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Research Article

UNIVERSAL HEARING SCREENING IN NEWBORN

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ABSTRACT
The objective behind the study was to study the incidence of hearing impairment in 'healthy' and 'high risk' newborns and know the feasibility of using hearing screening in health care system of developing country. A prospective observational study of hearing impairment screening was conducted on 800 newborns, which were screened with two staged Transient Evoked Otoacoustic Emissions TEOAE, using handheld TEOAE device, followed by confirmation with Auditory Brainstem Response (ABR). The study was done in Command Hospital Air Force, Bangalore, during Jan 2010 to May 2011, where in all 800 new born, born during the study period were screened, which included 757 healthy neonates and remaining 43 high risk neonates. 5 newborn among the study cohort of 800, had hearing impairment confirmed by ABR. The overall incidence of hearing impairment is 6.25/ 1000 screened with a 95 % confidence interval between 4.28-11.62. Incidence of hearing impairment in the 'no risk' group was 3.96/1000 with a 95 % confidence interval between 2.01- 4.66. Whereas incidence of 46.5/1000 with 95 % confidence interval is between 1.96-10.32 was seen in 'at risk' group. The incidence of hearing impairment in our study (6.25 per 1000) is much higher than results shown in previous studies and the national average of 4/1000. This high incidence advocate universal hearing screening and early intervention, as an essential step to prevent disability due to hearing impairment, more so in the at risk newborns who have the maximum incidence of hearing impairment of 46.5/ 1000. Also this study shows usage TEOAE followed by confirmation by ABR as the most cost effective and easily implementable method for hearing evaluation in a resource poor nation like ours.

Key Words: *Neonate, Universal Hearing Screening, Transient Evoked Otoacoustic Emissions*

INTRODUCTION
The advances in critical neonatal care, has led to increased survival of preterm infants and critically ill newborns, making it more important, to monitor and treat the morbidities such as hearing loss and retinopathy in Neonatal Intensive Care Units (NICUs). Hearing impairment is a primary communication problem limiting an infant's access to spoken language leading to devastating, detrimental and an invariably adverse impact on the development of new-born. Deafness is the most prevalent disability across nations often referred to as the hidden disability. Incidence of hearing impairment in at risk and not at risk infants range from 6 - 60 per 1000 neonates with an average of 4 per 1000 neonates (Norther and Hayes, 1994). The paucity of large scale studies on new born hearing screening in developing countries leaves a lacunae in real incidence of hearing impairment in the new born babies and the early detection methods. The study was undertaken to know the realistic incidence of hearing impairment and applicability of hearing screening methods for early diagnosis of hearing impaired infants with the aim of early intervention.

MATERIALS AND METHODS
All newborn babies born in Command Hospital Air Force, Bangalore [CHAF (B)], a tertiary care center, were enrolled into the study during the study period of Jan 2010 to May 2011, with prior informed verbal consent obtained from the parents. The enrolled subjects were grouped into 'at risk' and 'no risk' group based on the presence or absence of the risk factors included in the 'HRR' of JCIH 2007 respectively (Joint Committee on Infant Hearing, 2007).

The Risk indicators included-

1. Family history of permanent childhood hearing loss.
2. Neonatal intensive care of more than 5 days or any of the following regardless of length of stay: Extracorporeal Membrane Oxygenation (ECMO) therapy, assisted ventilation, exposure to ototoxic medications or loop diuretics and hyperbilirubinemia that requires exchange transfusion.
3. In utero infections, such as Cytomegalovirus (CMV), herpes, rubella, syphilis, and toxoplasmosis.
4. Craniofacial anomalies, including those that involve the pinna, ear canal, ear tags, ear pits, and temporal bone anomalies.
5. Physical findings, such as white forelock, that is associated with a syndrome known to include a sensorineural or permanent conductive hearing loss.
6. Culture-positive postnatal infections associated with sensorineural hearing loss, including confirmed bacterial and viral (especially herpes viruses and varicella) meningitis.
7. Head trauma, especially basal skull/temporal bone fracture that requires hospitalization.

