Factors Associated With Deafness in Young Children

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IN THE LITERATURE are a moderate number of references relating to the etiology of deafness in the young child. These references have resulted in identifying several conditions as probable causes of this impairment. Much research needs to be done on several undetermined factors, however, if a satisfactory understanding of the origins of hearing loss is to be attained. The literature states explicitly that the cause of deafness in young children is unknown in at least 40 percent of all cases (*1a*).

The classic work on the etiology of deafness in the young child was done indirectly by Gregg, an ophthalmologist. In 1941 he reported on the marked increase of cataracts and heart lesions in children whose mothers had rubella during the first trimester of pregnancy concurrent with a pandemic in Australia in 1939 and 1940 (*2*). Subsequently, numerous articles reporting cardiac lesions and deafness as important sequelae to maternal rubella were published in Australia. Maternal rubella is now established as a leading prenatal cause of deafness.

In addition to rubella, Wedenberg designated prematurity, asphyxia, brain damage, and blood incompatibility as likely causes of severe hearing loss (*1b*). Crabtree and Gerrard reported detection of 16 cases of perceptive deafness associated with kernicterus (*3*). Perlstein also reported deafness was a common sequel of kernicterus (*4*). Windle showed that anoxia was a major cause of neurological and sensory disorders and stressed that even brief periods of anoxia can induce profound and permanent changes in the health of an infant (*5*).

Bordley listed immunization of the mother during pregnancy as a factor in congenital deafness (*6*). Diabetes and cretinism were investigated by Keleman, who was first to describe abnormalities in the ears of a 6-month fetus delivered by hysterectomy of a diabetic mother (*7*). Altmann reviewed congenital atresia of the external auditory canal and its relation to hearing loss (*8*).

Wilson stated that meningitis was the leading postnatal cause of severe deafness in infants and young children (*9*). Similarly, Shambaugh listed meningitis, especially the meningococcic (or cerebral) type, as the most common postnatal cause of deafness in 1,192 children in schools for the deaf (*10*).

Zonderman referred to numerous studies on the effects of streptomycin, dihydrostreptomycin, and neomycin. He pointed out that the use of drugs for control of bacterial infection may result in nerve deafness (*11a*). Walker reported on 93 patients with tuberculous otitis media. Most of these patients were children whose median age was 7 years and who had been treated with streptomycin and dihydrostreptomycin (*12*).

Zonderman pointed out that the incidence of

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hereditary deafness is difficult to ascertain from the literature because the reported percentages vary greatly (*11b*). Van Egmond found that the number of cases of congenital impairment is presumably one-half to one-third of all deafness, recessive deafness predominating (*13*). A Public Health Service survey of schools for the deaf showed that the impairment in 61 percent of the children was labeled congenital, and in 41 percent of these children the condition was classified as hereditary (*14*). Fraser stated that in slightly more than 50 percent of the children with deaf-mutism the impairment was congenital and the condition in approximately 30 percent of these children was hereditary (*15*).

The National Center for Health Statistics has published information obtained through a national interview survey on characteristics of persons with impaired hearing. In this survey approximately 39.9 percent of the persons with a binaural hearing impairment stated they did not know the cause of their impaired hearing. Hereditary and congenital factors were reported as the cause of about one-fourth of all hearing impairments occurring in children under 6 years old. These factors, however, were rarely mentioned as causes when the hearing loss occurred later in life (*16*).

Research is needed on the importance of events surrounding labor and delivery. According to Zonderman, many authors have suggested that difficulties during birth may be associated with damage to the central nervous system and auditory disorders of young children (*11c*). In a similar vein, Myklebust stated that a number of children with peripheral hearing impairment had no other pathological condition except presumed damage at birth (*17*). Perhaps research will reveal that damage at birth can affect the supply of blood to the inner ear and that either deprivation or hemorrhage might result in deterioration of the organ of Corti or other cochlear damage.

