HYPERBILIRUBINEMIA AND HEARING LOSS - A REVIEW

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Independent Project submitted as part fulfilment for the first year M.Sc, (Speech and Hearing), Mysore.

All India Institute of Speech and Hearing
Mysore 570006
1998

CERTIFICATE

This is to certify that this Independent Project entitled *HYPERBIURUBINEMIA AND HEARING LOSS - A REVIEW* is the bonafide work in part fulfilment for the degree of Master of Science (Speech and Hearing) of the student with Register No.M9710

Mysore

May,1998

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CERTIFICATE

This is to certify that this Independent Project entitled **HYPERBILIRUBINEMIA AND HEARING LOSS - A REVIEW** has been prepared under my supervision and guidance.

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May, 1998

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DECLARATION

This Independent Project entitled ***HYPERBIURUBINEMIA AND HEARING LOSS -A REVIEW*** is the result of my own study under the guidance of Dr. 'K.Rajalajshmi, Lecture in -Audiology , All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any I Jniversity for any other diploma or degree.

Mysore

May, 1997 Reg. *NO.M9710*

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PARENTS

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INTRODUCTION

A human is bestowed with five senses :

(a) Vision
(2) Audition
(3) Smell
(4) Touch and
(5) Taste

All these senses enable us to understand and tackle with our environment. Audition is known to be a distant sense and plays a very important role in human's life. It is a wonderful sense that gives us an entry into the world of communication.

Hearing makes us aware of the unlimited capacity to communicate via speech. Loss of hearing partial or total can prove to be a very big obstacle in the present communicative world. A silent existence in this melodious world can prove to be very despairing.

Hearing is a late development in evolution but it has become the sentinal of our senses, always on the alert. Hearing does more. The ear and the brain analyze these sound waves are their patterns in time, and thus we can discriminate between two sounds, that we hear. What is more, we can locate the position of the carriage, and tell the direction in which it is moving.

Many animals and birds have also learned to signal to one another by their voices, both for warning and for recognition but we humans, with good ears and also mobile tongues and throats, and above all. Our large complex brains, have learned to talk. We

attach arbitrary and abstract meanings to sounds and we have language our experiences of the past and also ideas and plans for future action. For human beings, then the loss of hearing brings special problem even and a special tragedy. But human society creates a special problem even for those with perfect hearing - the problem of unwanted sound of noise, which is as much a *hazard* of our environment as disease germs or air pollution.

Both adults and children can have hearing loss. Hearing loss in children is more handicapping than in adults, because it disrupts language acquisition. Even a mild loss upto nine years of age has been known to disrupt language acquisition.

When Hearing Fails?

Defective hearing is a common physical impairment in our country today.

The burden is greatest for those who are completely deaf; for total deafness has devastating effects upon, psychological and social life, *"/ am Just as deaf as I am blind",* wrote Helen Keller. The problems of deafness are deeper and more complex. Deafness is a much worse misfortune. For it means the loss of the most vital stimulus - the sound of the voice that brings language, gets thoughts astir, and keeps us in the intellectual company of man. These poignant words describe the frustration of the child who was either bom deaf or became deaf at a very early age, and cannot recall ever hearing at all.

Whether language develops as a result of innate capability or whether it is learnt or whether it is acquired along with general

cognitive development, the acquisition or development of language is directly related to the kind extent of sensory input the child receives. For speech, the input is and must be auditory (Schuell, 1974) and there must be plenty of it. Anything that interferes with the input severely jeopardizes acquisition itself. The functional patency and the innateness of the hearing mechanism is therefore a must.

The present study aims at finding factors related to the prevention and early identification of hearing loss. And it also studies about how hyperbilirubinenia can affect the hearing sensitivity of the children and any other related (speech and Hearing) communicative disorders like cerebral palsy, mentally retardation and childhood aphasia, etc.

Crucial for later language development then ' *Early'* turns out to be very early indeed. Down (1978) put it more emphatically. It is important to identity hearing loss by three months of age. But Mencher (1980) goes further when we say early identification we mean at birth. When we say early diagnosis, we mean within the first month. In fact ... if he is over three months of age, he is a geriatric.

Why Early Identification of Hearing Loss is Necessary?

If hearing loss is identified as early as possible, then early intervention or management is possible which may include -

(1) putting a hearing aid on the child and
(2) giving him speech and language training.

Downs (1978) proposed that f the onset of hearing loss is after six years of age, the child will have good language. If the onset is around three years of age, the problem is not much as if the loss occurs at birth. If it is congenital then the child will have maximum problem. So according to Downs (1978) "If a *child with congenital hearing loss is given training as early as possible, his or her speech and language can be brought to the level of child, who has not acquired hearing loss".*

The present study explains about how hyperbilirubinemia can affect the hearing sensitivity of the person; and it also deals with how early we can diagnose the case.

Before going into the details of this review of literature, let us see what is hyperbilirubinemia and how it occurs.

Bilirubin

Bilirubin is a by product of red blood cell breakdown. Its high concentration in the blood is toxic to the new born babies.

There are two kinds of bilirubin products. One is by product of hemoglobin breakdown called *"Indirect or conjugated bilirubin itself. After this unconjugated bilirubin has been converted in the liver cells into conjugated or direct reacting bilirubin".*

. The unconjugated bilirubin is neurotoxic in infants if it is found in at high concentrations and under certain conditions accumulation of this bilirubin. It distinctly yellow whitened. This condition is called jaundice or Icterus.