"At risk" group included neonates who had distinct and significant associations with risk factors included in the 'HRR' of as JCIH 2007.[2] "No risk" group included neonates who did not fulfill the criteria mentioned in the HRR of as JCIH 2007.

Technique and Tool

Handheld TEOAE device, "MADSEN AccuScreen PRO" OAE Screener, manufactured by Fischer-Zoth Diagnosesysteme GmbH, Germany, was used in Initial Screening and First Follow-Up Screening. It has a clinical sensitivity of more than 99%, without requiring decisions or equipment adjustment by the user. Sound stimulus is by non-linear click sequence with stimulus level 45-60 dB HL and TEOAE testing frequency range from 1.4 to 4 kHz. Evaluation of results is by AccuScreen binomial statistics and the results are displayed as ' PASS'- , indicating that the patient has normal outer hair cell function, and 'REFER'- suggest a possibility of a sensorineural hearing loss or indicates requirement of further diagnostic hearing evaluation. Study was conducted in a noiseless environment, on a sleeping baby after ensuring no obstruction in external auditory canal. All subjects underwent the audiological tests as per the Screening – Rescreening Protocol and hearing deficit confirmed with ABR (flow chart 1).

Screening / Re-screening Protocol

The study protocol was carried out in three steps.

1. ***Initial Screening***- All newborns enrolled into study were screened by TEOAE within first 3 days of life / as soon as the babies were fit enough to undergo the test in case of very sick babies.

2. ***First follow-up Screening*** was done at 4 to 6 weeks of age by TEOAE for-

i. All babies of **"At risk"** group

ii. Babies of **"No risk"** group who failed the first test screening ('refer' category)

3. ***Second follow-up Screening*** was done at 3 months age to confirm the hearing impairment by ABR/ BERA test for-