Design of the Study

In the summer of 1966 our group decided to probe in depth factors relating to the onset of deafness in children under 5 years old. Most of these factors had not been investigated in a controlled manner.

The vehicle for the investigation was an inter-

Table 1. Comparison of abnormalities reported in cases of 118 deaf children and 54 hearing children

Factor	Deaf group (percent)	Hearing group (percent)	Difference probability
Prenatal:			
Fetal movement in third or fourth months	48	65	<.01
Emotional conflict	42	15	<.01
Exposed to communicable disease	37	20	<.01
German measles in first trimester	29	0	<.01
Drugs	23	11	<.02
Measles	3	0	<.04
Thyroid deficiency	3	0	<.04
Influenza in first trimester	2	0	<.10
Nausea in ninth month	13	7	<.12
Deaf sibling	12	0	<.01
Maternal ingestion of cod liver oil during pregnancy	4	0	<.01
Frequent ingestion of aspirin during pregnancy	2	0	<.10
Perinatal:			
Jaundiced at birth	25	8	<.01
Illness in hospital	18	4	<.01
Weight less than 4 pounds 8 ounces	14	0	<.01
Breech delivery	11	0	<.01
Body blueness	9	0	<.01
Mean weight of babies	[1]	[1]	<.01
Abnormal molding of head	9	2	<.02
Sleep normally	86	95	<.03
Placenta praevia	3	0	<.04
Cord around neck	8	2	<.07
Breast fed	16	26	<.10
Breathing difficulty	9	4	<.10
Facial bleeding	2	0	<.10
More than 5 days in hospital	41	31	<.12
Forcible delay of delivery	2	6	<.15
Induced delivery	15	17	[2]
Early childhood:			
Regressive speech after illness or trauma	11	0	<.01
Mental retardation	4	0	<.01
First words spoken	[3]	[3]	<.01
Earaches and ear infections	28	17	<.05
Potential sources of injury:			
Father smoked 20 cigarettes a day	37	19	<.01
Mother smoked 20 cigarettes a day	26	19	<.18

[1] Mean weight of babies in deaf group, 7 pounds; in hearing group, 8 pounds 8 ounces.

[2] No confidence.

[3] First words spoken by babies in deaf group, 24 months (mean); in hearing group, 11 months (mean). Excluded 29 children who had not spoken at time of interview.

