature review was to define the relationship between otitis media and hearing loss. The existing literature consistently agrees that there is a hearing loss associated with otitis media and it is variable in nature. The degree of loss is believed to be dependent on the volume of effusion within the middle ear. This factor is not addressed in most studies, making it difficult to establish a predictive measure of hearing loss in association with a given episode of otitis media due to the difficulty in determining the volume of fluid in the middle ear. A study that illustrates this variability in hearing loss was done by Bess (1983) who reported data from several studies in the form of a composite audiogram of subjects diagnosed with otitis media with effusion. Of these subjects, 7.7% showed an average hearing loss of 10 dB or less. Approximately 91% had a loss between 16 dB HL and 40 dB HL and 0.8% showed losses above 50 dB HL. The majority of the subjects had a loss ranging from 16 to 40 dB HL; this agrees with the reported average loss for the speech frequencies reported by Bess, which is 27.6 dB HL.

The term "fluctuating hearing loss" is often used to describe the hearing loss associated with otitis media which indicates that the hearing loss is not static, but changing throughout the episode of otitis media. It stands to reason that children tested for hearing sensitivity during an episode may have different results,

some experiencing a mild loss, some a moderate hearing loss and others experiencing no hearing loss at all. The results of this literature review were consistent with this assumption. Six studies reported a 15 to 25 dB HL hearing loss in 21% to 67% of subjects with otitis media. Eleven studies found cases of a hearing loss of 26 to 40 dB HL in subjects with otitis media; prevalence ranged from 6% to 41%, and seven reported 1% to 32% of subjects with otitis media having a hearing loss of 41 dB HL or more. The degree of hearing loss found in these studies varied from slight to moderate, with a slightly higher prevalence found in subjects with a hearing loss of 15 to 25 dB HL. The prevalence of slight hearing loss in subjects with otitis media would most likely not be as high as 67%, but the study that reported this high prevalence addressed hearing loss as any loss greater than 15 dB HL, and may include cases of mild and moderate loss also.

The second objective of this literature review was to determine the potential effects hearing loss on language development. Language is a complex process that carries over into virtually every aspect of living. Whether it be verbal or nonverbal, language is multifaceted and not a process that can be completely evaluated or measured with one or even several standard tests; however, some of the tests that are available for professionals to use for the evaluation of language, its content, form, and use are somewhat revealing and can help to indicate possible problems/problem areas with language. The articles used in this literature review were dominantly studies of performance on

one or several language tests by children with otitis media or a hearing loss. Results were varied and fairly inconsistent due to the many variables that cannot all be controlled. Not only is there the standard test variability such as tester, attitude and motivation of child, reliability and validity of the test, but there are several more variables with respect to otitis media. These include such things as time of onset, type of otitis media, volume and length of effusion, and degree of hearing loss, which were not addressed for the most part in the literature. The length of effusion and volume of fluid are the most important factors, because most children have impaired hearing when fluid is present and fluid often persists in the middle ear for weeks to months after each episode of otitis media (Klein, 1986) and the volume of fluid is thought to determine the degree of the hearing loss. Many of the studies that addressed otitis media and language performance did not address these factors; thus, results of formal testing must be interpreted with caution and is highly inconclusive with respect to general assumptions about effects of otitis media on language. We can, however, look at the trends that appear with regard to the varying effects of hearing loss on language and make some inferences as to the possible effects a fluctuating loss with otitis media could have on language.

Within the literature review, the majority of the studies found a difference in language scores between children with a fluctuating conductive or sensorineural hearing loss and children with normal hearing. Seven of ten studies found significantly

lower expressive language scores in groups with a hearing loss or in subjects with a fluctuating hearing loss (otitis media) than their peers with normal hearing; seven of nine studies found similar results in receptive language scores. Additionally, it is important to note that between groups with differing degrees of hearing loss, children with a greater loss did more poorly on language tasks than the other groups. It can be inferred from these observations that during an episode of otitis media, there would be greater risk for problems during periods of greater hearing loss or greater volume of middle ear effusion. Children with recurring episodes of otitis media spend more time with fluid in the middle ear and are therefore more at risk for possible language problems.

In discussing the importance of having good reception and expression of language, the interplay of compensatory abilities must be considered. It is thought that even with a distorted signal being received by a child or loss of hearing for a time during bouts of otitis media, a child has the ability to compensate for lost information in the time that hearing is normal. This innate ability of people to compensate for loss cannot be ignored; nevertheless, the optimal learning of children is of a great concern also. The group of children who may experience problems in language tasks due to recurrent episodes of conductive hearing loss are a concern to professionals who are interested in the academic success of children.

