Critical Review: Possible Causative Factors Related to the Occurrence of Otitis Media among Native North American Children

Cousineau, S.
M.Cl. Sc. Candidate in Audiology
School of Communication Sciences and Disorders, U.W.O.

This critical review examines the possible causative factors related to increased incidence and prevalence rates of otitis media among Native North American children. Study designs include: critical review and quantitative case study observations of health records, cohort studies, and comparative quasi-experimental studies. Overall, research supports the possible contribution of genetic factors, Eustachian tube structural differences, and exposure to harmful organochlorines. Further research is recommended to study these possible effects. Improved study design is recommended for other possible environmental or sociodemographic factors, which may be related to the occurrence of otitis media in this population.

Introduction

Otitis media is a leading cause of infection among Native North American children. What are particularly alarming are the increased incidence and prevalence rates among this population with regards to otitis media compared to the Caucasian population. In the 1990's, the Indian Health Service for the National Center for Health Statistics stated that outpatient visits and hospitalization rates for otitis media in Native children younger than 5 years, was almost 3 times higher than that of Caucasian children of the same age (Daly et al, 2007).

This increased incidence and prevalence of otitis media can lead to problems with respect to language acquisition, and hearing loss that Native children can ill afford (Bowd, 2002; Dewailly et al). It is important to understand why these children have an increased risk for this infection in order to facilitate education and information.

By acknowledging certain causative factors, facilitators can help ameliorate difficulties with respect to education, and the social life of the infant. There have been a number of possible causative factors related to the occurrence of otitis media put forth in the literature, yet, due to the difficulty of separating possible environmental factors, and the confounding that a number of factors can produce through correlational design, there is difficulty in narrowing causation down to a specific number of causes (Bowd, 2002; Daly *et al.*, 2007; Shaw *et al*., 1981).

There is also a tendency in the literature to infer factors related to the occurrence otitis media in the Caucasian population to those of the Native population. This paper will attempt to examine some of the causative factors cited as possible catalysts for increased rates of otitis media in the Native North American population.

Objectives

The objective of this review is to critically evaluate the existing literature regarding the possible risk factors involved in the occurrence of otitis media among Native North American children. In assessing the possible causative factors for this illness, possible prevention strategies can be implemented to assist in the facilitation of care and education of this population

Methods

Search Strategy

Computerized databases, including PubMed, and SCOPUS, were searched using the following search criteria:

> ((North American Indian) OR (Native American)) AND (children) AND (otitis media) AND (causes) OR (causation) OR (risk factors) OR (etiology).

The help of clinical audiologist Brian Holmes was also enlisted for information regarding otitis media in First Nations infants in Canada.

The search was limited to articles written in English between 1980 and 2007 dealing with Native North American children and possible causal relationships between otitis media and various factors.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to examine possible causation between related risk factors and the occurrence of otitis media in Native North American children during the time period of 1980-2007. No inferential data were included in the review.

Data Collection

Searches using the aforementioned databases yielded 5 studies with the above stated selection criteria. Study designs include: cohort (3), critical review and quantitative case study observations of health records (1), and quasi-experimental comparative (1).

Results

Beery *et al.* (1980) conducted a quasi-experimental comparative study to observe Eustachian Tube (E-tube) ventilation function in Native Americans. 25 Apache Natives were tested ranging in age from 3-36 years (5 from 3-5 years, and 10 from 6-14 years).

Ventilation function of the E-tube was recorded using a special recorder with a pump, pressure, and flow meter apparatus. A full otolaryngologic examination was also performed on each subject involving otoscopy and nasopharyngoscopy. Airflow was generated and controlled in order to open the Eustachian Tube of the subject.

Inflations-deflation testing was performed first. Once the Eustachian tube had been opened, airflow was stopped to allow the middle ear to regain equalization through closure of the Eustachian Tube. The middle ear pressure of the subject was then released, and the subject was then assessed again by generating pressure into the subject's middle ear of one half the opening pressure used, or 200 mm H20.

The subject was asked to swallow 4-5 times to assess the ability of the subject's E-tube to equalize middle ear pressure. This procedure was also performed for the generation of negative pressure in the middle ear, and also while the subjects performed Toynbee, Valsalva, and sniffing manoeuvres. These test situation variables were combined mathematically in analysis and determined the extent of the opening of the E-tube.

A forced-response test was also used to determine passive and active resistance of the subject's E-tubes. Airflow and pressure were passed through the subject's middle ears at four different rates until the E-tube opened. Both pressure and airflow were then kept at constant rates until a steady state was reached for both. Subjects were then instructed to swallow. This constituted passive (before swallowing) and active (during swallowing) resistance. These conditions involving pressure and airflow, stated as ratios, were then compared to determine if the E-tube was dilating efficiently (ratio of greater than one) or non-efficiently (less than or equal to one).