The bodys bilirubin formed from the breakdown of erythrocytes. The heme portion of haemoglobin produces the unconjugated bilirubin by the action of the liver and spleen splits. Normal neonates produce bilirubin at the rate of 6-8mg/kg/24 hours. The bilirubin is transported in albumin to the liver where it is a elangated. Thus unconjugated bilirubin accumulate to levels that is spread to albumin binding capacity. This accumulation may occur at levels of 20 mg/ 100 ml. blood.

Hyperbilirubinemia

This was first described by Crigler and Najjar (1952). It is a serious disorder in which abnormally high plasma bilirubin levels and encephalopathy results from hepatic disability to conjugate bilirubin with gluconomide. The most severe type is bilirubia encephalopathy also called kernicterus or erythroblastosis.

Kernicterus Mechanism

According to Nelson bilirubin interferes with oxygen utilization by cerebral tissues possibly by injuring the cell membrane.

According to Menkes biliruin binds of phospolipids and angliosides of cellular membrane and as a consequence of its binding to mitochondreal, phospolipids it interferes with neuronaloxygen consumption and oxidative phospholipids.

Microscopic alteration point to the cell membrane as primary site of damage with mitochondreal changes being secondary to disorganization of cytoplasmic membrane.

Clinical jaundice manifests as a serumbilirubin concentration of the bilirubia in the blood serum level of 4 mg. i.e. every 100 ml of serum contains a bilirubin concentration of 4 mg. It is the commonest abnormal clinical findings during the first week of life.

Clinical Features

As the extent of bilirubin accumulation in the skin increase trunk abdomen, extremities, palms and soles become yellow in the order. Yellow staining of the trunk indicates a level of 10-15% mg. and when soles and palsms are distinctly yellow stained the accumulation is said to be more than 15 mg.% (Singh, 1979).

Bilirubin accumulation in the order of 15 mg % or more is considered potentially neurotoxic depending upon the state of the infant (in premature and low birth weight babies, a lesser level is indicated).

Only few conditions, however, can result in such a high level of bilirubin accumulation like the hemolytic disease of the new bom due to Rh or blood group incompatibility.

Incidentally, ABO incompatibility though less severe in its effects than the Rh incompatibility is said to be more prevalent than the latter in India. Infection such as toxoplasmosis, CMR, syphilis rubella etc.

These conditions result in such as high serumbilirubin accumulation (Behrman, 1975).

Hy perbilirubinemia of the New **Born**

When total serum bilirubin levels reaches 18 to 20% mg. per 100 ml. blood during the first week of life. Bliorubinemia beyond *"physiologic"* bounds hyperbilirubinemia is considered to be present. This may occur as an exaggeration of physiologic *"Jaundice"* particularly in premature babies or as a result of excessive hemolysis, as in erythroblastosis fetalis. The term hyperbilirubinemia of the new bom, however should be reserved for those infants whose primary problem is a deficiency or inactivity of bilirubin transferase rather than an excessive load of bilirubin for excretion. Serum bilirubin may reach the alarming level of 60 to 70 mg. per 100 ml. in full term or premature infants in the absence of any blood group incompatibility.

The significance of hyper bilirubenemia lies in the high incidence of kernicterus associated with serum bilirubin levels over 18 to 20 mg. per 100 ml. and in fact this condition rarely occurs in infants.

THE PRESENT STATE OF ART

In the present state of the art, the high risk register is very well established, well supported by research data and recognised as being effective in identifying approximately 65 to 70% of those born deaf (Mencher, 1986; Northern and Downs, 1974).

THE HIGH RISK REGISTER (HRR)

The concept of HRR -was introduced to new born hearing screening by a paediatrician (Hardy).

Thus any child who has a suggestive history or by his physical appearance suggests an abnormality is at risk, he is a high risk infant.

However some studies have shown that the greatest number of hearing-impaired children fall into only six or eight categories of risk. The National Joint Committee has endorsed only these conditions for an effective HRR (Gerber and Mencher, 1976).

Most authorities believe that the following eight categories should alert the primary care physician to the fact that a new born might have a hearing loss.

1. Familial hearing loss or history of childhood hereditary impairment.
2. Low birth weight (less than 1500 grams).
3. Congenital rubella, cytomegalo virus infection, toxoplasmosis, herpes simplex infection.
4. ***Bilirubin*** level greater than 20 mg % per 100 ml. serum (hyperbilirubinemia)
5. Congenital malformations of skull or pinna or cleft lip or plate.
6. Meningitis
7. Ototoxic drugs i.e. kanamycin, neomycin.
8. Significant perinatal asphyxia.

In all the new born at risk should be referred to an audiologist for evaluation within the first two months of life. These categories constitute a screening that requires sophisticated testing by a trained professional.

Out of these above mentioned eight categories, among them hyperbilirubenemia plays a very important role in producing a

hearing loss and other related speech and hearing problems i.e. cerebral palsy, mental retardation, childhood aphasia etc.

This is a very important factor which will affect the hearing sensitivity of the child. Hyperbilirubinemia occurs in 6 per 1000 new borns and of this group 2 to 4% will have a hearing loss due to Rh incompatibility.