Truly, language is the basis for all learning and academic tasks. Children use language to communicate ideas, interact with peers, learn to read, and eventually learn to talk about language itself in a way that perpetuates learning. These are all significant components of the academic process that all children go through in today's school systems. The ability to use language effectively will determine a child's ability to "survive school" and emerge with the skills necessary to continue education or join the working world. Several studies within this literature review addressed the intelligence and reading skills of children with sensorineural or fluctuating conductive hearing losses. One hundred percent of the studies found differences in reading scores between children with some type of hearing loss and children with normal hearing. Seventy-five percent of the studies that addressed intelligence scores found that children with some type of hearing loss had significantly lower intelligence scores than the children with normal hearing. It is interesting to note that the bases of the Stanford-Binet Intelligence Scale and the Wechsler Intelligence Scale for Children-Revised (two of the intelligence tests that were administered in the studies) are based pretty heavily on verbal abilities, or in other words," language." If language is as important as we know it is, it is important to nurture the development of language in children and attend carefully to the language of children who may be "at risk" for language problems such as children with recurrent episodes of otitis media.

An important part of addressing the possible problems of these children with recurrent episodes of otitis media is knowing who is "at risk." The third objective of this paper was to document the prevalence of otitis media among native populations of the world, who have long been considered "at risk" for this disease. There are many studies that are dedicated to the documentation of the prevalence of middle ear disease in these populations and it is well accepted that there is indeed a prevalence and a need for intervention. Johnson (1967) reported that among some groups of American Indians there is a prevalence rate of 15 times that of the general population of the United States. Although it is difficult to establish any accurate prevalence figure due to the variability of otitis media, the prevalence rate is very low at any given time for Caucasian children, though most of these children will at some time experience an episode of otitis media. Lowe et al. (reported in a study comparing Eskimos to Caucasian children that none of the Caucasian children showed any sign of middle ear pathology. Thirty percent of the Eskimo children, however, had an active case of acute otitis. As mentioned, it is not unexpected for any child to experience one or even more episodes of middle ear disease early in life; but at any given time, thirty percent with active otitis media is abnormal.

This review of the literature supports the prevalence of otitis media in native populations. Results of this study indicate that 5% to 85% of native populations experienced multiple episodes of otitis media, the highest percentage occurring in Alaskan

Eskimos with otorrhea. This is significantly higher than what would be expected and brings up many questions about the factors involved in these particular groups that makes them more susceptible to middle ear disease. There is a concern at this time regarding these factors that need to be addressed and evaluated for their significance and the degree to which they can be altered or modified for the purpose of intervention. This literature review was designed to simply establish evidence of a prevalence of otitis media, but in the process, it was imperative to know what effect the factors had on the outcome of the studies. It appears that native populations from a rural background tend to have a higher prevalence of ear disease. Also, children that were bottle-fed in infancy had a higher prevalence of middle ear disease. Children who had a history of otitis media, particularly those whose age of first onset was in the first year of life, also had a higher prevalence of otitis media. Understanding these factors may make an impact on how a professional might consider intervention in a population "at risk" such as these native populations.

Conclusion

It is evident through the integration of these various findings that optimal language development is dependent on the ability to communicate. The inability to hear or to receive consistent linguistic signals can be a detriment to a child

requiring good auditory input and may, in fact, interfere with the overall academic performance of the child. The literature has shown that there is often a significant fluctuating conductive hearing loss that accompanies an episode of otitis media and with recurrent episodes, the child may experience a significant portion of time with hearing that is less than optimal for learning. In examining the findings of this literature review, it is also evident that otitis media is prevalent in many native populations of the world, indicating a need for attention and intervention by those professionals concerned with the overall success of these "at risk" children. Language is the foundation for success, for it is the key to the exchange of ideas and emotions, the control over self and situations, and the building of new ideas and philosophies about the world we live in. Every person is entitled to an opportunity to grow in these forms of expression and through the exploration, study of, and intervention with the problems that hinder this expression, more children will receive this opportunity.

Bibliography

Bess, F. H. (1983). Hearing loss associated with middle ear effusion. In: Effects of otitis media on the child. Pediatrics, 71, 639-652.

Blair, J., Peterson, M., & Viehweg, S. (1985). The effects of mild sensorineural hearing loss on academic performance of young school-age children. The Volta Review, 87(2), 87-94.

Brody, J. A., Overfield, T., & McAlister, R. (1965). Draining ears and deafness among Alaskan Eskimos. Archives of Otolaryngology, 81, 29-33.

Davis, J. (1974). Performance of young hearing-impaired children on a test of basic concepts. Journal of Speech and Hearing Research, 17, 342-352.

Davis, J., Elfenbein, J., Schum, R., & Bentler, R. (1986). Effects of mild and moderate hearing impairments on language, educational and psycho-social behavior of children. Journal of Speech and Hearing Disorders, 51(1), 53-62.

Friel-Patti, S. (1990). Otitis media with effusion and the development of language: A review of the evidence. Topics in Language Disorders, 11(1), 11-22.

Giebink, G. S., & Daly, K. (1990). Epidemiology and management of otitis media in children. Topics in Language Disorders, 11(1), 1-10.

Goodwin, M. H., Shaw, J. R., & Felman, C. M. (1980). Distribution of otitis media among four Indian populations in Arizona. Public Health Reports, 95(6), 589-594.

Holm, V. A., & Kunze, L. H. (1969). Effect of Chronic otitis media on language and speech development. Pediatrics, 43(5), 833-839.

