Research Roundtable Summary

13

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Otitis Media in Children and Later Language and Learning

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About This Series

The Research Roundtable Series, sponsored by the Maternal and Child Health Bureau (MCHB), disseminates the results of MCHB-funded research to policymakers, researchers, and practitioners in the public and private sectors. The results of these projects influence future service, research, and policy development. The Research Roundtable sessions provide an opportunity for researchers to discuss their findings with policymakers, MCH program directors, service providers, and other health professionals.

The Maternal and Child Health Research Program is directed by Dr. Gontran Lamberty and administered through the Division of Systems, Education and Analysis, Maternal and Child Health Bureau, Health Resources and Services Administration (HRSA). HRSA is a component of the Public Health Service (PHS), part of the U.S. Department of Health and Human Services (DHHS). The purpose of the research program is to support applied research relating to maternal and child health services that shows promise of making a substantial contribution to the advancement of those services.

Introduction

Dr. Gontran Lamberty introduced the speaker and the reactor for the research roundtable. Dr. Roberts is a senior research investigator at the Frank Porter Graham Child Development Center and a research professor of Speech and Hearing Sciences at the University of North Carolina at Chapel Hill. Dr. Roberts is well known for her research on the communication sequelae of otitis media. She has published extensively in speech-language, pediatric, early childhood, and audiology journals and has made many presentations on how otitis media affects children's communication and the implications for health care professionals, teachers, and families. Dr. Roberts is editor of the new book *Otitis Media in Young Children: Medical, Developmental, and Educational Considerations.* She recently served on a multidisciplinary panel of the Agency for Health Care Policy and Research that developed guidelines for the management of otitis media.

Dr. Gravel is director of Audiology at Montefiore Medical Center and an associate professor of Otolaryngology and Pediatrics at Albert Einstein College of Medicine. Dr. Gravel has published extensively on such topics as otitis media and communication abilities, hearing sensitivity in infants, and neonatal hearing screening. Dr. Gravel was the 1996 recipient of the Distinguished Achievement Award from the New York State Speech-Language-Hearing Association.

Presentation

Statement of the Problem

After the common cold, otitis media (middle ear disease) is the most prevalent illness of early childhood and the most common diagnosis made by physicians of children under the age of 15 years.

Tympanostomy tube insertion to eliminate fluid is the most common minor surgery procedure performed in young children. Health care costs for otitis media were estimated at $5 billion in 1995. When fluid is in the middle ear, the condition is called otitis media with effusion (OME). Fluid in the middle ear may persist for several weeks or even months after the onset of an episode of otitis media. Children with OME generally have some hearing loss, which continues as long as the fluid is present. The loss is usually mild to moderate in degree, averaging about 25 dB HL, though it can range from no loss to as much as 50 dB HL.

It has been hypothesized that children who experience hearing loss due to repeated bouts of otitis media during the early formative years of language learning will later experience speech and language disorders, learning disabilities, and academic problems. Many studies have found that children who experienced repeated or persistent bouts of otitis media have poorer speech, language, and academic performance during their preschool and school-age years. Although a growing number of studies have shown a significant relationship between a history of OME and later developmental sequelae, many studies have not supported this association; others have criticized the validity of previous OME language learning studies and claim that no reliable relationship has been identified.

Population Sample, Study Design, and Methods

This study examined how OME and its associated hearing loss during early childhood relate to the development of language and learning during the preschool years. The specific aims were to study: (1) The relationship between the amount of OME with accompanying hearing loss during infancy and the preschool period and patterns of speech, language, and neuropsychological development during the preschool period; and (2) other factors, such as stimulation within the home environment or the quality of the child care environment, which might interact with OME to predict later development of language and learning skills.

A total of 87 African-American children attending center-based child care participated in the study through 4 years of age. All parents of African-American infants enrolled in nine community child care centers in two small Southern cities were invited to join the research project. Criteria for participation in the study were that the infant was African-American, apparently biologically normal with a birthweight greater than 2,500 grams, 6–12 months of age, and enrolled in a participating child care center. Initially all subjects were from low-income families; however a protocol change 18 months into the study removed any income criteria. Children who left study child care sites after the completion of their 12-month assessments were followed at home or at their new child care sites for monthly ear examinations. Subjects were lost to followup because they left child care before 1 year of age, parents decided not to continue, or the family moved away from the area. Six children were lost between 1 and 2 years of age; none between 2 and 3 years, and two between 3 and 4 years. Of the 87 African-American children who were followed through age 4, two-thirds were from low-income families. Upon entry into the study, the mean maternal education was 12.5 years; 27 percent of the mothers had not graduated from high school; 31 percent were high school graduates; and 42 percent had greater than a high school education.