An infant with a bilirubin level of over 20 mg % per 100 ml or a rapidly rising bilirubin level with the last documented level at 15 mg % per 100 ml or a low birth weight new born with a lower bilirubin possibly as low as 10 mg. per 100 ml are at risk and should have a follow-up hearing test. It is estimated that 2 to 4% of these new borns will have a hearing loss.

The Joint Committee on new bom hearing screening stated that an infant falling into these high-risk categories should be referred for an indepth audiological evaluation within two months after discharge from the nursery. This is a most important step in management. Since early diagnosis can lead to earlier and more successful intervention, which may minimize educational, speech, language and behavioral problems.

OBJECTIVES OF THIS PROJECT

Functionally information required for high risk categorization and early identification of the problem comes from three sources -

1) Family history
2) Medical records
3) Physical examination or observation of the child either by an investigator only a physician. Historic information is collected

from the mother by a query. Mostly about family history and rubella exposure. Rest of the information is gathered from the hospital records. Thus in most new born screening programs conducted elsewhere medical records form the chief source of risk information.

Mostly in big hospitals confined to cities and town ships, even in these hospitals there barely exists any system of maintaining detailed case records on every birth. In many primary health centres babies are not even weighted. Clearly we cannot depend on medical records for obtaining risk information in India.

Thus we are left with only one source, history as given by the mother. History and potentially a very important source. Most physicians in India agree that history forms a very important source of information for a functional diagnosis (Shetty, 1988). Moreover, most physical abnormalities found at birth associated with deafness are quite evident even to a layman. Thus mother can report very well these abnormalities. As far other conditions like maternal infections, asphyxia and conditions resulting in the accumulation of bilirubin at birth makes themselves evident through their own symptoms and signs. Hence it is quite probable that the mother can relate these signs and symptoms reliably, as she reveals to a physician.

Thus it appear that the mother could be the only source of dependable if not accurate information. But the validity of relying solely on the mother as the sources of risk information is open for investigation.

Jaundice and Hyperbilirubinemia in the New Born Infant

Under usual nursery condition jaundice is observed during the 1st week of life in approximately 60% of term infants and 80% of pre-term infants.

The colour usually results from the accumulation in the skin of unconjugated, nonpolar, lipid. Soluble bilirubin pigment formed from hemoglobin reduction, and nonenzymatic reducing agents in the reticuloendothelial cells, it may also be due in part to the deposition of the pigment after it has been converted in the liver cell microsome by the enzyme uridine diphosphoglucuronic acid glucoronyl transferase to the polar water soluble easter glucuronide of bilirubin. The unconjugated form is neurotoxic for infants at certain concentrations and under various conditions.

Jaundice should be considered as a sign of risk for the risk infant with the degree of danger that it may present depending on the factors those affects the production, metabolism, excretion and distribution of bilirubin after birth.

Etiology

The new born infant metabolism of bilirubin is in transition from the fetal stage. When the placenta is the principal route of elimination of the lipid-soluble bilirubin, to the adult age. When the water soluble conjugated form is direct from the hepatic cell into the gastrointestinal tract. Any factor that increases the load of bilirubin to the metabolized by the liver (erythroblastosis fetalis), hemolytic anemias, shortened red cell life. Bring to immaturity or to transfused cells. Infection, any factor that may damage on reduce the severity of the enzyme, any factor that may compete for or block the enzyme on any factor leading to increase or decreased amount of the enzyme or reduction of the up take by the liver cell may be expected to cause or increase the degree of jaundice. The risk of toxic effects from elevated levels of bilirubin in the serum are increased by factors that reduce the factor that the reduction of bilirubin in the accumulation on factors that increase the permeability

of nerve cell membranes to free bilirubin or the susceptibility of the brain cell to its toxicity. Early feeding decreases and dehydration increase the serum level of bilirubin and prevent its deconjugation and resorption in the intestine.

Clinical Manifestations

Jaundice may be present at birth or may appear at any time during the neonatal period depending on the condition responsible for it. Jaundice resulting from deposition of indirect bilirubin in the skin tends to appear bright yellow or orange. Jaundice of the obstructive type a greenish or muddy yellow. This difference is usually appears only in severe jaundice. The infant may be lethargic lead poorly and become dehydrated. Signs of Kernieterus may be due to erythroblastosis fetalis, sepsis, cytomegalic. Inclusion disease, rubella and congenital toxoplasmosis. Jaundice in infants who have received intrauterine transfusions may be characterized by an annually high levelof direct reacting bilirubin.

Keeping in mind the importance of early identification of hyperbilirubinemia and how it affects the hearing sensitivity of the infants and easier models of screen and prevent the population for hearing loss.

This project aims at the review of literature on hyperbilirubenia and hearing loss and it also provides an appendix of cases of hyperbilirubinemia seenat All India Institute of Speech and Hearing during 1996-1997.

REVIEW OF LITERATURE

As we all know ***"PREVENTIONIS BETTER THAN CURE"*** if one is aware of probable causes of a problem. Hearing loss is a problem which hinders communication oral and aural. Communication is supposed to be a human quality which differentiates human beings from animals. So a hearing loss if it occurs has real bitter consequences. To avoid loss we can as "well look forward for the possibilities of *"PREVENTION"* of its occurrence.