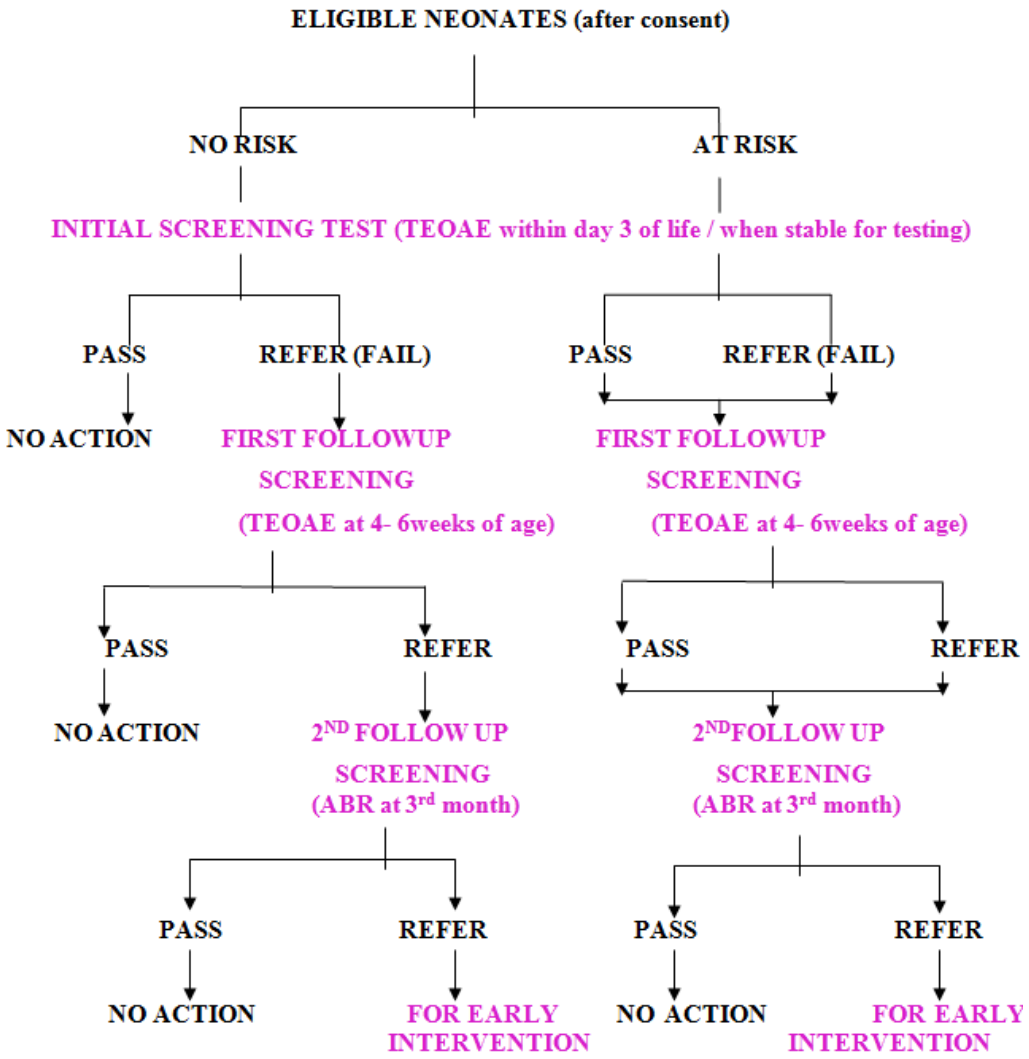
i. All babies of **"At risk"** group

ii. Babies of **"No risk"** group who failed the first follow-up screening ('refer' category)

Study protocol was approved by the ethical committee of our institution. The results of audiological evaluation were recorded in a standardized proforma. The data was entered into Microsoft Excel and analyzed using S.P.S.S package version 12.0.

RESULTS AND DISCUSSION

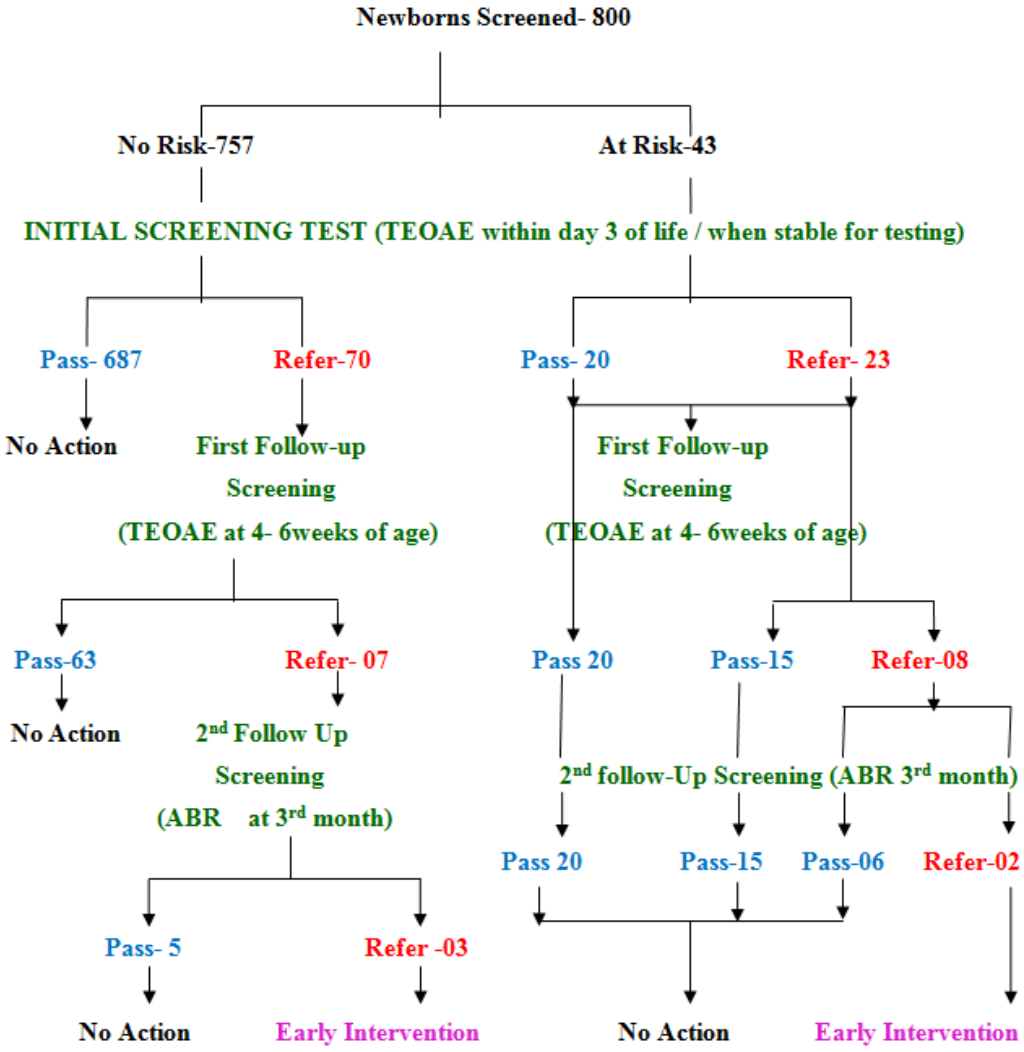
A total of 800 neonates were included into the study, of which 43 (5.3%) had risk factors for hearing impairment as per 'HRR' of as JCIH 2007 ("at risk group"). Results at different stages of the study are show in Table 1 and Flow chart 2