Howie, V. M., Ploussard, J., & Sloyer, J. (1975). The "otitis prone" condition. American Journal of the Disabled Child, 129, 676-678.

Ickes, W. K. & Kell, D. (1982). High prevalence of otitis media among Indian children: Fact or myth? Hearing Instruments, 33(2), 61-63.

Jaffe, B. F. (1969). The incidence of ear diseases in the Navajo Indians. Laryngoscope, 79(12), 2126-2134.

Johnson, F. L. (1967). Chronic Otitis media in school age Navajo Indians. Laryngoscope, 78, 1990-1995.

Johonnot, S. C. (1973). Differences in chronic Otitis between rural and urban Eskimo children: A comparative study. Clinical Pediatrics, 12(7), 415-419.

Kaplan, G. J., Fleshman, J. K., Bender, T. R., Baum, C., & Clark, P.S. (1973). Long-term effects of Otitis media-a ten year cohort study of Alaskan Eskimo children. Pediatrics, 52(4), 577-585.

Klein, J. O. (1986). Risk factors for otitis media in children. In J. F. Kavanagh (Ed.) Otitis media and child development (pp. 45-51). Parkton, MD: York Press Inc.

Kodman, F. (1963). Educational status of hard-of-hearing children in the classroom. Journal of Speech and Hearing Disorders, 28, 297-299.

Lewis, A. N., Barry, M., & Stuart, J. E. (1976). Screening procedures for the identification of hearing and ear disorders in Australian Aboriginal children. Journal of Laryngology and Otology, 88(4), 335-347.

Margolis, R., Daly, K., Giebink, G., Gravel, J., & Roberts, J. (1992). Otitis media in children: Pathogenesis, epidemiology, treatment, and sequelae. Paper presented at American Speech-Language-Hearing Association Annual Convention, San Antonio, Texas.

Matkin, N. (1979). Language delay in chronic otitis media. In R. J. Wiet & S. W. Coulthard (Eds.) Proceedings of the Second National Conference on Otitis Media (pp. 58-61). Columbus, Ohio: Ross Laboratories.

Maynard, J. (1969). Prevention of otitis media: epidemiologic observations from studies of Alaska natives. In A. Glorig & K.S. Gerwin (Eds.) Otitis media: Proceedings of the National Conference (pp. 151-157). Springfield, Illinois: Charles C. Thomas Publisher.

McShane, D., & Mitchell, J. (1979). Middle ear disease, hearing loss and educational problems of American Indian children. Journal of American Indian Education.

Nelson, S. M., & Berry, R. I. (1984). Ear disease and hearing loss among Navajo children - A mass survey. Laryngoscope, 94, 316-323.

Nicolosi, L., Harryman, E., & Kresheck, J. (1989). Terminology of communication disorders: Speech-language-hearing (3rd ed.). Baltimore, Maryland: Williams & Wilkins.

Olmsted, R. W., Alvarez, M. C., Moroney, J. D., & Everdsen, M. (1964). The pattern of hearing following acute otitis media. Journal of Pediatrics, 65(2), 252-255.

Perkins, G. B., & Church, G. M. (1960). Report of pediatric evaluations of a sample of Indian children - Wind River Indian reservation. American Journal of Pediatric Health, 50(2),181-194.

Reed, D., Struve, S., & Maynard, J. E. (1967). Otitis media and hearing deficiency among Eskimo children: a cohort study. American Journal of Public Health, 57(9), 1657-1662.

Reed, D., & Brody, J. (1966). Otitis media in urban Alaska. Alaska Medicine, 8, 64-67.

Roland, P. S., & Brown, O. (1990). Tympanostomy tubes: a rational clinical treatment for middle ear disease. Topics in Language Disorders, 11(1), 23-28.

Schaefer, O. (1971). Otitis media and bottle-feeding: an epidemiological study of infant feeding habits and incidence of recurrent and chronic middle ear disease in Canadian Eskimos. Canadian Journal of Public Health, 62(6), 478-489.

Shaw, J. R., Todd, N. W., Goodwin, M. H., & Feldman, C. M. (1981). Observations on the relation of environmental and behavioral factors to the occurrence of Otitis media among Indian children. Public Health Reports, 96(4), 342-349.

Shaw, J., Todd, N., Goodwin, M., & King, G. (1979). Observations on otitis media among four Indian populations in Arizona. In R. J. Wiet & S. W. Coulthard (Eds.), Proceedings of the Second National Conference on Otitis Media (pp. 99-101). Columbus, Ohio: Ross Laboratories.

Silva, P. A., Chalmers, D., & Stewart, I. (1986). Some audiological, psychological, educational and behavioral characteristics of children with bilateral Otitis media with effusion: a longitudinal study. Journal of Learning Disabilities, 19(3), 165-169.

Strange, W. (1986). Speech input and the development of speech perception. In J. F. Kavanagh (Ed.), Otitis media and child development (pp. 12-26). Parkton, MD: York Press Inc.