In the past decade a series of national studies have been held to identify which infants at birth have a higher risk for deafness. Most authorities believe this including speech and language pathologist and audiologist, paediatrician. Among the major eight factors, hyperbilirubinemia (20 mg/ml of blood or higher the level) is one of the causes for hearing loss.

The surveys of speech and hearing problems in India show wide discrepancies. Palmer (1962) estimated that 6% of general population has communication disorders. Vishwanath et al. (1977) examined 410 children between the ages- of 5 and 16 years and reported that 1.3% of girls had speech problems and 18.49% had hearing problems Manohar and Jayaram (1973) tested children between the ages of 3-16 years. Out of the total of 1454 children tested 74% were found to have incidence of speech problems and 15.79% had both speech and hearing problem. Aithal (1989) examined a total of 6211 individual during the various camps carried out in Karnataka. He reported that 2443 had speech and hearing problems. He further carried out an age wise classification and found that of the total 256 above the age of 17 years. 63 had speech

problems and 193 had hearing problems. Further classification of cases with hearing loss revealed that 122 had Sensori-Neural loss. 38 had mixed loss and 33 had conductive hearing loss.

Jajje and Lutherman estimated that hyperbilirubinemia occurs in six per 1000 new borns and of this group 27 to 4% have a hearing loss due to hyperbilirubinemia.

Nevertheless, an infant with a bilirubin level of over 20 mg/ 100 ml or a low birth weight new born with a lower bilirubin, possibly as low as 10 mg/100ml are at risk and should have a follow-up hearing test. It is estimated that 2% to 4% of these new borns will have a hearing loss.

THE NATIONAL JOINT COMMITTEE RECOMMENDATION

Downs and others had carefully analysed the available data and very cleverly came up with a simple and very efficient five point high risk register (Downs, 1972).

which is given below :

1. Affected family (congenital sensori-neural hearing loss in first cousins or closer).

2. Serum bilirubin levels of 20mg/100ml blood or more.

3. Congenital rubella (regardless of trimester).

4. Any observable defects of ENT (any first arch syndromes)

5. Small at birth (1500 grams or less).

Mencher (1974) had reported that among these 5 causes 15 of the cases had hyperbilirubinemia and he found that most of them had sensori-neural hearing loss.

THE HIGH RISK REGISTER

The concept of high risk register was introduced to new born hearing screening by a peadiatrician (Hardy). The concept utilizes history and 100 evidence of physical abnormality to anticipate the likelihood for hearing loss to occur or develop in any given child. Its basic assumption is that deafness has a suggestive history or by the physical appearance suggests an abnormality is at a risk. He is a high risk infant.

In case of hearing loss there are a large number of factors that have been associated with the handicap. However some studies have shown that the greatest number of hearing-impaired children fall into only 5 or 6 categories of risk. The National Joint Committee has enforced only these conditions for an effective HRR (Gerber and Mencher, 1973) among those five categories the hyperubilirubinemia is playing a major role.

THE PRESENT STATE OF ART

Recommended Screening Procedure

In the present state of the art, the high risk register is very well established, well supported by research data and recognised as being effective in identifying approximately 65 to 70% of those born deaf (Mencher, 1971; Northern and Downs, 1974).

With children failing a behavioural test if added, the sensitivity of high risk register increases to nearly 80% (Mencher, 1977).

The Jerusalam Study

The Joint Committee of Infant Screening (July, 1972) recommends that, infants at risk for hearing-impairment should be identified by means of history and physical examination. These children should be tested and followed up as here after described.

The criterion for identifying a new born as at risk for hearing-impairment is the presence of one or more of the following factors. Out of that hyperbilirubinemia has been considered as a major factor producing deafness in children.

The University of Colorado Screening Project

Supported by a National Foundation Grant this program starting from 1972 began to apply a hearing screening program for new borns.

The program followed a procedure which had three parts. Out of that the review of hospital charts to collect data on hyperbilirubinemia. Information on every new born was collected and a risk category was assigned. Parents and physician were informed when a child fell into this group and follow up appointment were made.

As in 1977, the results showed Gerkin (1977) that out of a total no.of 10,727 births were classified as high risk infants (one in nine i.e. 10.7%) and 17 were identified of having hearing loss (one

in 67 or 1.5%) due to hyperbilirubinemia. Four subjects suspected with hearing loss were lost to follow-up.

The Halifax Project

A mass infant screening program was initiated in the Grace Maternity Hospital, Halifax, Nova Scotia in Canada in 1977. The program incorporated the recommendations of the Nova Scotia conference and utilised the HRR proposed by the National Joint Committee and a behavioural test.

The testing was done as outlined by the Nova Scotia Protocal. Eventually 110 infants were referred for detailed evaluation. 70 of them were cleared after the initial visit. Of the remaining 3%. Eight were definite. Subsequently 15 of the 20 had been cleared and eight were still pending.

Among 8 failures one had confirmed sensori-neural loss and five had conductive hearing loss. However it was sure if any of these conductive hearing loss had a sensori-neural component as well. As Mencher et al. (1980) noted it is quite possible that any or all seven of them may develop a sensori-neural hearing loss later on.

However, it should be noted that all three of the confirmed hearing loss cases were hyperbilirubinemia babies.

