PROGRESSIVE HEARING LOSS SUBSEQUENT TO CONGENITAL CYTOMEGALOVIRUS INFECTION

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ABSTRACT

Congenital cytomegalovirus infection is the most frequently occurring viral disease among the newborn. It is the most common viral cause of mental retardation, yet 95% of infants affected with the disease are asymptomatic. It is now reasonably established that severe sensory-neural hearing impairment is also a frequent sequela to this perinatal disease, but it is not clear at what age it appears. Generally, it is thought that these infants are born with normal or nearly normal auditory sensitivity and the hearing loss appears later. This paper reviews the mechanisms of deafness associated with this disease and presents what we believe to be the first longitudinal study of progressive hearing loss in an infant with congenital asymptomatic cytomegalovirus infection.

Congenital cytomegalovirus infection (CMV) is the most frequently occurring viral disease among the newborn. According to Marx (1975), it is the most common viral cause of mental retardation, more common than even the rubella virus. The cytomegalovirus is so common, in fact, that Marx predicts "up to 80% of the population acquires antibodies that are indicative of infection with the virus by the age of 35 or 40 years". The presence of antibodies has been shown in 34% of adults in Nova Scotia (Affias and Embil, 1978). According to Reynolds et al. (1974), the prevalence of this infection in infants approximates one in four hundred. In fact, they reported that in the United States and in the United Kingdom, there was "a consistent incidence of between 0.5 and 1.5% of all live births". It is 0.55% in Halifax (Affias and Embil). However, 95% of all infants affected with the disease are asymptomatic.

Congenital cytomegalovirus infection reveals itself in a manner very similar to that of the congenital rubella syndrome. The significance of this fact is that cytomegalovirus occurs far more frequently than rubella, and its effects are essentially the same. What makes it more serious and more difficult than rubella is that nearly all infants who are born with this chronic perinatal infection will be missed during the early months of life because they display no signs or symptoms of the disease. Yet, according to Top (1970), "infants may shed virus in saliva for six months and in urine for as long as fifty months". Alford, Stagno, and Reynolds (1974) observed further that cytomegalovirus was the most common cause of perinatal infection but virtually all infected neonates were asymptomatic.

There has not been a great deal of study devoted to the auditory sequelae of congenital CMV infection. Dahle et al. (1974) speculated that some of the infected children may have progressive hearing impairments. In fact, Hanshaw (1971) found a much larger number of children with hearing impairments in his CMV population than in a control population. Similarly, Reynolds et al. (1974) found four of their sixteen infected infants had bilateral sensory-neural hearing impairments. Furthermore, they observed what they called an "apparent propensity for high frequency involvement . . . ".

Also, there has been rather little histopathological study of the effects of cytomegalovirus on the endocochlear space. According to Catlin (1978), in those few cases where the temporal bones had been available for study, the findings are those of an endolymphatic labyrinthitis (Myers and Stool, 1968). The studies have found cells which include a cytomegalovirus in most of the structures of the inner ear including the vestibular organs, the stria vascularis, and Reissner's membrane. Curiously, though, the few pathology studies have reported no infection in the organ of Corti and also reported that hair cells were intact.

Reynolds et al. (1974) and Dahle et al. (1974) have suggested that the hearing impairment subsequent to congenital cytomegalovirus infection may be progressive. They reported in some of their patients that audiometric thresholds assessed behaviorally were poorer at several months of age than they were earlier in life. Furthermore, they suggest that the presence of a high frequency hearing loss may itself be indicative of progressive sensory-neural impairment. To our knowledge, however, no one has ever reported the progress of such a hearing loss. We have in our clinic an infant with frank evidence of the sequelae of congenital cytomegalovirus infection, and we have monitored her audiometrically over a period of time. This report, then, is a case study of this one child.

DH was born to a 25-year-old Gravida V, Para IV white woman. She was apparently full-term and full-size presenting with a birth weight greater than 4500 grams. Her physical examination at birth was unremarkable, although the birth history indicated that she had had some difficulty and was delivered by Caesarean section. Her one minute Apgar score was 8-9. Due to difficulty in caring for her other children, DH's mother placed her for adoption immediately. She has never seen her daughter.

DH's foster mother reported that, at the age of 4 weeks, she apparently was not responding to events occurring in her acoustic environment. The pediatrician charged with her care immediately referred her to the Speech and Hearing Centre at the University of California in Santa Barbara. She was seen at the age of two months. In her first visit, she was awake initially but not responsive to speech or to narrow band noise at 90 dB hearing level in the sound field. Tympanometry was attempted and, in spite of the difficulty, did suggest normal compliance bilaterally. No acoustic reflexes were elicited at the limits of the bridge. Clearly, we were dealing with a hearing-impaired child who needed to be seen again.

