

ESTIMATING THE INCIDENCE OF NEONATAL HEARING LOSS IN HIGH RISK NEONATES

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Abstract- Regardless of severity, earlier intervention to correct hearing loss in children improves speech development and conversational abilities. A cross-sectional study was performed on 230 neonates who were at risk of hearing loss in Tehran University of Medical Sciences hospitals between September 2000 and February 2002. Hearing was examined before the 3rd month by auditory brainstem responses (ABR). Eighteen neonates (8%) had sensorineural hearing loss. There was no significant relationship between hearing loss and sex. We found significant statistical relationships between hearing loss and craniofacial anomalies (P value < 0.000001), the neonate's age during hospitalization (P value < 0.005), hyperbilirubinemia (P value < 0.01), using artificial ventilation (P value < 0.05) and use of ototoxic drugs (P value < 0.05). It seems that it is much better to screen all neonates for early detection of hearing loss. If this goal is not achievable, all neonates with risk factors must be checked. Severe hyperbilirubinemia is a main risk factor of hearing loss.

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Key words: Neonate, ABR, hyperbilirubinemia, hearing loss, aminoglycosides, craniofacial anomaly

INTRODUCTION

Screening is one of the most important methods of early diagnosis of treatable diseases in children and hearing loss is an important treatable disease of childhood. The incidence of hearing loss in neonates is 2 - 4 cases in every 1000 live births. Hearing loss, especially in mild and moderate forms, may not be recognized before the second year, but may produce great defects in conversational abilities (1). Irrespective of severity, earlier treatment of hearing loss in children improves speech development and conversational abilities (1).

Half of the neonates with hearing loss show no risk factors (1, 2). It is recommended to check all neonates for hearing loss after birth or at the most during their first three months of life (1). On the other

hand, half of these neonates do show risk factors (1). In some countries where screening all neonates is not feasible, all those with risk factors must be checked.

In this study, we examined all neonates born in or referred to the hospitals of Tehran University of Medical Sciences, in order to identify high risk cases and then examined these neonates with auditory brain stem responses (ABR) to identify those with hearing loss. ABR is one of the most important methods for surveying hearing loss in neonates and is standard test for screening hearing loss in neonates, with high sensitivity and specificity (3-5).

MATERIALS AND METHODS

A cross-sectional study was performed to evaluate all neonates who were hospitalized or referred to the children's hospitals of Tehran University of Medical Sciences from September 2000 to February 2002. High-risk patients were referred for ABR before the age of 3 months (at most).

The following were considered as risk factors: (1,2,6,7)

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1. Familial history of hearing loss.
2. Intrauterine infections (TORCH).
3. Craniofacial abnormalities including pinna anomalies and canal agenesis.
4. Hyperbilirubinemia needing blood exchange.
5. Using ototoxic aminoglycosides for more than five days or using them with loop diuretics.
6. Bacterial meningitis.
7. Apgar scores of less than 4 in the first minute or less than 6 in the fifth minute.
8. Needing mechanical ventilation for more than 5 days.
9. Neonatal intensive care unit (NICU) patients (\geq 2 days).
10. Manifestations of syndromes with hearing loss, such as Usher- Refsum syndrome.

After the first visit in our auditory centers, tympanometry was performed in order to rule out other problems such as internal ear effusion. Patients were also checked to have no ear wax in their external acoustic meatus.

Before six months, ABR does not require anesthesia or sedation, but we used chloral hydrate to overcome the interruptions of ABR waves with muscle movements in excited neonates (1). Neonates had to be NPO for at least one hour, and awake for the two hours prior to testing (no sleep or even napping). For ABR, three electrodes were placed on the infant's scalp; vocal stimulation was made by a headphone on his/her ears. Diagnosis of hearing loss was based on the absence of, or decreases in, the amplitude of ABR waves. For performing ABR, we used Madson ERA 2250 (Denmark).

After performing ABR, patients' characteristics (such as age, sex, weight and risk factors) were gathered in questionnaires and analyzed by SPSS software. We used chi-square and other statistical methods for detecting significant relationships between hearing loss and other variables.

RESULTS

From 230 high-risk cases, 18 (8%) had sensorineural hearing loss. Relationships between hearing loss and risk factors are shown in table 1.

From 136 boys, 11 (8%) and from 94 girls, 7 (7.5%) had hearing loss. Hearing loss had no significant statistical relationship with sex ($P = 0.85$).

From 159 term neonates, 13 (8.1%) and from 61 preterm neonates, 5 (8%) had sensorineural hearing loss. There was a significant relationship between hearing loss and the age at time of hospitalization ($P < 0.005$) (Table 2).