The Haifa Study

Between 1965 and 1967 this study screened nearly 10,000 babies with a very broad high risk register consisting of five high risk factors. It included such factors as -

1. Family history of deafness.
2. Hyperbilirubinemia (20mg/100ml. of blood)
3. Low birth weight (less than 1500 grms)
4. Congenital rubella
5. Congenital malformation of skull or pinna.

On extensive follow up, the Haifa Committee could identify 80 deaf children. Deafness was two to three times common in the high risk population than in the general population.

The Newzealand Study

Started with the assistance of National Audiology centre. Adiland in 1972 this program known as the National Women's Hospital Program, screened 17,250 children between 1972 and 1976. It employed a hearing test and a nine month at risk screening program. All children were tested within 1-2 days after birth or before being discharged.

Those who failed twice to respond to a warble tone of 90 dB and 100 dB and also those at risk were followed up at nine months. Of them 29 failed. Among the 140 high risk infants 100 were followed up and only 10 were found to be deaf (Greville and Keeth, 1972). This is a good performance in view of the reported efficiency of high risk register.

High Risk Register as **an** Adjunct to Behavioural Screening **and** Research

Mencher (1977) it's an adjunct to validate Crib-o-gram and found it a valid method of differentiating infants with severe impairment from normal children. He also noted an abnormally

high percentage of M.R. cerebral palsy. Childhood aphasia and other speech and hearing problems.

Katherine Pike Gerk (1982) has summarized the risk factors and their most common effect on the hearing mechanism. However this categorization is merely a guideline and each risk factor should be viewed as any individual is viewed-unique variables and with endless possibilities.

High Risk Factor Most Common **Manifestation of Hearing Loss**

	Conductive	SN	**Mixed**	**Univ. BiL**	**Degree**
1 .Family history		+	-+	+ +	Mild-profound
2.Elevated Bilirubin		+	+	+	Mild-Profound
3.Low birth weight		+	+	+	Mild-Profound
4.Congenital Rubella		+		+	Mild-Profound
- 5.Asphyxia	+			+	Mild-Profound

But repeated follow ups were recommended.

Jerry Halpera, Holly Hosford, Dunnand Mala Chowsb's Natalie (1987) studied the high risk factors for sensori-neural hearing loss in the neonatal period included :

- Family history
- Hyperbilirubinemia
- Congenital infections

They found that the five National Joint Committee items retrospectively to data from a number of sources and found that the five item registers (including hyperbilirubinemia) would have correctly detected about *66°/o* of true positive cases and they had found that about 6 to 8% of the new born population and 2 to 4% of the high risk population will prove to have a hearing loss and of these perhaps half will be severely impaired cases (Gerber, 1977).

Deafness due to hyperbilirubinemia associated with hemolytic disease of the new born in connection with blood group incompatibility has been well documented (Crabtrel and Gerrand, 1950 and Fisch and Orborn 1954; Keaston and Nyman, 1969). This type of hearing loss is probably due to toxic damage to the cochlear nuclei or even to more central auditory pathways (Matkin and Garhart, 1968). Deafness due to hyperbilirubinemia associated with blood group incompatibility at present is rare, because the treatment is improved to avoid such undesirable sequele. Clerk et al. (1966) had estimated that deafness due to this cause is becoming rare.

The same authors had reported a perspective study of 405 patients mostly with hyperbilirubinemia and they found that deafness occurred more often in premature than in mature children with hyperbilirubinemia group.

It was in 1950 Goodhill pointed out that hyperbilirubinemia produces a certain specific type of deafness called cochleonuclear deafness.

Goodhill (1968) later on Dublin (1974), Altenaw (1975) and Chisin et al. (1979) confirmed that high levels of bilirubin accumulation causes damage to cochlear nuclei and thus cases a hearing loss. The incidence of hearing loss among

hyperbilirubinemia children is high. Stever (1974) found 8 deaf children in a sample of hyperbilirubenemic children.

Lensford (1977) estimated that high levels of bilirubin accumulations cause severely retardation, cerebral palsy and a hearing deficit.

Marcus (1970) based on his survey of studies that had been made between (1948) and (1960) concluded that about 10% of severe hearing loss is related to hyperbilirubinemia.

Shimuzu (1976) noted that around 1.5% incidence of prelingual hearing loss is due to hyperbilirubinemia.

Hymen et al. (1969) reported the following abnormalities in 405 infants followed for 4 years with a history of hyperbilirubinemia, 15% had sensory neural hearing loss athetosis, strabismus, minimal cerebral dysfunction syndrome or miscellaneous problems (impaired mentality, psychotic behaviour or spontaneous nystagmus). Hearing-impairment was found in 4.2% or 17 of the 405 infants. This included 4 with mild loss, 8 with moderate to severe loss and 2 with profoundly deaf children, 3 with profound loss in one ear and normal hearing in the other ear.

Kemicterus has also been related to the incidence of cerebral palsy (Donhoff, 1 960; Goodhill, 1 956). One form of athetosis, has been shown to correlate quite highly with hearing loss, both are affected by hyperbilirubinemia with subsequent kernicteric brainstem lesion (Brans, 1972).

There are few reports in the literature of the exact numerical incidence of hearing loss as a result of hyperbilirubinemia.

Gerber (1977) reported a study by Stewert in which 10, 07, 82 infants studied. They had bilirubin levels greater than 20 mg. per 1OO ml or had blood exchange transfusions. Five children had confirmed hearing loss whereas two were highly suspected.