She was seen at the age of ten weeks for electric response audiometry. The results of this test are shown in Table 1. It was difficult to establish the latency of Wave V in her left ear as there were no consistent peaks in the latency range that one expects in a 2-month-old. A peak was found at 7.4 ms in the right ear, and we believe these data to be indicative of moderate hearing loss. In an effort to gain frequency specific information, we attempted to evoke the middle components of the auditory electric response. She was stimulated with 500 Hz tone bursts, and appeared to respond at 75 dB in the right ear and at 50 dB in the left ear. At a higher frequency, 3000 Hz, responses were obtained at 50 dB in both ears. We concluded at that time that DH has a flat moderate loss in the left ear and an upward-sloping audiogram for the right ear. She was fitted with bilateral body-worn hearing aids on a trial basis.

Some weeks later, impedance testing was attempted again, and again revealed normal compliance. She was now wearing her hearing aids, and her foster mother reported that she occasionally startles to sudden noises and does turn to a speaker when she hears a voice. Also, an otological examination was done at that time, and the results were normal. At about the same time, the pediatric examination revealed a positive titer for cytomegalovirus. Ophthalmological examination was essentially normal, as was an orthopedic examination occasioned by an apparent mild left hemiparesis. Electric

TABLE 1

AUDITORY BRAINSTEM RESPONSES

Age (in weeks)	Wave V Latency (ms) Left Ear Hearing Level (dB)			Right Ear Hearing Level (dB)		
	75	95	103	75	95	103
10	No Peak	No Test	No Test	7.4	No Test	No Test
22	8.0	7.6	7.3	No Peak	7.6	7.6
31	No Peak	No Peak	11.0	No Peak	No Peak	11.0

response audiometry with the brainstem components at this time (i.e., 22 weeks, see Table 1) revealed responses at 95 and 103 dB hearing level, which is the limit of our averaging system.

On her last visit, before she was placed for adoption and moved away from Santa Barbara, she was tested behaviorally in the sound field and made no responses (unaided) to any of our endeavors. We again evoked a brainstem response. When tested by ERA, responses were seen only at the limits of the averaging system, 103 dB hearing level. At that level, a consistent response peak occurred at 11 ms. This is a latency which is longer than normal, clearly it is at a level much higher than normal, and reveals that DH has a severe to profound loss of hearing bilaterally.

What is revealed by this sequence of tests is what has been suspected previously and reported in the literature, namely that progressive sensory-neural hearing impairment does follow congenital cytomegalovirus infection. We estimated DH's threshold of hearing for clicks to be in the neighbourhood of 45 dB hearing level when she was two months of age. When she was five months old, her threshold was no better than 75 dB HL, and by seven months of age was clearly poorer than 95 dB. Knowing that we have only this single case to report, obviously we cannot claim that such progressive hearing loss is a necessary sequela of congenital cytomegalovirus infection. However, given that other people have observed change of hearing in their patients from one time to a much later time, and given that we have sequential audiograms on this child, it appears a probable conclusion that congenital cytomegalovirus infection can lead to degenerative sensory-neural hearing impairment. Therefore, we urge all primary care providers, pediatricians, audiologists, and speech pathologists to be alert to CMV and its neurosensory sequelae.

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REFERENCES

Affias, S. and Embil, J., Congenital Infections and the TORCH Syndrome. **The Nova Scotia Medical Bulletin,** 57(2), 43-47, 1978.

Alford, C. A., Stagno, S. and Reynolds, D. W., Perinatal Infections Caused by Viruses. In S. Aladjem and A. K. Brown (Eds.), **Clinical Perinatology,** C. V. Mosby Co., Saint Louis, 1974.

Catlin, F. I., Etiology and Pathology of Hearing Loss in Children. In F. N. Martin (Ed.), **Pediatric Audiology,** Prentice-Hall, Inc., Englewood Cliffs, NJ, 1978.

Dahle, A. J., McCollister, F. P., Hammer, B. A., Reynolds, D. W. and Stagno, S., Subclinical Congenital Cytomegalovirus Infection and Hearing Impairment. **Journal of Speech and Hearing Disorders,** 39, 320-329, 1974.

Hanshaw, J. B., Congenital Cytomegalovirus Infection: A Fifteen Year Perspective. **Journal of Infectious Diseases,** 123, 555-561, 1971.

Marx, J. L., Cytomegalovirus: A Major Cause of Birth Defects. **Science,** 190, 1184-1186, 1975.

Myers, E. N. and Stool, S., Cytomegalic Inclusion Disease of the Inner Ear. **Laryngoscope,** 78, 1904-1914, 1968.

Reynolds, D. W., Stagno, S., Stubbs, K. G., Dahle, A. J., Livingstone, M. M., Saxon, S. S. and Alford, C. A., Inapparent Congenital Cytomegalovirus Infection with Elevated Cord IgM Levels: Causal Relation with Auditory and Mental Deficiency. **The New England Journal of Medicine,** 290, 291-296, 1974.

Top, F. H. (Ed.), Report of the Committee on Infectious Diseases. **American Academy of Pediatrics,** Evanston, IL, 1970.