Flow Chart 1: Screening and Re-Screening Protocol

Table 1: Result of screening protocol

	Total Number Screened	Refer In Initial Screening (Refer Rate)	Refer In 1st Follow-up Screening (Refer Rate)	Refer In 2nd Follow-Up Screening(Refer Rate)	Incidence Of Hearing Impaired
TOTAL SCREENED	800	93 (11.6%)	15(1.875 %)	05 (0.62 %)	6.25/1000
AT RISK	43	23(53.4%)	08 (18.6%)	02 (4.6 %)	46.5/1000
NO RISK	757	70 (9.2%)	07(0.92%)	03 (0.3 %)	3.96/1000



Flow Chart 2: Results of Screening and Re-Screening

Incidence of Hearing Impaired in the Total Study Cohort- 5 newborn among the study cohort of 800 screened had hearing impairment confirmed by BERA. The overall incidence of hearing impairment is 6.25/ 1000 screened with a 95 % confidence interval between 4.28-11.62 (Table 2).

Incidence of Hearing Impaired in no Risk Newborns- Among 757 infants with no risk factors screened only 3 had hearing impairment, showing an incidence of 3.96/1000 in the no risk group with a 95 % confidence interval is between 2.01- 4.66. (Table 2)

Incidence of Hearing Impairment in at Risk Newborns- 43 at risk neonates were screened and 2 were detected to be hearing impaired, which is an incidence of 46.5/1000 (95 % confidence interval is between1.96-10.32) (Table 2). The distribution of 'at risk' infants screened as per their risk factors and the hearing impaired in various groups of infants with risk factors is shown in Table 3.

In this study two hearing impaired infants were detected in at risk group. One of the hearing impaired newborn suffered congenital rubella syndrome and sepsis in early neonatal period. The other newborn was a preterm, with weight <1.5kg along with Birth asphyxia (APGAR at 1min<4/ 5min<6) and respiratory distress requiring ventilator support for more than 5 days. No hearing impaired cases were detected in newborns with other risk factors.