Suga et al. (1974) described the auditory and vestibular function of children with a history of hyperbilirubinemia. Two had bilateral SN hearing loss. Their audiograms showed a mild loss at less than 1000 Hz, sloping, to be a consistent finding in all studies.

Blakeley (1959), Flottorp et al. 1957; Himura (1973) they had reported that there is no doubt that the incidence of Kerrictesic hearing loss has decreased considerably with the development of the hyperbilirubinemia.

ABR **Findings in Neonatal Hyperbilirubinemia** :

Hearing loss in young children may occur due to one or more risk factors that may occur during prenatal, perinatal or post natal period. One such risk condition is neonatal hyperbilirubinemia.

Yellow staining of certain parts in the brain has been reported over a hundred year ago by Orth (1875), Fisch (1955) reported that dorsal cochleo nucleus was more susceptible to hyperbilirubinemia

Cadavar studies by Dublin (1951) seven infants dying from neontal jaundice suggested that various levels of the auditory pathway showed neuronal damage and the maximum neuronal damage occurred at the level of the cochlear nuclei-

Penwick (1974) support the above findings of Dublin and explains that Dorsal cochlear nucleus has rich capillary net work

and therefore is more susceptible to anoxia which increases permeability to the bill pigment or unconjugated bilirubin.

Genard (1952) and Christen et al. (1979) have also suggested that the site of bilirubin lesion to be neural rather than peripheral.

Brainstem evoked response audiometry (BSERA) is one of the most sensitive test in the audiological test battery to objectively detect, localize and monitor the hearing-impairment in difficult to test populations. Therefore in the present study the effect of bilirubin toxicity on the auditory nervous system function has studied using BSERA.

Subjects :

The study group consisted of 6 neonatal (4 males and 2 females) with a history of Rh incompatibility or ABO incompatibility. These subjects referred from a local hospital for the BSERA were less than 3 months of age with serum bilirubin levels at or above 15 mg/ml. These neonates were treated at the referral hospital.

The recording and measurements of the ABR waveforms were carried out in a sound treated room, using Nicolet Compact-4 electrodiagnostic system. Silver electrodes were applied to 4 sides. One common electrode at the forehead, negative electrode on each mastoid bone and positive electrode at the vertex.

The wave forms of the group were analysed for their morphology, absolute and interpeaks patencies I and III, V and amplitude ratio of I and V, the absolute latencies of I, III, V peaks and their interpeak latencies were measured in msec, from clicks onsets by displaying screen cursor.

Results

Clear morphology ofABR waves with peaks I, III and V were observed in all the subjects of that group. But in the study group the wave morphology was not clear in some of the recordings as in three recordings the peak I was diminished and two recordings demonstrated loss of Peak HI.

The comparison of the absolute latencies in the study group showed that the absolute latency of peaks I, III were not significantly prolonged but the absolute latency of peak III has significantly prolonged (0.05 level). The interpeak latency of peak I, II in this group was not significantly prolonged.

The above findings suggest that the toxic effect of the bilirubia in these neonates may be on the auditory pathway. Mainly at the upper brainstem level rather than in the cochlea.

The neurophysiologic data derived from auditory brainstem response audiometry thus aid in unvailing acute neurotoxic encephalopathy caused by bilirubin.

COCHLEAR **AND BRAINSTEM RESPONSE IN HEARING LOSS FOLLOWING NEONATAL HYPERBILIRUBINEMIA**

The site of lesion in hearing loss following neonatal hyperbilirubinemia is unclear. The pathological studies have implicated the brainstem auditory nuclei while other investigation has hinted at a lesion in the cochlea. In order to clarify this issue attempts were made into record responses from the auditory pathwaty in 18 patients with hearing loss, following neonatal hyperbilirubinemia.

The sequelae of neonatal hyperbilirubinemia include hearing loss as well as other central nervous system deficits together known as kernicterus. The histopathological studies in infants and animals with acute bilirubin enchephalopathy have incriminated the brainstem auditory nuclei. However few autopsy studies have been performed in order tofind patients with the established clinical syndrome of kernicterus.

Methods and Material

13 hearing-impaired patients with previous history of neonatal hyperbilirubinemia were referred from audiology clinics after audiometric studies had established the presence of sensori-neural hearing loss. Neonatal hyperbilirubinemia was ascertained amnestically and by examination of the neonatal chart of all patients. Additional relevant clinical data for each patient were also seen including gestational age of 37 weeks. Score any treatment (exchange blood transfusion, and the existence of evidence of CNS damage such as cerebral palsy and delayed developmental milestones).

In order to conduct the recordings, various types of sedation were used in different children. The recording electrodes were applied to the skin of the earlobe to the vertex and to the skin over the naucions.

The responses obtained in this group of hearing-impaired patients following neonatal hyperbilirubinemia were compared with responses obtained in a group of normal children of similar age and in an additional group of hearing-impaired children with no previous history of neonatal hyperbilirubinemia.

This study has presented functional evidence of auditory nerve damage in patients with hearing loss following neonatal hyperbilirubinemia while the hair cells were often spared. It thus serves as an example of the ability of these functional tests to separate the term sensory-neural heading loss into sensory hearing loss when the Cochlear Microphonic response and auditory nerve response in both absent and a neural hearing loss when only the nerve response is absent. So this study shows that hyperbilirubinemia may affect the functions of auditory nerve response because of this it may lead to produce a sensory-neural hearing loss.

