

## Original Research Article

# Screening of hearing loss in neonates and infants: a hospital based prospective study

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## ABSTRACT

**Background:** Approximately 12,000 new babies with hearing loss are identified every year, according to the National Institute on Deafness and other communication disorders. In addition, estimates are that another 4,000 to 6,000 infants and young children between birth and 3 years of age who passed the newborn screening test acquire late onset hearing loss. Therefore, 16,000 to 18,000 new babies and toddlers are identified with hearing loss per year making hearing loss the most common birth defect. Numerous studies over the decades have demonstrated that when hearing loss of any degree is not adequately diagnosed and treated, it can negatively affect the speech, language, academic, emotional and psychosocial development of young children. Hence, the most important aspect of managing a child with hearing loss is early identification.

**Methods:** The screening test was done on high risk neonates and neonates admitted in NICU for more than 48 hours from January 2018 to June 2019 for early detection of hearing loss if any.

**Results:** Our results showed that neonates with hyperbilirubinaemia, Low birth weight, birth asphyxia, meconium aspiration showed higher risk of hearing loss as the Oto Acoustic Emissions were absent in significant percentage of these high risk neonates and infants as compared to neonates without NICU admission.

**Conclusions:** Screening of high-risk neonates and infants is essential for early detection of hearing loss. Hence preventing the child from further developing profound hearing loss with loss of speech.

**Keywords:** Oto acoustic emission, Hearing loss, High risk neonates

## INTRODUCTION

Hearing assessment in children is, very unfortunately, still one of the dark and underutilized areas in our discipline, in spite of the fact that 2 out of every children below 6 years of age have permanent bilateral deafness above 60dB.<sup>1</sup> The aim of our study is to find the incidence of hearing loss in infants (with history of NICU admission for more than 48 hours). Our main objective is early diagnosis of hearing loss by screening all infants using Distortion Product Oto Acoustic Emission (DPOAE) and also to identify the risk factors. Oto Acoustic Emissions (OAEs) are biological sounds, which are generated in a normal cochlea either by

itself (called spontaneous OAE) or can be evoked when the cochlea is processing a sound stimulus that has been presented to it (called evoked OAE). Testing for OAEs is the most important, efficient and popular method of hearing screening nowadays.<sup>2</sup>

The incidence of severe bilateral congenital sensorineural deafness has been reported to be between 1 and 4 out of every 1000 live births. Half of this is genetic in origin and other half is acquired due to prenatal rubella, use of ototoxic drugs during pregnancy etc. Unfortunately, the deafness remains undiagnosed in a very large portion of these cases and when the deafness is finally diagnosed, it

is already too late, the child has reached an age where remedial measures will not be adequately effective. The efficacy of remedial measures reduces with increasing age.<sup>1</sup>

A hearing impaired child develops psychological, social, educational, and even cognitive problems. If a child has a hearing impairment, it must be corrected before the child reaches 6 months of age. Late detection will lead to poor development of speech and language in the child. Hence screening of all infants is a must for early detection of deafness.<sup>1</sup>

Oto Acoustic Emissions (OAEs) are biological sounds, which are generated, in a normal cochlea. OAEs are acoustic signals produced in the cochlea that can be measured with a low noise microphone placed in the ear canal. They occur spontaneously in approximately 40% of the population and can be evoked by various stimuli in 92 – 100% of a normal hearing population. Both spontaneous and evoked OAEs are thought to emanate from the outer hair cell. Evoked OAEs are absent when the hearing loss is more than 30dB.<sup>2</sup> This sound is generated in the cochlea either by itself (spontaneous OAE) or can be evoked when the cochlea is processing a sound stimulus that has been presented to it (called evoked OAE).<sup>2</sup>

