Original Article

Early Detection of Hearing Impairment among High-Risk Neonates

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Objective: *T*o assess the frequency of hearing impairment among pre-defined high risk newborns.
Study Design: A cross-sectional analytical study.
Place and Duration: Fatima Memorial Hospital, Shadman, Lahore in 2008
Materials and Methods: Two successive otoacoustic emission (OAE) recordings were followed by brain stem auditory evoked potential (BAEP) and otolaryngeal {ORL} consultation, in those cases screened to have hearing loss. One hundred neonates fulfilling the criteria of being high risk were studied at Fatima Memorial Hospital, Shadman, Lahore in 2008.
Results: Among high risk neonates, 92.0% were found normal for auditory functions. 6.0% were found to have bilateral impairment and definite hearing loss. Six percent hearing impairment on screening test was quite high to initiate such tests in major obstetrical units. Early detection and management carries better prospects.
Conclusion: Hearing impairment has a very serious impact on cognitive development, language acquisition and social integration, every public and private sector tertiary care hospitals should start screening every newborn if possible or atleast high risk neonates in Pakistan. In view of such studies American Academy of Paediatrica recommended, hearing loss diagnosis, to be completed by less than three months.
Keywords: High risk neonates, Congenital hearing impairment; Hearing assessment.

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Introduction

Hearing screening programs of neonates have proved to be the most needed opportunity to detect their permanent congenital hearing loss, and the subsequent initiation of auditory rehabilitation before the age of three months universally. Such a screening represents a secondary prevention of hearing impairment /deafness; it is well documented that the delayed identification of children with congenital/early-acquired hearing impairment will no longer be there with the implementation of universal neonatal hearing screening programs.[1]

There are three essential reasons for undertaking early childhood auditory screening. Firstly, childhood hearing loss has a serious impact on cognitive development, language acquisition and social integration. It seems likely that very early auditory experience will play a part in language development, language acquisition, beginning straight after birth, with the neonate listening to his or her native language.[2]

Mostly permanent childhood hearing impairment (PCH1) is sensori-neural but it also includes structural conductive impairment (e.g., ear canal atresia). Congenital impairment is defined as impairment recognized at birth or believed to have been present since birth. Late -onset impairment is not present at birth and that cannot be attributed to congenital anomalies. Acquired impairment is not present at birth and for which an exogenous cause can be identified.[3] The U.S. Joint Committee on Infant Hearing (JCIH) has published a series of guidelines for risk indicators that predispose newborns and infants to congenital, progressive, late-onset or acquired PCHI.[4]

A 'high-risk group' can be defined among both full- and pre-term neonates, in terms of multifactor mechanisms as listed by international committees: Family history of hereditary childhood sensori-neural hearing loss; in utero infections such as cytomegalovirus, rubella, syphilis, herpes, and toxoplasmosis; bacterial meningitis; ototoxic medication including but not limited to aminoglycosides, in multiple courses or in combination with loop diuretics; birth weight below 1500g; serum hyperbilirubinemia requiring exchange transfusion and/or phototherapy; apgar scores of 0-4 at 1 min or 0-6 at 5 min; 5 days or more mechanical

ventilation; craniofacial anomaly, including those involving morphological anomaly of pinna and ear canal; and stigmata or other findings associated with syndromes known to include sensori-neural and/or conductive hearing loss.[4]

The present study shows the results of systematic auditory screening of high-risk neonates (both pre-term and full term), by Transient evoked otoacoustic emissions (TEOAEs) and brainstem auditory evoked potentials (BAEPs). All neonates were delivered at Fatima Memorial Hospital and were admitted in the neonatology unit because of their high risk status prior to the age of 3 months. This was in fact a pilot study/program to assess the need for screening of high risk neonates and to determine the burden of auditory impairment in relation to risk factors.

Materials and Methods

One hundred high risk neonates fulfilling the inclusion criteria (Table I) were investigated at Fatima Memorial Hospital Lahore during year 2008. After taking an informed consent from the parents, those neonates were subjected to routine otoacoustic emission tests (OAE) in the neonatology unit from 4 days after birth (Table II). One hundred selected cases were subjected to otoacoustic emission tests (OAE) in first week and then in fourth week of their birth. In the next step those cases who failed were subjected to another otoacoustic emission testing (OAE) in sixth week.