MANAGEMENT : PREVENTION OF KERNICTERUS

When bilirubin reaches levels at which kernicterus is a risk. So it necessary to keep indirect bilirubin levels under 20mg/100ml blood.

This included in addition to measures to prevent or to anticipate hemolytic disease of the newborn avoidance of the use of sulfisoxazole and novobiocin, high doses of vitamin K anoxia, prematurity and other at present unknown factors.

To avoid hearing and speech/language problems like cerebral palsy and mental retardation, chilhood aphasia etc. necessary to go for detail audiological followups frequently.

Treatment of Hyperbilirubinemia

Irrespective of etiology the goal of therapy of jaundice is to prevent the concentration of indirect reacting bilirubin in the blood fromreaching levels at which neurotoxicity and kernicterus mayoccur. It recommneded that (i) exchange blodd transfusion (ii) Photo therapy.

These two methods are use to keep the maximum total serum bilirubin below the levels and the risk of injury to the central nervous system from bilirubin must be balanced against the risk inherent in the treatment for each infant.

Phototherapy may require 12 to 24 hours tohave a measurable child. It must be started at bilirubin levels below the dangerous limit.

SUMMARY AND CONCLUSION

The aim of the present Review of Literature was to know about how Hyperbilirubinemia can cause hearing loss or how it can affect the hearing sensitivity of the affected infants.

The information was collected from the literature on high risk register programmes, etiological and epidemeological studies. The review information also includes factors suggested by various authorities in India and abroad.

Utilizing the normative value for hyperbilirubinemia in serum blood level the data was collected from different literature on high risk registers and from different studies done by different authors.

The data were collected from different case files. Referrals were done by the paediatricians from the Government Medical Hospital and from Well Baby Clinics.

At the end of the study an appendix has been provided which gives a report of the cases seen at All India Institute of Speech and Hearing, Mysore durung 1996-1997.

CONCLUSION

The following tentative conclusions can be drawn from the Review of Literature and from the case reports :

1. A majority of the infants come with the complaint of hearing loss and few cases come with the complaint of hearing loss with cerebral palsy, mental retardation, childhood aphasia etc.

2. Majority of the cases reported in the literature as well as those seen at All India Institute of Speech and Hearing have bilateral symmetrical sensory-neural hearing loss.

3. The information was collected from different literature on high risk register programmes and different studies done by different authors. The percentage of high risk infants in that population is drawn. The prevalence factors have been reported.

How early we can find the problem or how early we can diagnose hearing loss and type of hearing loss. Finally the percentage of infants suspected of having hearing loss was also deducted. From the studies done on HRR, it is shown that out of 90 infants screened 20% of the new born population was at risk of hyperbilirubinemia as causative factor and it was found to be more prevalent.

The treatment for hyperbilirubinemia is (i) exchange blood transfusion (*ii)* Photo therapy.

Photo therapy may require 12 to 24 hours to treat a child with high level of bilirubin. It must be started at bilirubin levels below the dangerous levels.

Percentage of infants suspected of hearing loss is 44.4% as reported in the literature and 55.6% had normal hearing. And it was also reported that the high level of serum bilirubin is evident if it is more than 15 mg % per 100 ml blood or more is considered potentially neurotoxic.

Depending on the state of the infants it will affect the hearing sensitivity of the infants. So the more amount of bilirubin toxicity will affect the cochlear nucleus and it will lead to hearing loss in infants.

However to confirm about the hearing loss, high risk programme has to be supplemented with other objective procedure like BSERA, BOA etc.

The paediatric evaluation regarding hyperbilirubinemia and other high risk factors should be calculated very clearly and very early. This will help us in the prevention of hearing loss and also a regular follow-up should be done to monitor who are found to have the high risk of hyperbilirubin levels for those in the early infancy.

BIBLIOGRAPHY

Ashok Kumar M.M. (1980). A High Risk Questionnaire for Hearing Loss in Children : A feasibility Study on an India Population. An Independent Project submitted in part fulfillment for the First Year M.Sc, (Speech and Hearing), University of Mysore.

Davis, H.A. (Ed.) (1964). The Young Deaf Child Identification and Management proceeding of the Conference held in Torando Canada. *Acta Otolaryngol,* Sup.206.

Gerber, S.E., & Mencher, G.T. (eds). (1978). *Early Diagnosis of Hearing Loss.*

Gerber, S.E. (1974). *Hearing Screening of New Born Babies. An Address to Helen Keller Seminar of Hearing.* Lions International Convension, San Francisco.

Gerber, S .E. (1976). *Conduct and Follow-up of a High Risk Babies.* ASHA Convension. Texas (1978).

Gerber, K. (1984). *The High Risk Register for Deafness.* ASHA, 1975.

Goldstein (1971). Critique of Neonatal Hearing Evaluation. *Journal of Speech and Hearing Disorder,* 36, 3-18.

Joan D'Mello, Venugopal, S., & Chandrashekhar, R. (1990). ABR Findings in Neonatal Hyperbilirubinemia. *Journal of Speech and Hearing Association,* 7, 22-25.

Ling, D. (1976). Comment on Use of a High Risk Register in New Bora Screening. *Journal of Speech and Hearing Disorder,* 41, 555.