Values for the Apache Native group were then compared to the values on similar tasks for two Caucasian groups. One Caucasian group had experienced traumatic tympanic membrane perforations, and the other had experienced chronic perforations. The Apache group had generally lower values for each condition than the two Caucasian groups. Essentially, the Apache Native group have E-tubes that allow for easier passage of materials through to the middle ear, thus increasing their susceptibility to infection.

Daly *et al.* (2007) performed a cohort study to observe the relationship between otitis media and risk factors such as exposure to smoke, duration of bottle feeding, history of upper respiratory infection, and maternal history of otitis media.

408 Ojibwe women and their 344 infants were recruited to take part in the study. Trained nurses gave ear examinations and tympanograms at 2 weeks; at 2, 4, and 6 months; and then every 3 months until children reached the age of 2. Hearing screening took place four times during follow up appointments. Results for the diagnoses were abnormal if an infant's static admittance was less than 0.2 mmho or if tympanometric width was more than 300 daPa.

Furthermore, abnormality was determined if infants showed effusion or ottorhea, or if 2 or more 5 frequency hearing screening tests of the same ear were failed. Interviews were also conducted by nurses at 2 weeks before birth, and 6 months after birth to determine possible sociodemographic characteristics, and risk factors for otitis media. Questionnaires were also completed before birth by Ojibwe mothers to determine alcohol and marijuana use.

Statistical analysis of the study involved frequency tables used for categorical variables, and means and standard deviations for quantitative variables. The X^sup2^ and t test were used for statistical analysis to observe relationships between otitis media, sociodemographic, and other risk factors. Logistic regression analysis with terms was used for interactions among variables. Odds ratios were used in the assessment of history of upper respiratory infection relating to incidence of otitis media.

Results from the study indicate that a history of upper respiratory infection was not a risk factor for otitis media. Furthermore, there was no significant interaction between short duration breast-feeding, or

exposure to smoke with the incidence of otitis media. Maternal history of otitis media was significantly related to a child's increased incidence for contracting otitis media. This indicates a genetic predisposition to otitis media for Aboriginal children.

Dewailly *et al.* (2000) attempted to observe the prenatal effects of harmful organochlorine compounds in Inuit mother's breast milk and these compounds association with the incidence of otitis media in their infants. Organochlorine compounds are often found in the environment, which come from a number of pollutive sources. The compounds are often found in species such as polar bear, beluga and seal, in which the Inuit find sustenance.

This cohort study examined 213 Inuit women who gave birth from July 1989 to September 1990. Data was available for 171 of the mother's infants. Questionnaires were given to mothers to obtain information on residence, postnatal maternal body weight, pregnancy duration, and breast feeding history. Both bottle-fed and breast-fed infants were examined due to the mother's prenatal exposure to organochlorines. Breast milk samples were also taken prenatally from mothers to determine the amount of organochlorine compounds in their system.

Infants were then seen to gather blood samples, and for medical evaluation at 3, 7, and 12 months postnatally. Unfortunately, there was not enough information gathered from infant's blood to make any significant analysis postnatally. Mothers were also asked about their breast feeding practices. Otitis media was said to be present if otoscopic examination revealed any abnormal tympanic membrane appearance. Furthermore, the presence of fever, irritability, pain, and/or discharge, assisted in a positive diagnosis for otitis media.

For statistical analysis, a continuous variable was used for the number of episodes of otitis media since the last visit with a nurse. A dichotimized variable was also used for two categories: one in which no episode of otitis media took place, and one in which one or more episodes took place. Two more categories were also included in analysis: one in which no episode occurred during the first year of life, and one in which 3 or more episodes occurred during the first year of life.

T-tests or the chi-square test were used for statistical significance concerning the breast-fed versus bottle-fed groups and the potential risks involved for each group concerning the contraction of otitis media. Logistic regression analyses were used to limit confounding factors such as breast feeding duration, maternal age, and duration of past breast feeding occurrences. Log transformed values were also used in the statistical analysis of information. Of the 171 infants examined, 98 were breast-fed, and 73 were bottle-fed. 118 were followed throughout their first year of life. Information was only available from breast-fed mothers due to the presence of organochlorines in breast milk fat.

The incidence of otitis media increased for breast-fed infants, especially when examined during the second visit with nurses and throughout their whole first year of life. From the data provided, there is an increased susceptibility to otitis media for the infant in its first year of life because of prenatal exposure to organochlorine compounds.

A cohort study was conducted by Shaw *et al.* (1981) to determine possible environmental and behavioural factors associated with the contraction of otitis media in 3 Native American populations (Hopi, Apache, and Colorado River Natives) in 4 different reserve locations.