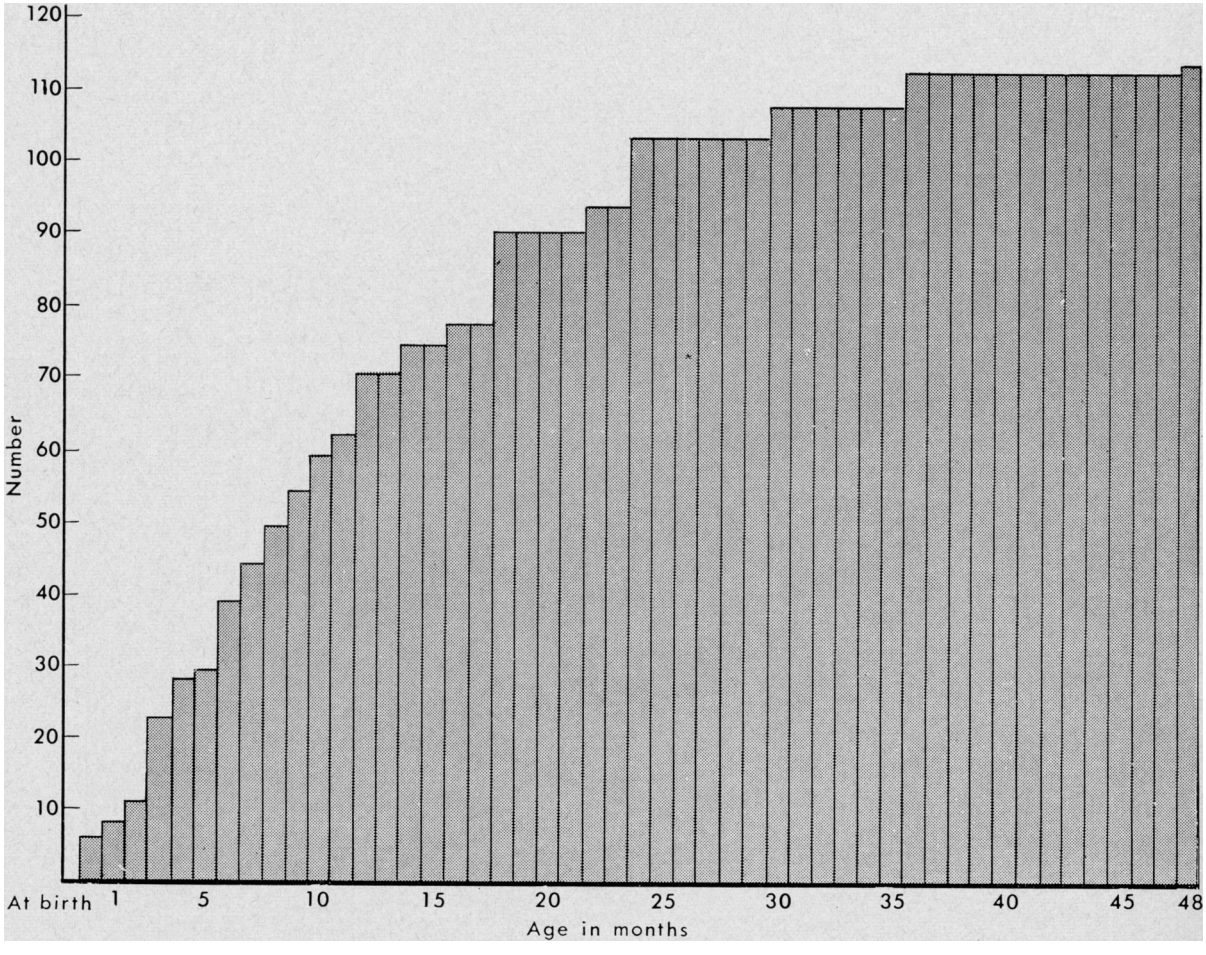
view technique developed and used by six coworkers (Dr. Honora B. Foster, Mrs. Jim Gorman, Sister M. Helen Joseph, Mrs. Susan C. Hillman, Mrs. Helen M. Peters, and Robert J. Reardon) sponsored by the Boston School for the Deaf, Randolph, Mass. These persons had had extensive experience in conservation of hearing, particularly in relation to problems of growth and development of young deaf children.

The interview procedures were intended to guide members of the group in conducting lengthy conversations with mothers of deaf children. Questions were framed to elicit specifics in the father's, mother's, and child's histories. Such specifics included, for example, a careful description of any high-risk occupations of the father before deafness was first suspected in the child. Also included were detailed data about the delivery as recalled by the mothers of the impaired children.

A comprehensive listing of physical and mental disorders of members of the family and their close relatives also was made. In addition we inquired about factors potentially injurious to mother or child, such as drug ingestion during pregnancy or heavy smoking by either parent. Questions about dietary habits of the family were intended to help determine possible links between deafness and nutritional deprivations.

The interviewers sought answers to all items in the master guide. However, mothers were also provided an opportunity to talk freely and at length about any factor which they believed might be significant in the deafness of their child. In particular, mothers were asked to dis-

Age, in months, at which hearing loss in 113 children was first detected [1]



[1] Parent was unsure in two cases; three parents gave no response.

cuss thoroughly any details of pregnancy and delivery which were not specifically sought in the interview guide.