Teele, D. W., Klein, J. O., Rosier, B. A., & the Greater Boston Otitis Media Study Group. (1984). Otitis media with effusion during the first three years of life and development of speech and language. Pediatrics, 74(2), 282-287.

Updike, C., & Thornburg, J. D. (1992). Reading skills and auditory processing ability in children with otitis media in early childhood. Annual Otorhinolaryngologist, 101(6), 530-537.

Wallace, I. F., Gravel, J. S., McCarton, C. M., & Ruben, R. J. (1988). Otitis media and language development at 1 year of age. Journal of Speech and Hearing disorders, 53, 245-251.

Wright, P., Thompson, J., & Bess, F. H. (1991). Hearing, speech, and language sequelae of otitis media with effusion. Pediatric Annals, 20(11), 617-618, 620-621.

Zinkus, P. W., & Gottlieb, M. (1980). Patterns of perceptual and academic deficits related to early chronic Otitis media. Pediatrics, 66(2), 246-252.

Appendices

Appendix A

Glossary of terms

Acute otitis media. A condition generally symptomatic with signs and symptoms of upper respiratory illness, fever, ear pain, and decreased hearing. Often synonymous with the terms *suppurative, purulent,* and *bacterial* otitis media.

Chronic otitis media. otitis media characterized by persistent infection in the middle ear cavity for a prolonged period of time often used to describe conditions such as middle ear effusions, ossicular fixation, and eardrum perforation.

Mucoid otitis media. this type of otitis media refers to the type of effusion in the middle ear, characterized by a thick, highly viscous, often glue-like fluid, which is usually cloudy.

Otitis media. Otitis media is an inflammation in the middle ear often associated with buildup of fluid. This fluid may or may not be infected. Symptoms, severity, frequency, and length of the condition vary. At one extreme is a single short period of thin, clear, noninfected fluid. The other extreme is repeated bouts with infection, thick "glue-like" fluid.

Otitis media with effusion. A condition involving persistent, asymptomatic escape of fluid into the middle ear cavity; a frequent otoscopic finding is clouding of the tympanic membrane with reduced eardrum mobility and often a retracted tympanic membrane. Synonyms used interchangeably with this term are secretory, nonsuppurative, serous, and mucoid otitis media.

Otorrhea. Draining of the middle ear; associated with build-up of fluid in the middle ear leading to perforation of the ear drum and draining of middle ear fluid.

Serous otitis media. This term refers to the type of effusion in the middle floor characterized by amber colored, thin fluid.

Tympanic membrane. Thin, parchment-like membrane, which separates the outer and middle ear; perforation of this membrane is often indicative of build-up of fluid due to middle ear effusion.

(Giebink, 1990; Nicolosi, L., Harryman, E., & Kresheck, J., 1989)

Appendix B

Coding Sheet

Number of Study					
Focus of Study					
Otitis Media and Hearing					
OM/Hearing loss and language					
OM and environmental factors					
OM and "at risk" populations					
3) Population:					
Alaskan Caucasian					
Alaskan Eskimo					
Navajo					
Canadian Eskimo					
American Indian					
North American Caucasian					
Aleut					
Aborigine					
Hopi					
Apache					
Colorado River tribes					
Non-Indian (mixed)					
4) Residency					
Reservation residence					
Non-Reservation residence					
5) Group					
Experimental Group					
Control Group					
6) Sex					
Male					

Female					
7) Number in Study					
8) Age					
0-1 year					
0-2 years					
2-4 years					
4 years and older					
9) Socioeconomic Status:					
Low					
Middle					
High					
Unknown					
10) Environmental factors					
Crowded living conditions					
Poor hygiene					
Day Care					
Poor Diet					
No electricity					
No indoor plumbing					
Unknown					
11) Frequency of health care					
Regular					
Irregular/rare					
Unknown					
12) Feeding method					
Bottle-fed					
Breast-fed					
Unknown					
13) Population background					

Urban					
Rural					
Unknown					
14) History of Ear disease					
At least one attack					
Multiple attacks					
History of fluct. hearing loss					
No history/unknown history					
Age at first attack					
0-1					
1-2					
3 and older					
Incident of OM in family					
Mean time of effusion					
15) Instruments used to test ear condition					
Otoscopic Examination					
Pure tone testing					
Audiometric screening					
Immittance audiometry					
Parental Report					
16) Characteristics of group/results of testing					
Otorrhea/draining ear					
Otitis media					
Chronic otitis media					
Acute otitis media					
Serous otitis media					
Broken tympanic membrane					
Scarred tympanic membrane					
Illness prior to onset of OM					
Normal Hearing					

Failed screening at one freq.					
Hearing Loss					
Unilateral hearing loss					
Bilateral hearing loss					
Slight hearing loss 15dB+					
Mild hearing loss 26dB+					
Moderate hearing loss 41dB+					
Irregular tympanogram					
18) Formal Language tests					
Articulation test					
Expressive Language					
Receptive Language					
Vocabulary					
19) Informal language tests					
Scales					
Case History					
Parent Interview					
Observation/language sample					
20) Results of language tests					
Normal results					
Significantly lower than peers					

Appendix C

Otitis media and hearing

*all references made in the tables are made to the first author only; see bibliography for full references.