Mencher, G.T. (1976). *Early Identification of Hearing Loss.*

Mencher, G.T. (1973). Identifying Deafness in the New Born. *Journal of Otolaryngology,* 6, 490-499.

Periman, M., & Fairmesser (1983). Auditory Nerve Brain Stem Evoked Response in Hyperbilirubinemia Neonates. *Paediatrics,* 72, 658-664.

Renwick, J.D. (1970). Neonatal Jaundice as a Cause of Deafness. *Laryngoscope,* 90, 925-932.

Risch, L., & Osborn, D.F. (1954). Congenital Deafness and Haemolytic Disease of the New Born. *Archives of the Disabled Child,* 29,309-316.

Stewert, I.F. (1977). New Born Infants Hearing Screening : A Fine Year Pilot Study. *Journal of Otolaryngology,* 16, 481-497.

Swigonoski, N. et al. (1977). Hearing Screening of High Risk New Born. *Ear and Hearing,* 8, 26-30.

Wallace (1991). Relevant Factors in Identification of Hearing Loss. *Ear and Hearing,* 12,26-30.

APPENDIX

CASE STUDIES

In this particular cases, the history indicates that the childrens had hearing loss and other speech and hearing problems and the cause was hyperbilirubinemia in their blood groups.

The patient had reported to All India Institute of Speech and Hearing with a complaint of inability to hear the sounds. The cases had undergone for audiological findings.

Case No. *1*
Age *9 years/Female*
Language - *Malayalam*

Complaint:

The parents reported to AIISH on 14.3.97 with the complaint of inadequate speech and language. They also suspected that the child could not hear. The child could say /amma/ /appa/ meaningfully. Most of her communication through gestures.

History

The baby was found to have severe jaundice the next day blood transfusion was done at the 3rd day and subsequently two more' blood transfusion were carried out.

Audiological evaluation

The child could comprehend the instruction through gestures.

Diagnosis : Right ear severe hearing loss
Left ear moderately severe hearing loss.

The lower frequencies have better response than high frequencies.

Immittance : Both ear - As type 'No response'

BSERA : 90 dB nHL - NR - both ears.
TEOAE - Absent in both ears

BOA : The response observed was head turn, the case of speech it was localization.

Paediatric evaluation

The provisional diagnosis given by the paediatrician was - post kernicterus sequalae, dyskinetic CP with delayed speech and language.

**

Case No.*2*
Age *.2.6 years/female*
Language : *English*

Complaint

The parents reported to AIISH on 5.5.97 with the complaint of inadequate speech with hearing loss. She says only /amma/ /appa/ meaningfully. Occasionally comprehend simple verbal commands. Has a vocabulary of around 10-15 words.

History

Dr.Shashikala (Nagpur) had diagnosed s high risk infant with static encephalopathy, global developmental delay.

BERA : Diagnosis : Right ear profound loss
Left ear first wveform detected at 90dB.

Treatment :

On 10.5.97 exchange blood transfusion was done with A +ve blood, which bilirubin was 18.5 mg % per 100 ml. Baby with stood that produce the cause of jaundice was prematurity.

Diagnosis. 1) Preterm (2) DGA (3) HEE(4) Septreaming (5) Hyperbilirubinemia.

Audiological Evaluation

BSERA : Diagnosis : Both ear 90 *dB* nHL - No response.

Immittance : Both ear 'B' type.

BOA : Ddiagnosis bilateral severe hearing loss.

Case No.3
Age : *7 years/female*
Language : *Kannada*

Complaint

The parents reported to AIISH on 9.2.1997 with the complaint of inadequate speech with hearing loss. She says only /amma/ appa/ /tha/ /ajji/ and some of the monosyllabic words and simple verbal commands. She has a vocabulary of around 20-25 words and history of delay motor development.

History

Dr.Krishna Kumar (Bangalore) had a diagnosed as high risk infant with global developmental delay.

Diagnosis : Right ear severe sensori-neural hearing loss
Left ear profound hearing loss

Treatment :

On 14.8.96 blood exchange transfusion was done with AB +ve which biliruben was 17.5.mg *%o* per 100ml. Baby with stood to produce the cause of hearing loss.

Diagnosis : (1) Preterm (2) DBN (3) HIE (4) Causotricin (5) Hyperbilirubenemia.

Audiological evaluation

The child could comprehend the instruction through conditioning and gestures.Diagnosis : Right ear severe sensorineural hearing loss

Immittance : Both ear As type no response.

Paediatric evaluation :

Diagnosis : Post kernicturs sequale. Dyskinetic Cerebral Palsy with hearing loss.

**

Case No.4
Age : *8 years/male*
Language : *Kannada*

Complaint:

The parents reported to AUSH on 27.6.97 with the complaint of inability to hear the sounds since childhood.

- Delayed motor milestones -Motor incoordination.
- Articulated problems. -No history of earpain/ear discharge

Treatment :

The baby was found to have severe jaundice of the age of 3rd day they gave phototherapy (but not continuously). At the age of 6 days they have undergone for blood transfusion (Twice).

Audiological evaluation

Diagnosis . Right ear moderately severe sensorineural hearing loss
Left ear severe sensorineural hearing loss

The lower frequencies were better than high frequencies.
Immittance : Both ear - As type - No response.