Those who failed in all the previous tests were, after detailed ENT consultation were sent for brain stem auditory evoked potentials (BAEP).

Finally, all who failed in these screening tests were kept under observation for auditory rehabilitation (early hearing aid and cochlear implant later on).

Table I: Risk factors and modes of identification for assessing hearing impairment

Sr. No.	Inclusion Criteria
1.	Family history of hereditary childhood hearing loss.
2.	Vertical transmission of TORCH syndrome
3.	Craniofacial anomalies
4.	Birth Weight less than 1500 g
5.	Hyperbilirubinemia
6.	Ototoxic medications during pregnancy. Aminoglycosides. Vancomycin, Frusemide
7.	Bacterial meningitis
8.	Apgar score of 4 – 6 at 1 & 5 minutes
9.	Mechanical Ventilation candidates
10.	Hydrocephalus
11.	Seizures
12.	Miscellaneous syndromes likely to affect Hearing

Cases maintaining the failure status were kept under observation in otolaryngology department for follow-up. The collected information was analyzed through SPSS version 12 and presented in terms of qualitative and quantitative indices. The study being without any control group so did not require any test of significance.

Table II: Hearing testing used in the study

Hearing Tests	Description
Otoacoustic Emissions (OAE)	Otoacoustic emission testing is the recording of sounds that the ear produces itself. They appear to be generated by motile elements in the cochlear outer hair cells.
Brainstem Auditory Evoked Potentials (BAEP)	BAEP test is a useful diagnostic tool for measuring hearing when more conventional hearing tests cannot be used. BAEP test is reliable, objective, noninvasive and painless. Brain wave activity in the auditory centers of the brain is recorded in response to a series of clicks presented to each ear. Thus, BAEP test indirectly estimates the level of hearing in the peripheral auditory system (middle ear and inner ear).

Results

The 100 high risk neonates were distributed as listed in Table III. The data shows that low birth weight (<l.5 Kg) along with pre-maturity (24-37 weeks of gestation) was the major group. Low birth weight without pre- maturity (12%) and jaundice alone (10%) were the other main factors.

Table III: Distribution of subjects by high risk criteria at the time of inclusion

Sr. No.	Reasons/ risk factors	Number
1,	Low Birth weight with pre-maturity	32
2.	Septicemia	17
3.	Low birth weight	13
4,	Jaundice & pre-maturity	12
5,	Septicemia & pre-maturity	11
6,	Hyperbilirubinemia	10
7,	History of ototoxic drug intake	02

8.	History of deafness in parents	01
9.	Microtia	01
10.	Fits	01
	Total	100

Table IV shows the outcome of 100 studied subjects in relation to major risk factors for the positive cases by sex and by steps of hearing assessment. The data presented shows that among failure cases from step 1 to step 4, prematurity and low birth weight separately or in combination accounted for 75% or more of the cases. By sex 29% of the cases were female at step 1 and they all passed by step 4. The two drop out cases were male.

Figure 1 shows the flow chart of the 100 subjects. In the first examination, 24 were found to fail, out of whom 10 passed in the second examination. Six further passed in the third step with one dropout. By the final step, 2 cases dropped out and six were sent for clinical assessment and follow-up. Ninety two neonates passed while 06 were detected to have hearing impairment while 02 dropped out from the study.

Discussion

The highest quality UNHS data was provided by the New York State UNHS demonstration project. For this program, the adjusted prevalence of hearing impairment greater than 20 dB in either ear was 2.8 per 1,000 live births. For five acceptable program reports addressing at least mild, congenital PCHI in any ear (unilateral or bilateral impairment), the median unadjusted prevalence was approximately 2.2 per 1,000 live births. This value is biased negatively by incomplete follow-up. The adjusted median estimate accounting for children lost to follow-up was 3.2 per 1,000 live births.[5]

Prevalence estimates for PCHI in at-risk groups varied greatly. In addition to the sources of variation noted earlier, risk determination itself added further variability. Reported proportions of infants at risk varied with the risk indicator set and ranged from 3% to over 15%.[6]

Indicating prevalence in our high-risk population of 2.9% it was found that a congenital hearing loss was present in 5/6 patients [sensory neural in 3 (5/6 ears) and was conductive severe in 2 (4/4 ears)]. In the three cases of sensory-neural hearing loss, the combination of severe preterm birth and low Apgar score at 1 minute seemed important factors. Both cases of severer conductive hearing loss were