The middle ear status of the children was monitored every other week by otoscopy and acoustic immittance measures by one of two pediatric nurse practitioners. Examinations were done at each child's child care program. The diagnosis of OME was established with pneumatic otoscopy in conjunction with acoustic immittance measures. Agreement between judgments of mobility on pneumatic otoscopy and tympanometry based on 5,721 ear exams was 91 percent (k=.68). Otoscopic findings were validated between the nurse practitioners and the pediatrician with independently performed ear examinations to maintain reliability. Interobserver agreement between the primary nurse practitioners and the pediatrician was 94 percent (k=0.86) for mobility and 95 percent (k=0.87). Interobserver agreement between the primary nurse practitioner and an otolaryngologist, whose otoscopy skills were validated

against myringotomy, was 89 percent (k=0.66) for mobility and 89 percent (k=0.64) for diagnosis based on 76 ear examinations. When purulent OME occurred, children were prescribed antibiotics. If tympanostomy tubes were indicated, the project pediatrician or nurse practitioner discussed this with the parents and a recommendation was made for the family to consult with their primary care provider. Duration of each episode and percentage of observations with unilateral OME (number of days of left or right ear only) and bilateral OME (number of days of both left and right ears) were recorded. The duration of OME was calculated by subtracting the OME-onset date from the OME-resolved date. The audiologic assessment consisted of age-appropriate pure tone threshold measures (visual reinforcement audiometry, visual reinforcement operant conditioning audiometry, or play audiometry). Acoustic immittance procedures (tympanometry) were also completed. Audiologic assessments were performed in an audiologic test suite in a mobile test van. Age-appropriate threshold measures for pure tones were obtained four times a year, beginning at the age of 6 months. Threshold tests were also obtained within a week of any newly diagnosed OME, when there was a change in ear status, and at weeks 4, 7, and 13 following the OME diagnosis.

A battery of standardized and widely used developmental/intellectual tests was administered, including Bayley Scales of Infant Development, Wechsler Preschool Primary Scale of Intelligence, MacArthur Communicative Development Inventory: Toddler (Adapted Version), Communication and Symbolic Behavior Scales, Peabody Picture Vocabulary Test-Revised, and Clinical Evaluation of Language Fundamentals-Preschool. The child's language use was also assessed with language samples and a narrative task. The interaction styles of the child and mother were examined during a teaching task and the reading of books. Family measures used include Home Observation and Measurement of the Environment, Parenting Stress Index, Beck Depression Inventory, and the Wechsler Adult Intelligence Scale-Revised. The Infant Toddler Environment Rating Scale and Early Childhood Environment Rating Scale were administered for each classroom in the child care centers. Assessments were done in a sound room either at the Frank Porter Graham Child Development Center or in a mobile test van.

Between study entry and 4 years of age, children's ears were examined with otoscopy and tympanometry an average of 71.9 times (SD=18.6). Children's hearing was tested an average of 20.6 times (SD=4.1). The number of completed developmental assessments and the age of administration were 95 children at 12 months, 87 at 18 months, 88 at 24 months, 88 at 30 months, 88 at 36 months, 87 at 42 months, and 87 at 48 months.

The study explored the association between OME in early life, hearing loss, and later language and learning. The independent variables of interest index OME experience and the spectrum of associated hearing loss. From the children's medical charts, the total number of days of OME (bilateral and unilateral) occurring during the first 4 years of life were computed. Hearing loss was defined as 25 dB HL or greater for more than half of the frequencies tested and was computed during the first 4 years of life. The dependent variables were selected measures of language and cognitive skills. Factors such as the child's gender and socioeconomic status, the quality of the home environment, the quality of child care experience, and the mother's educational level are likely to be related to performance on these tasks. Structural equation analyses and regression analyses were used to examine how OME, OME-associated hearing loss, and mediating factors (e.g., child's home and child care environments) affected the development of children's language and cognitive skills.

Research Findings

The results showed a higher incidence of OME than reported in previous studies among young children. From 6 to 12 months of life, children experienced OME (bilateral or unilateral) 89 percent of the time, four-fifths of which was bilateral OME. From 12 to 24 months, children experienced OME 55 percent of the time. The incidence of OME decreased to 21 percent of the

observations between 2 and 3 years of age and to 15 percent between 3 and 4 years. Sixty-five percent of children had at least 4 months of continuous bilateral OME from 6 months to 2 years, which was resolved in 76 percent of these children by age 2 years. Hearing loss (defined as 25 dB HL or greater for more than half of the frequencies tested) was present 57 percent of the time from 6 months to 1 year of age, 40 percent from 1 to 2 years, 18 percent from 2 to 3 years, and 9 percent from 3 to 4 years. Children who experienced more OME experienced more hearing loss over time (r=.75) and higher mean thresholds (indicative of poorer hearing) (r=.67).

The investigators found a direct association between OME and associated hearing loss and measures of children's receptive and expressive language and cognition at 1 and 2 years of age. However, these relationships were no longer significant when the quality of home and child care environments were taken into account. Thus, these findings suggest that there are indirect associations between OME and associated hearing loss and language and cognitive skills at 1 and 2 years of age as mediated by the quality of the home and child care environments. That is, children with more frequent OME and associated hearing loss tended to have less responsive home and child care environments, and this association was linked to poorer performance in language and cognitive development at 1 and 2 years of age. Next, longitudinal analyses were conducted examining OME, hearing loss, and communication and cognitive measures at 1, 2, and 3 years of age; the analyses controlled for child, family, and child care characteristics. These results showed that OME and associated hearing loss during the preschool years appeared to be related to a developmental pattern of a slightly slower acquisition of receptive and expressive language skills over time. That is, the children with the most versus the least amount of OME differed by as much as 3 months in expressive language and 2 months in receptive language by 3 years of age. Thus, during the preschool years the investigators are finding a very weak but direct association between OME and associated hearing loss and language skills. However, measures of the home and child care environments did explain considerably more of the variance in the cognitive and language skills than did OME and associated hearing loss.