N=number in study; AlEsk=Alaskan Eskimo; AlCauc=Alaskan Caucasian; NAC=North American Caucasian; AOM=acute otitis media; AmerI-m=American Indian-mixed; NI-m=non-Indian-mixed; Nav=Navajo; TM perf=tympanic membrane perforation; SOM=serous otitis media; TM=tympanic membrane; AOM=acute otitis media; Tymp=tympanogram

Author, year*	Pop.	Age/# in study	Factors	Hearing loss
Reed, 1967	AlEsk	Age: 2+	History Otorrhea in 1st two years of life; one episode: 22% multiple: 40%	26-41 dB: 25% (79% U; 21% B) 41+ dB: 6% (36% U; 64% B)
Reed, 1967	AlEsk AlEsk	Age: 2+ N=139 Age: 2+ N=96	Crowded living, irregular health care Single attack Otorrhea Crowded living irregular health care Multiple attacks Otorrhea	26-41 dB: 35% 26-41 dB: 49%
Olmstead, 1964	Aleut	Age: 2+ N=82	Urban dwelling AOM	15-26 dB: 67%
Brody, 1965	AlCauc NAC AlEsk	Age: 0+ N=244 Age: 0+ N=87 Age: 0+ N=327	Otorrhea: multiple attacks Otorrhea: multiple attacks Otorrhea: multiple attacks	26-41 dB: 36% 41+ dB: 1% 26-41 dB: 25% 41+ dB: 1% 26-41 dB: 26% 41+ dB: 13%
Brody, 1965	AlEsk AlEsk	Age: 0+ N=29 Age: 0+ N=72	Otorrhea: one episode Otorrhea: multiple episodes	26-41 dB: 28% 41+ dB: 24% 26-41 dB: 33% 41+ dB: 32%

N=number in study; Nav=Navajo; AlEsk=Alaskan Eskimo; AmerI-m=American Indian-mixed; NI-m=Non Indian-mixed; SES=socioeconomic status; TM perf=tympanic membrane perforation; SOM=serous otitis media; AOM=Acute otitis media; OM=otitis media; TM=tympanic membrane; Ab=Aborigine; NAC=North American Caucasian

Ickes, 1982	AmerI-m	Age: 2+ N=45	Low SES Day Care, Irregular Tymp: 39%	Failed Screen: 9%
	NI-m	Age: 2+ N=42	Low SES Day Care; Irreg. Tymp: 38%	Failed Screen: 4%
Nelson, 1984	Nav	Age: 4+ N=1609	Reservation/rural dwelling Otorrhea: .8% AOM: .04% SOM: 2% TM perf: 4%	Failed Screen: 7% 26-41 dB: 4%
Nelson, 1984	Nav	Age: 4+ N=768	Reservation/rural dwelling Broken TM	15-26 dB: 28% 26-41 dB: 41% 41+ dB: 3.8%
Nelson, 1984	Nav	Age: 4+ N=536	Reservation/rural dwelling SOM	15-26 dB: 29% 26-41 dB: 14% 41+ dB: .7%
Nelson, 1984	Nav	Age: 4+ N=225	Reservation/rural dwelling Otorrhea	15-26 dB: 21% 26-41 dB: 24% 41+ dB: 6%
Kaplan, 1973	AlEsk	Age: 0+ N=268	Reg. health care during study Rural History TM perf	26-41 dB: 14% 41+ dB: 4%
	AlEsk	Age: 0+ N=93	Reg. health care during study Rural No history ear disease	26-41 dB: 7.5% 41+ dB: 1%
Lewis, 1976	Ab	Age: 4+ N=71	Rural Otorrhea: 12% TM perf: 19% Scarred TM: 16%	26-41 dB: 27% U 14% B
Perkins, 1960	NAC	Age: 0+ N=214	Rural OM: 17% TM perf: 3%	H. Loss: 6%

Appendix D

Hearing Loss/Otitis Media and Language Development

N=number in study; SES=socioeconomic status; COM=chronic otitis media; PPVT=Peabody Picture Vocabulary Test; ITPA=Illinois Test of Psycholinguistic Abilities; MVLDS=Mecham Verbal Language Development Scale; S/N=sensorineural; BTBC=Boehm Test of Basic Concepts;

Author, year	Age/# in study	Factors/Variables	Tests given	Significant differences
Holm, 1969	Age: 4+ N=16	Low SES Urban Mult. attacks COM 1st attack: 0-2 yrs. History of fluctuating H.Loss vs.	PPVT ITPA MVLDS	PPVT, ITPA total score, subtests: visual decoding, verbal analogies, expression of ideas, use of grammar and syntax, sequencing, MVLDS
	Age: 4+ N=16	Low SES Urban Normal hearing No history COM		
Davis, 1974	Age: 6-8 N=12	Urban Normal Intelligence S/N H.loss 35-50 dB HL Mid SES vs.	BTBC	58%: below 10th percentile
	Age: 6-8 N=12	Urban Normal Intelligence S/N H.loss 51-70 db HL Mid SES vs.		91%: below 10th percentile
	Age: 6-8 N=12	Urban Normal Intelligence Mid SES Normal hearing		0%: below 10th percentile 83% above 80th percentile