Table IV: Distribution of failed cases by sex, step of hearing assessment and risk factor

Sr. No.	Risk Factors	Step 1 (n= 24)		Step 2 (n = 13)		Step 2 (n = 07)		Step *4* (n =06)	
		m	f	m	F	m	f	m	f
1.	LBW with prematurity	6	4	4	3	3	1	3	-
2,	Jaundice with pre-maturity	3	2	2	1	1	-	1	-
3.	Septicemia & pre-maturity	3	-	1	-	1	-	1	-
4.	Jaundice	2	-	1	-	-	-	-	-
5.	Parental deafness	1	-	I	-	1	-	1	-
6,	Septicemia	1	-	-	-	-	-	-	-
7.	Ototoxic drugs	1	-	-	-	-	-	-	-
	Total	17	7	9	4	6	1	6	-

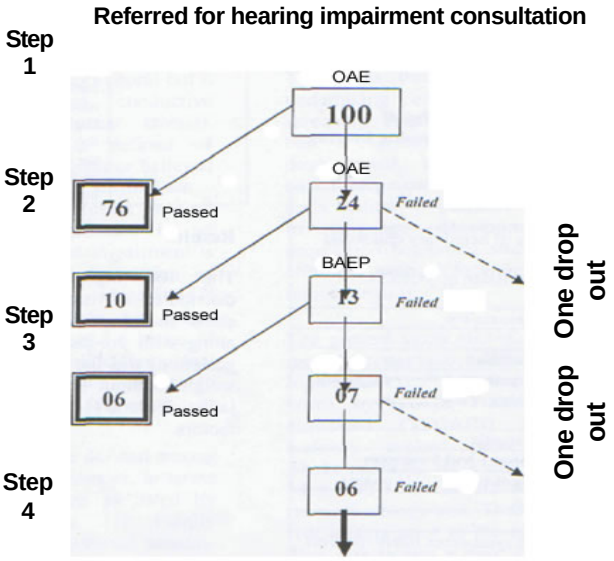

Figure I: Flow chart of steps and study groups

associated to cranio-facial malformations.-In one out of six patients (2/2 ears) where the hearing loss was delayed onset, its etiology was not yet fully established.[2]

The fact that childhood hearing loss has a serious impact on cognitive development, language acquisition and social integration has encouraged many researchers to find out if the hearing impairment in neonates had any pre-disposing risk factors and if detected early, would it be of any beneficial value for early referral and management.[4]

A few studies used the high risk neonate group approach to find higher incidence and showing the effort-effective status of the screening steps.[7] Many studies have used all live birth cases to estimate the incidence of neonatal hearing impairment. Most of them found the incidence to be under 2%. [8]

In the present study we found 6.0% of the high risk neonates to have hearing impairment. Other studies have also found slightly lower rates. We found pre-maturity alone or in combination with low birth weight to significantly raise the chances of developing hearing loss in the early stages of life. Other studies have also found pre-maturity to be a major risk factor for the hearing impairment.[9] This perhaps suggests that sensori-neural development of ears is closely related to the length of gestation. We have found that male gender is more prone to auditory defects in relation to risk factors. No other study has commented on gender effects. Many studies have looked into the reliability of the initial and later tests for their sensitivity, false positivity, etc. and found the tests to be quite reliable.[10-12]

Some studies have suggested the influence of about 40 genes to control the auditory function development. Some hazardous genes have been identified to cause hearing impairment in neonates.[13] We have not taken up these issues in our study and it is quite difficult to eliminate the confounding effect of faulty genes in our study.

The six cases in the present study have been under clinical follow up, audiometric normalization by age. Another study has found this regression of audiometric problem by 2.7 ± 1.3 months.[9]

In view of such studies American Academy of Paediatrica recommended hearing loss diagnosis to be completed by less than 3 months of age.

Conclusion

In view of the fact that hearing impairment has a very serious impact on cognitive development, language acquisition and social integration, every public and private sector tertiary care hospitals should start screening every newborn if possible or atleast high risk neonates in Pakistan. In view of such studies American Academy of Paediatrica recommended, hearing loss diagnosis, to be completed by less than three months.

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