The examiners interviewed 109 mothers of 118 deaf children and a control group of 54 mothers with hearing children. Selection of the control group was accomplished largely through the mothers of the deaf children. Mothers of deaf children were asked to select hearing children who matched their own children as closely as possible but not to choose children from families which included a child with a hearing impairment. The mothers, all residents of Massachusetts, were from the same geographic areas and socioeconomic groups. The control group was asked all the pertinent questions in the outline guide.

Most of the deaf children attended schools, day classes, or preschool centers for deaf children, but a few attended schools for children who could hear.

Notable Differences in Responses

Replies of the 163 mothers were divided into 209 categories, reviewed, and tabulated. A few answers by mothers of deaf children were not obtained from mothers with hearing children because the inquiries were not applicable.

All data were grouped systematically. Birth weights, for example, were tabulated in pounds and ounces, but early activity of infants was tabulated as extremely active, active, normal, or still and quiet. Many factors were listed only as present or absent. Data were expressed as percentages of either the deaf or hearing group. Finally, two percentages—one derived from elements pertaining to the 118 deaf children and the other related to the 54 hearing children—were directly compared (table 1).

In table 1 each notation indicates the probability that the observed difference in rate is due to chance. Chance probabilities not ordinarily considered significant—for example, probabilities higher than 0.05—are included because more research may show that some of these differences actually are discriminating.

Some unexpected results emerge in the data of table 1. For example, report of movement of the fetus in the third or fourth month after conception appears to occur with significantly less frequency in the cases of children born deaf. Data in the table also confirm studies which have tentatively associated maternal thyroid deficiency with deafness in the child.

Breech delivery and body blueness are unquestionably associated with deafness. Inability of infants with hearing loss to sleep normally in the nursery also may prove valuable in establishing criteria for screening babies whose risk of deafness is high.

The frequent coincidence of paternal cigarette smoking and deafness and maternal ingestion of cod liver oil during pregnancy and deafness are factors which would appear to require further investigation.

Despite a negligible difference in the rates of induced delivery of hearing and deaf children, its frequent occurrence among both groups pro-

Table 2. Comparison of selected abnormalities reported in the cases of 46 children with deafness of undetermined origin and 54 hearing children

Factor	Deaf group (percent)	Hearing group (percent)	Difference probability
Pregnancy:			
Measles	9	0	$<.02$
Bleeding	30	15	$<.05$
Streptococcal sore throat	4	0	$<.10$
Influenza after first trimester	4	0	$<.10$
Mumps	4	0	$<.10$
Deafness in family	28	18	$<.15$
Hives	2	0	$<.20$
Unidentified viral illness during first trimester	2	0	$<.20$
Tumor in uterus	2	0	$<.20$
Chickenpox after first trimester	2	0	$<.20$
Infancy and early childhood:			
Birth weight less than 4 pounds 8 ounces	17	0	$<.01$
Mycin drugs during neonatal period	13	2	$<.03$
Body blueness	7	0	$<.04$
Neonatal jaundice	20	8	$<.05$
High temperatures during neonatal period	9	2	$<.08$
Unattended birth	2	0	$<.20$
Cataracts	2	0	$<.20$
Cerebral palsy	2	0	$<.20$
Minor blood incompatibility [1]	2	0	$<.20$
Cord around neck	4	2	$<.40$
Breathing difficulty	7	4	$<.40$

[1] Slight anemia in first 3 weeks after birth or faint jaundice appearing within 24–36 hours of birth but fading within a few days.

vides an interesting commentary on current obstetrical procedures. Forcible delay of delivery was reported surprisingly often. If the difference in rates is meaningful, delivery of deaf children may have been forcibly delayed less often because their mothers were in poorer physical condition than mothers with hearing children.

Statistical data depicted in the chart show in cumulative form the ages of children when their hearing loss was first detected. Deafness was not suspected in 50 percent of these children until some time between 8 months and 48 months of age although most of them probably were deaf within the first two months after birth. These data reflect the long delays typical in arriving at a diagnosis of deafness and the need to improve methods for early detection of hearing loss.