N=number in study; OM=otitis media; COM=chronic otitis media; SRT=speech reception threshold; PTA=pure tone average; WISC-R=Weschler Intelligence for Children; CTACL=Carrow Test for Auditory Comprehension of Language; ITPA=Illinois Test of Psycholinguistic Abilities; WRAT=Wide Range Achievement Test; PPVT-R=Peabody Picture Vocabulary Test; WJPEB=Woodcock-Johnson Psycho-Educational Battery; GFW=Goldman Fristoe Woodcock Auditory Skills Battery; CRI=Classroom Reading Inventory

Zinkus, 1980	Age:7-11 N=20 Age:7-11 N=20	History of COM in 1st 3 yrs. ventilation tubes in 90% 10-20 dB loss(B): 20% 20-30 dB loss(B): 10% 10-20 dB loss(U): 15% Auditory processing problems vs. <1 episode OM in 1st 3 years 10-20 dB loss: 10% Auditory processing problems	WISC-R CTACL ITPA WRAT Informa l	3-word phrase development 10-word vocabulary development CTACL ITPA:subtests auditory assoc. grammatic closure aud. sequencing WISC-R, global IQ verbal IQ WRAT reading
Davis, 1986	Age:5-11 N=16 Age:5-11 N=15 Age:5-11 N=9	PTA: 44 dB and less vs. PTA: 45-60 dB vs. PTA: 61 dB+	PPVT-R WISC-R WJPEB	WISC-R verbal IQ
Kodman, 1963	Age: 7-17 N=100	SRT: 20-65 dB		57 grades repeated mean = 1-2.24 grades

N=number in study; OM=otitis media; PPVT=Peabody Picture Vocabulary Test; S-B=Stanford-Binet; WISC-R=Wechsler Intelligence Scale for Children-Revised; RDLS=Reynell Developmental Language Scale; ITPA=Illinois Test of Psycholinguistic Abilities; BWRT=Burt Word Reading Test; SOLST=Stephens Oral Language Screening Test; SOLST=Stephens Oral Language Screening Test; GFW=Goldman Fristoe Woodcock Auditory Skills Battery; CRI=Classroom Reading Inventory

Updike, 1992	Age:6-7 N=24 vs. Age:6-7 N=24	Normal hearing Normal tympanogram No history OM vs. Chronic conductive hearing loss with OM History of OM 1st episode before 2 yrs.	GFW CRI	GFW subtests: I sound mimicry III sound analysis IV sound blending CRI subtests: *word decoding *independent level *instructional level *frustration level *comprehension independent level *comprehension instructional level *comprehension frustration level
Silva, 1986 cohort from age 3-11	N=39-44 vs. N=297-323	Bilateral OM Urban vs. Normal Urban	PPVT: 3 yrs S-B: 5 yrs WISC-R: 7,9,11 RDLS: 3,5 ITPA 7,9 BWRT 7,9,11	S-B intelligence scale; 5 yrs. RDLS ITPA: verbal expression verbal comprehension BWRT
Matkin, 1965	Age: 4+ N=9 vs. Age: 4+ N=16 Age: 4+ N=25 Age: 4+ N=1 vs. Urban Multiple attack OM 41+ dB H. loss	Urban multiple attack OM Normal hearing vs. Urban Multiple attack OM 15-26 dB H. loss vs. Urban Multiple attack OM 26-41 dB H. loss	SOLST	11% fail 11% borderline 40% fail 20% borderline 36% fail 40% borderline 100% fail

N=number in study; OM=otitis media; PPVT=Peabody Picture Vocabulary Test; ZPLS=Zimmerman Preschool Language Scale; P=probability; OME=otitis media with effusion; BSID=Bayley Scales of Infant Development; SICD=Sequenced Inventory of Communication Development

Wallace, 1988	Age: 0-1 N=11 Age: 0-1 N=13	Regular health care Urban Multiple attacks OM vs. Regular health care Urban No history OM	BSID SICD	SICD-expressive scale
Blair, 1985	Age: 8-10 N=8 Age: 8-10 N=8	Hearing loss: 20-45 dB HL in better ear vs. Normal hearing	ITBS	ITBS: subtests vocabulary reading comprehension language
Teele, 1984	Age: 2-4 N=52-54 Age: 2-4 N=58-63 Age: 2-4 N=80-88	Regular health care Urban OM <30 days vs. Regular health care Urban OM 30-129 days vs. Regular health care Urban OM >130 days	PPVT ZPLS	PPVT P+.002 ZPLS: subtests Auditory comprehension quotient; P=.039 Verbal Ability quotient; P=.05 scores declined significantly as time with effusion increased Time spent with bilateral OME was significantly associated with lower scores; P=.027