Three of 17 neonates with birth weight under 1500 grams (17%), 7 of 85 cases with weights between 1500 and 2500 grams (8%) and 8 of 128 neonates with more than 2500 grams birth weight (6.2%) had hearing loss ($P = 0.25$).

Incidence of hearing loss had no significant statistical relationship with head circumference ($P = 0.35$).

There were 2 cases of craniofacial anomalies; both had sensorineural hearing loss. So there is a significant statistical relationship between hearing loss and craniofacial abnormalities ($P = 0.00001$).

Seven cases had a history of hearing loss in their families, but no hearing loss was detected in these cases ($P = 0.43$).

Five (12.5%) of the 40 cases with hyperbilirubinemia, and 7 (16.5%) of the 43 with hyperbilirubinemia accompanied by other risk factors, had hearing loss ($P < 0.015$) (Fig.1).

None of the 95 cases with history of aminoglycoside use for more than 5 days with no other risk factors had hearing loss.

Table 1. Relationship between hearing loss and risk factors

Hearing loss risk factors	Abnormal ABR	
	No.	%
Hyperbilirubinemia	5	28
Craniofacial anomalies	2	11
Meningitis + Antibiotics*	1	5
NICU + Aminoglycosides + Icterus	1	5
Icterus + Low weight + Aminoglycosides	3	17
Aminoglycosides + Icterus	3	17
NICU + Aminoglycosides + Low weight + Mechanical Ventilation	3	17
Total	18	100

Abbreviation: ABR, auditory brain stem responses; NICU, neonatal intensive care unit.

*Including aminoglycosides.

Table 2. Incidence of hearing loss based on age*

Age	ABR					
	Abnormal		Normal		Total	
	No.	%	No.	%	No.	%
< 7 days	14	14.5	82	85.5	96	42
7-14 days	3	3	102	97	105	46
>14 days	1	3.5	28	96.5	29	12
Total	18	8	212	92	230	100

Abbreviation: ABR, auditory brain stem responses.

* $P < 0.005$

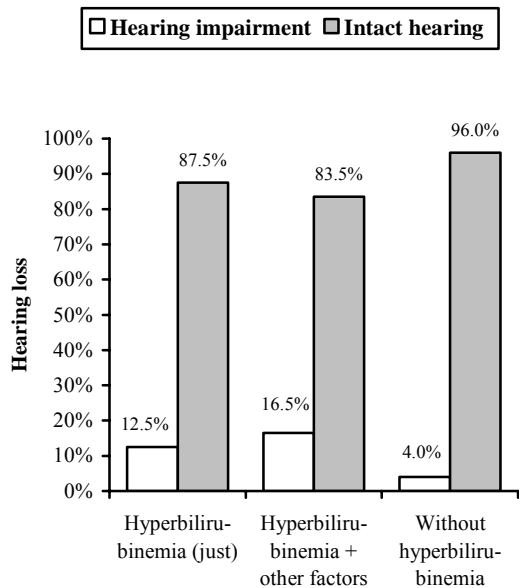


Fig 1. Relationship of hearing loss and hyperbilirubinemia

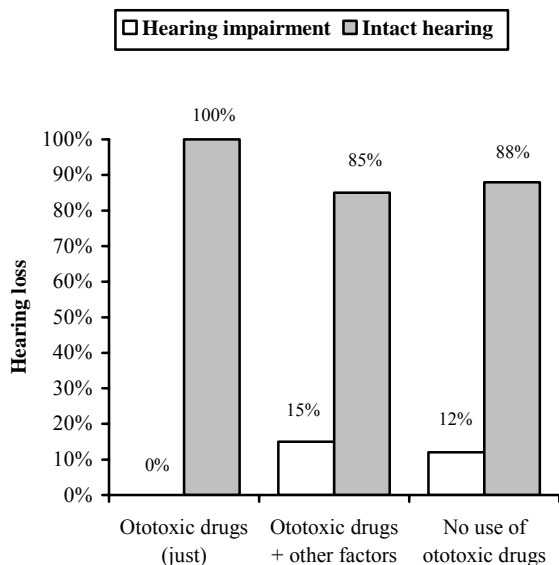


Fig. 2. Relationship of hearing loss and ototoxic drugs.

Of the 75 cases with history of aminoglycoside use and other risk factors, 11 (14.6%) had hearing loss (P value < 0.00087 , Fig.2).

Three (21%) of the 14 cases with a history of mechanical ventilation (with other risk factors) had hearing loss ($P < 0.05$).

Four (16%) of the 25 cases who were hospitalized in NICU, and 1 (25%) of the 4 with bacterial meningitis, had hearing loss ($P = 0.1$ and $P = 0.19$, respectively).