Analyses of Causes

Probable causes were analyzed in each of the 118 cases of deaf children. Whenever the information appeared to warrant attributing the child's impairment to a recognized cause, the etiology of his deafness was classified accordingly.

Illnesses in the first trimester of pregnancy among mothers whose babies had hearing loss were rubella—33, influenza—3, chickenpox—1, and scarlatina—1. Blood incompatibility caused deafness in five children, and hearing loss in four others apparently resulted from their having had meningitis. Heredity was the predisposing factor in 15 cases, and one child had been traumatized.

The histories of nine children and their parents were essentially normal.

In the histories of the 46 remaining children, however, were recorded frank abnormalities which had an unknown effect on the deafness of the group. Total abnormalities were more than 46 because some children had more than one.

Five of the factors in table 2 were previously listed in table 1. Measles in pregnancy is relisted because its rate in the selected 46 cases is sharply increased over its rate in the entire 118 cases. It would appear, therefore, that measles in pregnancy may be an important factor in the etiology of these unclassified cases.

Similarly, birth weight less than 4 pounds 8 ounces is relisted because this factor appears more significant in the unclassified cases than in the entire group of 118 deaf children. It should be noted that these children are not identical to groups sometimes classified premature because premature technically includes all babies weighing 5 pounds 8 ounces or less.

Table 2 includes a relisting of three factors with rates which dropped in comparison with those reported in table 1. These factors include cord around neck, body blueness, and breathing difficulty. The obvious explanation for the decline in these rates is that these conditions are associated with conventional causes of deafness. Children whose mothers had rubella in the first trimester of pregnancy tended, for example, to have more difficulty in breathing than the 46 children whose deafness was etiologically unclassified.

Apart from shifting the emphases on these five factors, the recalculations entailed in table 2 also turned up a number of significant anomalies which did not appear in table 1. Some of these new conditions appeared to warrant consideration in determining the etiology of deafness in previously unclassified cases.

Of events occurring in pregnancy and delivery, maternal bleeding is particularly important. Streptococcal sore throat in pregnancy, maternal influenza after the first trimester, and mumps during pregnancy also are suggestive.

Relative to events in infancy and early childhood, the rates of treatment with mycin drugs before the age of 1 month and neonatal jaundice among deaf children are most striking when compared with the rates of these occurrences among the 54 hearing children. Other factors listed in table 2 are less sharply defined, but many are conditions which may be proved important as more work is done on the etiology of deafness.

Summary

The mothers of 118 deaf children were questioned intensively about the physical and mental disorders of members of their families, their families' dietary habits, exceptional events in their pregnancies, hereditary influences, and numerous other factors which might have contributed to their children's deafness. A control group of 54 mothers of hearing children also was interviewed in a parallel manner.

The results of this study pointed to certain factors which had not been given sufficient attention as probable causes of deafness in young children. These factors included absence of fetal movement in the third or fourth month of pregnancy, maternal thyroid deficiency, breech delivery, and body blueness in the neonatal period. Other significant etiological elements in the pattern of deafness included maternal measles in the first trimester of pregnancy, bleeding in pregnancy, birth weight under 4 pounds 8 ounces, and administration of mycin drugs before the infant was 1 month old.

Hearing loss was not suspected in 50 percent of the deaf children until some time between 8 months and 48 months of age although most of the children probably were deaf within 2 months after birth. The importance of improving methods of early detection of hearing loss is thus emphasized.

Etiological classification of deafness in 118 children showed the causes were maternal rubella in the first trimester, 28 percent; hereditary factors, 12.7 percent; blood incompatibility, 4.2 percent; childhood meningitis, 3.4 percent; maternal influenza in the first trimester, 2.5 percent; and maternal chickenpox or scarlatina in the first trimester and child trauma, 0.8 percent each. In this group approximately 39 percent had histories of frank abnormalities, but the cause of their deafness was unknown. The remaining 7.6 percent had essentially normal histories.

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