There are several limitations of these findings. First, these findings can only be generalized to African-American children primarily from low-income families who attended child care centers in infancy. Second, only short-term effects of OME on children's language and cognitive skills were examined; one cannot make any generalizations about the long-term effects of OME. The investigators will continue to follow the study children until second grade to further understand any long-term associations with OME. Third, as in any observational research, it cannot be inferred directly from this study that OME and associated hearing loss cause differences in child-rearing patterns that then affect communication and cognitive skills.

The results of these studies have several implications for health care delivery situations. First, given that OME is highly prevalent in early childhood, particularly among children in child care, it is important to monitor children's middle ear status and provide routine hearing screenings for children at risk or who experience repeated or prolonged bouts of OME. Second, given the finding of a weak association between OME and language outcomes, the language of children who experience recurrent or persistent OME should be screened. Third, given the importance of the caregiving environment in the relationship of OME to later development, families, child care providers, and other health care providers should receive information about the signs and symptoms of OME, hearing loss, and language delay. Further, they should be encouraged to use strategies that promote the health (e.g., frequent hand washing), language (e.g., respond positively to children's communication attempts), listening (e.g., decrease background noise in noisy environments), and learning (e.g., read often to children, checking to see if they understand what is being read) of children who experience chronic OME. Finally, it is not possible to recommend more aggressive surgical management of children with frequent and/or persistent OME until the long-term effect of a history of OME into the school-age years has been examined. In summary, the results support screening for OME, hearing loss, and

language delays in young children at risk for or who experience chronic OME. The results also support providing information on management of OME to families and child care professionals.

Reaction

Dr. Gravel complimented Dr. Roberts' research and the contributions it made to the study of children with otitis media. Dr. Gravel commented on the strengths of the research, the limitations of the study, and future direction for the study of otitis media. The most significant outcome, according to Dr. Gravel, is Dr. Robert's finding that children with more frequent hearing losses tended to have less responsive mothers and home environments. That association is linked to poor performance in receptive and expressive language, vocabulary development, and cognitive skills at 1 and 2 years of age. When the quality of the home environment, such as living in poverty and stress life factors, are taken into account there is no direct association between OME and its accompanying hearing loss and communication and cognitive outcomes in infancy and toddlerhood. Dr. Gravel found it intriguing that children with frequent but mild hearing losses in early life tended to have less responsive mothers and home environments.

Another critical strength of the study, according to Dr. Gravel, is that it is a prospective cohort study. Fifty percent of the time OME is a silent condition; if you do not look for it you will not know it is there. Asking parents the number of episodes a child has is not a good way to quantify the amount of otitis media that a child experiences. Dr. Robert's study documented OME frequently and consistently across all study sites, using objective tests (acoustic immittance) and subjective measures (pneumatic otoscopy) of middle ear status. This study also examined hearing sensitivity along with the presence of otitis media. This is a critical factor in determining if it is the disease otitis media or the disorder—hearing loss—that is associated with otitis media that results in childhood sequelae. The frequent documentation of hearing levels before, during, and after OME episodes; between episodes; between frequency levels; the variability over time of hearing loss; as well as during periods of normal middle ear function were all strengths of the study.

Another positive part of the study was that numerous outcomes using developmentally appropriate standardized measures of speech, language, cognition, attention, memory, and preacademics were used. The use of measured family home setting, parent factors, child care factors, and the classroom/child care centers in which these children participated was a unique study strength.

Limitations of the study were few. Enrollment in the study began after 6 months of age, the average age was 7.5 months. Data in the first few months of life may be missing. The study population was limited to predominantly low-income, African-American children, which restricts the generalizability of findings. The variable of hearing loss is difficult to examine. Criterion used (less than 25 dB HL) may or may not be conservative. Although critical, standardized measures of global language abilities may not detect subtle but important deficits in speech perception and/or speech production.

Dr. Gravel was emphatic that more studies in otitis media need to be done because there are still many unanswered questions. The amount of fluctuation of hearing loss, the degrees of hearing loss, and the quality and the quantity of linguistics experiences children have in the child care environment are still unanswered questions. Identifying children at risk, helping teachers in the classroom, and amplifying classroom settings are also issues Dr. Gravel hopes will be addressed.

Discussion questions from attendees addressed issues such as racial and ethnic differences in otitis media prevalence and the limitations of the size of the current cohort. Both Dr. Gravel and Dr. Roberts see the need for a larger multibased study using the same measurements and criteria to obtain the kinds of answers that are required to undo the confusion surrounding otitis media.

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