Appendix E

Otitis media and Native populations

AlEsk=Alaskan Eskimo; E=experimental group; C=control group; Nav=Navajo; AlCauc=Alaskan Caucasian; NAC=North american Caucasian; N=number in study; URI=upper respiratory infection; OM=otitis media; H=hearing; SES=socioeconomic status; AOM=acute otitis media; TM=tympanic membrane; perf=perforation; SOM=serous otitis media; COM=chronic otitis media

Author, year	Population /group	Age/# in study	Factors	Prevalence of ear disease
Reed, 1967	AlEsk	Age: 2-4 N=378	Health care irregular *First episode: 0-2 yrs-89% 2+ yrs-11%	Otorrhea: One episode=22% Multiple=40%
Reed, 1966	AlCauc	Age: 0+ N=277	URI before OM: 79% Urban	History OM: 68%
	AlCauc	Age: 0+ N=447	Siblings to Exp. group Urban	History OM: 50%
Johnson, 1967	Nav	Age: 4+ N=3318	Reservation living	Broken TM: 6% Scarred TM: 8%
Johonnot, 1973	AlEsk	Age: 2+ N=136	History of OM: 50% Urban dwelling	History OM: 50% COM: 4%
	AlEsk	Age: 2+ N=300	History of OM: 50% Rural dwelling	History OM: 50% COM: 18%
Brody, 1965	AlCauc	Age: 0+ N=103		Otorrhea: one episode=5% multiple=15%
	AlCauc	Age: 0+ N=162	Rural dwelling	Otorrhea: one episode=4% multiple=4%
	NAC	Age: 0+ N=99		Otorrhea: one episode=10% multiple=5%
	AlEsk	Age: 0+ N=95	Rural dwelling	Otorrhea: one episode=6% multiple=5%
	AlEsk	Age: 0+ N=1003		Otorrhea: one episode=8% multiple=23%

AlEsk=Alaskan Eskimo; AI-m=American Indian-mixed; NI-m=non Indian-mixed; Nav=Navajo; Ab=Aborigine; N=number in study; SES=socioeconomic status; AOM=acute otitis media; Ab=Aborigine; OM=otitis media; TM=tympanic membrane; perf=perforation; SOM=serous otitis media; AOM=acute otitis media

Brody, 1965	AlEsk	Age: 0+ N=189	Rural dwelling Normal hearing	Otorrhea: one episode=48% multiple=35%
	AlEsk	Age: 0+ N=65	Rural dwelling 26-41 dB H.Loss	Otorrhea: one episode=28% multiple=33%
	AlEsk	Age: 0+ N=35	Rural 41+ dB H.Loss	Otorrhea: one episode=24% multiple=30%
Brody, 1965	AlEsk	Age: 0-4	Rural	Otorrhea: one episode=9% multiple=25%
	AlEsk	Age: 4+	Rural	Otorrhea: one episode=7% multiple=24%
Ickes, 1982	AI-m	Age: 2+ N=45	Low SES Day Care	Failed Screen: 9% Irregular Tymp: 39%
	NI-m	Age: 2+ N=42	Low SES Day Care	Failed Screen: 9% Irreg. Tympanogram: 38%
Nelson, 1984	Nav	Age: 4+ N=1609	Reservation dwelling	Otorrhea: .8% AOM: .04% SOM: 2% TM perf: 4% Irreg. Tympanogram: 8%
Kaplan, 1973	AlEsk	Age: 0+ N=503	Rural dwelling Regular health care 1st attack: 0-1 yrs: 78% 1+ yrs: 22%	OM history One episode: 18% Multiple: 57% Otorrhea history: 76%
*Kaplan, 1973	AlEsk	Age: 0+ N=291	Age of onset: 0-1 yrs. Rural	Otorrhea: 1 episode: 15% multiple: 85%
	AlEsk	Age: 0+ N=83	Age of onset: 1+ yrs. Rural	Otorrhea. 1 episode: 54% multiple: 46%

AlEsk=Alaskan Eskimo; AI-m=American Indian-mixed; NI-m=non Indian-mixed; Nav=Navajo; Ab=Aborigine; N=number in study; SES=socioeconomic status; AOM=acute otitis media; Ab=Aborigine; OM=otitis media; TM=tympanic membrane; perf=perforation; SOM=serous otitis media; AOM=acute otitis media CRT=Colorado River Tribes; Nav=Navajo; Ap=Apache; N=number in study; SES=socioeconomic status; OM=otitis media; AOM=acute otitis media; TM=tympanic membrane; perf=perforation