Health records from all births involved in the study were collected, and the homes of these infants were also visited to examine living conditions approximately 6 weeks after birth. Living conditions were examined by trained technicians, who also collected information on the number of people in the living quarters, the number of sleeping areas, water supply, sewage disposal, heating and cooling apparati, electricity, method of infant feeding, distance to health care, and the mother's education.

These were used as possible environmental factors contributing to otitis media contraction. Follow up visits were made once a year. Information on otitis media contraction frequency was gathered from medical reports. Otitis media was said to be present if an examiner observed a bulging, inflamed tympanic membrane accompanied by pain and fever.

Data were collected from mid-1974 to June 1979 on 1428 children during the first year of life. 5 comparison conditions were analyzed: (1) rates and frequency of encounters of otitis media among the 4 locations, (2) rates of otitis media related to environmental factors at each location, (3) encounter frequency of otitis media related to environmental factors, (4) frequency of environmental factors compared to homes in which contracting rates of otitis media were found, and (5) rates of otitis media in homes, which were found to have each environmental factor, compared to rates in homes without environmental factors.

The first condition is not detailed here as the results are not relevant for this review. In the second condition, environmental factors were not significantly associated with increased rates of otitis media among the 4 locations of Native Americans.

Using chi-square testing, the investigators found that there was no significance associated with encounter frequency of otitis media and environmental factors in the third condition. The

investigators admit this may be due to questionable causal relationships, as nothing was found to be significant for any individual location. Furthermore, results were often highly variable and inconsistent.

Again, using chi-square testing, no significance was also found regarding the fourth test situation of frequency of environmental factors among groups of infants with contrasting rates of otitis media.

The final condition of a comparison of rates between homes experiencing environmental factors and those which are not yielded no relevant or consistent results through chi-square testing. In terms of breast feeding practices, no statistical significance was found among those infants who were bottle or breast-fed.

The results of this study were highly variable and inconsistent. No significant links were made observing the contribution of environmental factors to the contraction of otitis media.

Using health records from two Inuit communities, Stewart (1989) attempted to explain the incidence of otitis media as it relates to the sex of the infant through quantitative case study observations. The medical records of all children born in 1984 were examined throughout their first year of life. Statistical analyses involved means, ranges and standard deviations for 3 conditions: sex versus age at first episode, sex versus the severity of episodes (the number of episodes), and sex versus other health conditions.

No comparisons reached statistical significance. No significance was associated with geographic location and weather conditions relating to the incidence of otitis media. However, it is interesting to note that while none of the data reached significance, males had less favourable results than females regarding rates of otitis media in the three conditions observed.

Conclusions

With regards to this systematic review, the significant causal factors relating to high incidence and prevalence rates among North American Native Children are: (1) Prenatal exposure to organochlorines; (2) Eustachian Tube structural differences; and (3) Genetic propensity.

The strength of these studies can be questioned because randomized controlled trials were not included in the assessments. However, it is often difficult to perform these types of experiments due to population and ethical restraints, particularly regarding this systematic review and within the communication sciences and disorders realm.

Dewailly *et al.'s* (2000) study of organochlorine compounds has its weaknesses. Bottle-fed infants were included in analysis, yet, it was stated that only breast-fed infants could be analyzed due to the significant presence of organochlorines in breast milk fat. Yet, samples were also taken prenatally, and it was noted that bottle-fed infants could be included due to this factor. This is very confusing when attempting to understand the study design. This study still gives us valuable information regarding the harmful effects of organochlorine compounds on breast-fed infants, and will help in the prevention of otitis media.

While Daly *et al.'s* (2007) study does give significant insight regarding genetic predisposition of otitis media, this should be studied further in order to rule out additional confounding factors.

Beery *et al.'s* (1980) study on the differences between Caucasian and Native Eustachian tube function and structure is very useful considering the possible prevention and education that could occur from the results of the study. This difference can be noted when Native North Americans are screened for their hearing status. Early prevention can occur in the form of antibiotics or surgery as required.

The other studies included in this review were optimistic in their attempts to highlight some other environmental factors as they relate to the incidence and prevalence of otitis media among Native North American children, yet they fell short of significance, consistency or relevance. These factors such as: smoking effects, overcrowding, sex of the infant, mother's education, proximity to a health facility, infant feeding practices, access to clean water, heat, and electricity and prior history to infection should all continued to be noted and examined.

As noted previously, it is often hard to separate environmental causal factors due to their overlapping and confounding nature. In the future, attempts should be made, if possible, to single out, focus on, and define specific environmental causes, without the use of inferencing or inconsistency. All efforts should be made to determine if such causal factors exist in this population to help ameliorate adverse educational, social, and health conditions.

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