Due to lack of reliable information from parents, the Apgar score variable was omitted from our study.

DISCUSSION

The goal of early diagnosis of hearing loss is to achieve better verbal and social communication. Delayed diagnosis may have a negative impact on the patient’s verbal, educational, psychological and socioeconomic abilities. Downs and Yoshingata-Itano have reported the effects of early diagnosis of hearing loss in neonates on the normal development of speech. They showed that the diagnosis of hearing loss before 6 months of age is of critical importance, and this can be done by Universal Newborn Hearing Screening (4).

It is universally accepted that screening for hearing loss in neonates is crucial. In a survey by Welzel-Muler *et al.* in which they compared healthy nursery neonates and those who were hospitalized in NICU, it was reported that screening all neonates is more valuable than screening just those who were hospitalized in the NICU (8).

Recognition and treating hearing loss in its early phase by screening is of critical value, but economical aspects of such screening should be kept in mind (9). By considering the economical aspects, for the time being, we consider screening only in those with risk factors for hearing loss. Lutman *et al.* studied 218 patients who were at risk. The incidence of hearing loss in neonates who were in the NICU for more than 48 hours was about 2-4% (10). Patients hospitalized in the NICU must be screened for hearing loss, because these neonates probably have more problems and multiple risk factors, such as prematurity, low birth weight, use of ototoxic drugs and mechanical ventilation. Hearing loss incidence in

neonates hospitalized in the NICU who had primary pulmonary hypertension and underwent extracorporeal membrane oxygenation was 20 - 25% (7). Stein reported that hearing loss incidence for NICU patients is 20 - 50 times more than normal neonates in nurseries (11). Roizen studied high-risk neonates and reported that 13% of those with hearing loss had low birth weight. Neonates who were discharged from NICU had 17% incidence of hearing loss (12).

In our study, the incidence of hearing loss in NICU patients was 16%; 4 of the 25 patients had bilateral sensorineural hearing loss. All had other risk factors (such as low birth weight, icterus, antibiotic therapy or use of mechanical ventilation) as well. This statistical difference may be due to the factors that cause these neonates to be hospitalized in the NICU.

In the study performed by Hess *et al.*, 942 neonates who were at risk for hearing loss were studied by ABR from 1990 to 1997. They found 17 (1.9%) cases of hearing loss, 14 (1.4%) of whom had bilateral hearing loss of more than 30 db. Aminoglycoside use was not an important risk factor in this study, and 4 of the 13 patients with hearing loss had malformations (13). In our study, aminoglycosides use per se had no correlation with hearing loss. Of the 95 patients with history of using these drugs (with no other risk factors), none had hearing loss. However, 11 (12.6%) of the 75 patients with a history of using aminoglycosides and other risk factors had hearing loss ($P < 0.0084$).

We found two cases of craniofacial anomalies; one had external ear and canal agenesis and the other had trisomy 21 (low hair line and epicanthal fold). Both of these patients had sensorineural hearing loss. This variable had a significant statistical relation with hearing loss ($P < 0.000001$).

Severe hyperbilirubinemia causes hearing loss. When indirect bilirubin passes the blood brain barrier, it will be deposited in the basal ganglia, and also in the vestibulo-cochlear nucleus and the consequence of this phenomenon will be sensorineural hearing loss. It has been reported that 33% of newborns with blood bilirubin levels of 15 - 25 mg/dl had loss of wave complexes IV and V in ABR (7). In a study performed by Sheykholslami and Kaga for localization of the pathological etiology

of hearing loss in those with a history of hyperbilirubinemia, 3 cases had abnormal ABR. They found that in severe hyperbilirubinemia at least some defects exist in the cochlea and especially in the outer hair cells and even moderate forms of hyperbilirubinemia (< 20 mg/dl) would be able to cause SNHL (14). In Amin *et al.* study, ABR was performed for immature neonates (28-32 weeks) during their first week of life, and total and indirect bilirubin were tested 48 and 72 hours after birth. Increasing indirect bilirubin was more sensitive in predicting abnormalities in ABR and encephalopathy of hyperbilirubinemia than total bilirubin. In fact there was a direct significant relationship between hearing loss and indirect hyperbilirubinemia (15). In our study, 5 (12.5%) of the 40 cases with hyperbilirubinemia, and 7 (16.5%) of the 43 with hyperbilirubinemia accompanied by other risk factors had hearing loss ($P < 0.015$). Based on this study and those from other centers, it is much better to screen all neonates for early detection of hearing loss. If this goal is not achievable, all neonates with risk factors must be checked. Severe hyperbilirubinemia is a main cause of hearing loss so it can be stated that early diagnosis and treatment of icterus is of great importance for preventing hearing loss.

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