Kaplan, 1973	AlEsk	Age: 0+ N=319	History of OM Rural	Otorrhea: 10% TM perf: 20% Scarred TM: 16%
	AlEsk	Age: 0+ N=103	No history of OM Rural	
Lewis, 1976	Ab	Age: 4+ N=71	Rural	Otorrhea: 12% TM perf: 19% Scarred TM: 16% Irreg. Tympanogram: 53%
Perkins, 1960	Shoshone Arapaho	Age: 0+ N=214	Rural Reservation dwelling	OM: 17% TM perf: 3%
Shaw, 1979	AI-m	Age: 0+ N=618	Observed 1 year Rural/Reservation Low SES	AOM: one episode: 23% multiple: 31%
	AI-m	Age: 0+ N=250	Observed 2 years Rural/Reservation Low SES	AOM: one episode: 25% multiple: 36%
Shaw, 1979	CRT, Nav, Hopi, Ap	Age: 0+ N=331	Observed 1 year Low SES History OM, 1st attack, 0-1 yrs: 76%	AOM
	CRT, Nav, Hopi, Ap	Age: 0+ N=414	Observed 1 year Low SES History OM 1st attack, 0-1 yrs: 85%	AOM multiple: 68%
Jaffe, 1968	Nav	Age: 4+ N=2000	Reservation/rural Low SES Crowded living Poor hygiene Irregular Health care	Otorrhea: 1% TM perf: 4.2% Scarred TM: 9.4%
Shaw, 1981	Nav Ap CRT Hopi	Age: 0-1 N=1428	Reservation/rural Low SES Bottle-fed: 85% Breast-fed: 6% 1st encounter: 0-1 yrs.	AOM history 1 episode: 24% multiple: 40%

Nav=Navajo; Ap=Apache; N=number in study; AOM=acute otitis media; CRT=Colorado River Tribes; OM=otitis media; CanEsk=Canadian Eskimo

1981	Hopi	Age: 0-1 N=529	no electric: 27% crowded living: 66% no indoor plumbing: 58%	AOM history 1 episode: 25% multiple: 34%
	Nav	Age: 0-1 N=250	no electric: 91% crowded: 88% no plumbing: 90%	1 episode: 25% multiple: 44%
	Ap	Age: 0-1 N=428	no electric: 0% crowded: 53% no plumbing: 11%	1 episode: 22% multiple: 52%
	CRT	Age: 0-1 N=221	crowded: 10% no plumbing: 1%	1 episode: 26% multiple: 27%
Goodwin, 1980	Hopi, Nav Ap, CRT	Age: 0-1 N=1710	Reservation/rural	AOM history; 1 ep: 26% multiple ep: 34%
	Hopi, Nav, Ap, CRT	Age: 1-2 N=1206	Reservation/rural	1 episode: 24% multiple: 19%
	Hopi, Nav, Ap, CRT	Age: 2-4 N=1136	Reservation/rural	1 episode: 16% multiple: 18%
Schaefer, 1971	CanEsk	Age: 0+ N=314	Breast-fed Rural	OM: 3.5%
	CanEsk	Age: 0+ N=37	Bottle-fed Rural	OM: 27%
	CanEsk	Age: 0+ N=89	Breast-fed Rural	OM: 11%
	CanEsk	Age: 0+ N=29	Bottle-fed Rural	OM: 62%

Appendix F

Tests Cited in Studies

BSID — Bayley Scales of Infant Development; designed to provide evaluation of a child's developmental status in the first 2 1/2 years ; consists of a mental scale, motor scale, and infant behavior record

BTBC: — Boehm Test of Basic Concepts; designed to measure children's mastery of basic concepts

BWRT: — Burt Word Reading Test;

CTACL: — Carrow Test for Auditory Comprehension; designed to assess the ability to process auditory information of varying complexity

CRI: — Classroom Reading Inventory;

GFW: — Goldman-Fristoe Woodcock Auditory Skills Battery; battery of tests designed for diagnostic assessment of auditory skills; includes auditory selective attention test, auditory discrimination test, auditory memory test, and sound symbol test

ITBS: — Iowa Test of Basic Skills

ITPA: — Illinois Test of Psycholinguistic Abilities; twelve subtests to assess various aspects of language processing (reception, association, expression)

MVLDS: — Mecham Verbal Language Development Scale; observation by parents on child's abilities to perform on a series of language tasks

PIAT: — Peabody Individual Achievement Test

PPVT: — Peabody Picture Vocabulary Test; measures vocabulary comprehension by a picture pointing task

PSI: — Pediatric Speech Intelligibility Test; includes 10 sentences that were generated by a large group of normal language children aged 3-6 years. each sentence is 8 syllables on average. Closed set responses; child points to picture that corresponds to picture

RDLS: — Reynell Developmental Language Scales

S-B: — Stanford-Binet Intelligence Scale (Terman & Merrill): measures general intelligence through various tasks;

although some items are labeled as performance, there is heavy emphasis on verbal abilities

SICD-R: Sequenced Inventory of Communication Development-Revised (Hedrick, Prather, & Tobin): diagnostic test designed to evaluate the communication abilities of normal and retarded children; has 2 major sections: receptive and expressive

SOLST: Stephens Oral Language Screening Test; screening device for potential problems in syntax and/or articulation

WISC-R: Wechsler Intelligence Scale for children-Revised (Wechsler); Measures mental ability of young children; divided into 5 verbal and 5 performance subtests

WRAT: Wide Range Achievement Test

WJPEB: Woodcock Johnson Psycho-Educational Battery; this test includes tests of associations, synonyms, and antonyms.

ZPLS: Zimmerman Preschool Language Scale