Table 2: Incidence of hearing impaired

Children Screened	Incidence in the cohort	Incidence expressed /1000 screened	95% confidence interval per 1000 screened
Total Screened	5 / 800	6.25	4.28 - 11.62
At Risk	2 /43	46.5	2.01 - 4.66
No Risk	3 / 757	3.96	1.96 – 10.32

Table 3: Distribution of risk factors among at risk infants and the hearing impairment

Risk Factor	Number Screened	No. of infants with hearing impairment
Family history of childhood hearing loss.	1	0
Hyperbilirubinemia exchange level	1	0
In utero infections,	11	1(also suffered sepsis)
Craniofacial anomalies	1	expired
Syndromes associated	2	1-expired
Culture positive postnatal infections	6	0
Birth asphyxia (APGAR at 1min<4/ 5min<6)	10	1 (also Wt<1.5kg + ventilated)
NICU stay >5d/ mechanical ventilation / birth Wt <1.5/ ototoxic medication	11	0
Total	**43**	**2**

Discussion

This study is one of the many steps towards evaluating the need and applicability of universal hearing screening in a developing nation like India. We have tried to look into the incidence of hearing impairment in at risk and no risk group using two staged TEOAE followed by confirmation by BERA, as per the recommendations of National Institutes of Health Consensus (NIHC) Development Conference Statement.[3] TEOAE was preferred as screening tool as its is cost effective, convenient, easy to use and time saving. ABR was used to confirm the hearing defect in TEOAE failed infants to decrease the false alarm and unnecessary intervention. ABR was also done for all the at risk infants with the aim of identifying false negative TEOAE (e.g. auditory neuropathy or auditory dyssynchrony).

The incidence of hearing impairment in this cohort is 6.25/1000 with a 95 % confidence interval is between 4.28to11.62. As per most of the western studies, incidence of congenital sensorineural hearing loss (SNHL) averages approximately 3/1000 (Albright and Neal, 1998; Barsky-Firkser and Sun, 1997). There are few surveys showing incidence of hearing impairment in India. In one such study, by Nagapoornima *et al.*, in 2006 an incidence of hearing impairment of 5.6/1000 was demonstrated (Nagapoornima *et al.*, 2007). The incidence of hearing impairment in our study (6.25 per 1000) is much higher than previous studies and the national average of 4/1000 (Rehabilitation Council of India, 2000). This may be because our hospital being a tertiary care centre has large number of high risk deliveries leading to larger case load of at risk group. The incidence of hearing impaired 6.2/1000 is very high in

relation to other congenital defects for which cure can be provided (Mehal and Thomson, 1998) advocating for an early implementation of hearing screening in our nation.

In this study a high incidence of hearing impairment of 46.5/ 1000 is seen in at risk group when compared 3.96/1000 in no risk group. A huge disparity has been noticed in the incidence of hearing impairment in at risk and no risk groups, with incidence in at risk group being 11 times more than the no risk group. This finding is at par with the literature reports, which state, the incidence in at risk infants being approximately 10 times greater than the incidence in normal population (year 2000 position statement).

It's worthwhile to note that among the five hearing impaired detected in the study three didn't have any risk factor. Hence just an 'at risk' hearing screen would have missed detection of 3 of the 5 hearing impaired (60% of total hearing impaired in the study cohort would be missed). Although the incidence of hearing impaired in no risk group (3.9/1000) is much less than the incidence in the at risk group (46.5/1000), the magnanimity of newborn population in 'no risk' group is huge, leading to a large number hearing impaired missed by high risk screening.

It is necessary and high time to implement and incorporate universal neonatal screening in our country to secure normal, social and holistic development of the child by detecting hearing loss at birth and providing remedial services at the earliest. Universal newborn hearing screening can yield high returns, and the two staged hearing screening programme is cost effective and feasible. A child who receives early interventions for hearing loss requires less expensive special education in later part of life and has better chance to have a normal social life and improved quality of life.

Conclusion

This study has shown that two–stage TEOAE hearing screening followed by ABR to confirm the hearing deficit, can be successfully implemented as newborn hearing screening method in a hospital set-up, for early detection of hearing impaired, on a large scale, to achieve the high quality standard of screening programs. The incidence of hearing impairment and other findings of the study are consistent with previous researches, indicating hearing loss to be one of the most frequently occurring birth defect requiring an early identification and intervention. This study has also brought out the fact that, though the incidence of hearing impaired in 'at risk' newborns is higher than the 'no risk' newborns, universal hearing screening is essential to detect the large number of hearing impaired in the magnanimous 'no risk' newborn population.

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