Risk factors for permanent congenital hearing loss are well established. Three major risk factors are: history of treatment in neonatal care unit for more than 48 hours. Family history of early childhood sensori neural hearing loss. Craniofacial anomalies associated with hearing impairment.<sup>3</sup> About 60% of congenital bilateral permanent hearing loss of moderate degree or greater is associated with one or more of these risk factors, in the proportions 29.3% NICU, 26.7% family history and 3.9% craniofacial anomaly. Hence, in early 1990s attempts were made to screen these high risk babies to identify early, the true causes of babies with congenital hearing loss.<sup>3</sup>

Hyperbilirubinemia is a common neonatal problem with toxic effects on the nervous system that can cause hearing impairment. Internationally, deafness and hearing impairment as a consequence of bacterial meningitis has been reported to be the most common serious complication of bacterial meningitis in the paediatric population; occurring in 6 to 31% of cases depending on the type of meningitis investigated and the type and severity of hearing impairment included in the sample (Brookhouser et al, Fortnum and Hull et al, Dodd et al. Woolley et al, Asadi-Pooya et al).<sup>4</sup> Meningitis is also the most common identifiable cause of acquired profound hearing loss in children and adults (Dodds et al).<sup>5</sup> Asadi-Pooya, Asadi-Pooya and Rosin assert that deafness or some degree of hearing impairment occurs in 3.5% to 37% of survivors of meningitis.<sup>6</sup> OAEs were found to be highly sensitive and relatively specific. Furthermore the technique was found to be well tolerated by patients. Therefore, in-patient OAE screening has been identified as a method of early

diagnosis of hearing loss and prompt auditory rehabilitation (Richardson et al).<sup>7</sup>

## METHODS

The type of our study is Cross-sectional study. The screening test was done for all neonates and infants who had history of NICU stay for more than 4 days from the period January 2018 to June 2019 at Dr. D. Y. Patil Medical college and Research centre, Pimpri, Pune. The neonates and infants who had history of NICU admission for more than 4 days were selected randomly. Neonates and infants with history of Hyperbilirubinaemia, low birth weight, meconium aspiration, birth asphyxia, cardiac anomalies, Hyaline membrane disease were included in the study. Screening was done with prior informed consent of one of the parents. Neonates and infants with congenital anomalies of the ear, cleft palate and craniofacial anomalies were excluded from the study. This test was done for both ears separately in a sound treated Audiometry room while the child is asleep or silent. Testing for OAEs is the most important, efficient, and popular method of hearing screening nowadays and possibly the most commonly used audiological test in clinical practice. The biggest advantage of OAE test is that it is not only a non-invasive test but also an objective test, easily repeatable, reliable, and very fast test that can be carried out by any trained person not necessarily a clinician or an audiologist. The results are immediately available.

The results in the OAE monitor are assessed at 1KHz, 2KHz, 3KHz, 4KHz and 5KHz frequencies. If OAEs are present at all frequencies, then the result appears as pass. And if OAEs are absent at particular frequencies, it shows as refer.

A total of 220 high risk neonates and infants underwent DPOAE testing. Among which 124 showed normal result and another 96 showed absent OAEs at 1, 2 and 3KHz.

Infants with absent OAEs were further subjected to BERA.

### Recording OAEs

The basic requirements for documenting and measuring OAEs consist of- a miniature but very sensitive microphone that fits into a probe that can be housed in the external auditory meatus, one for TEOAE or two for DPOAE miniature speakers that are also housed inside the probe, an amplifier, an analogue to digital converter, and a computer for sampling and digital averaging. These speakers present sound stimuli to the ear that travels from from the external auditory canal through the middle ear to the cochlea where the sound is processed. Cochlear amplifier emanates a sound that travels retrograde from Outer hair cells to the external auditory meatus where the very sensitive microphone picks it up, sends it to the amplifier, and from there to the analogue to digital converter and finally to the computer where it is averaged and documented.

Along with NICU stay history, we also assessed number of full term, pre term and low birth weight babies. Other parameters like neonates born with history of birth asphyxia/delayed cry, hyperbilirubinemia, respiratory distress syndrome/hyaline membrane disease, meconium aspiration, meningitis/encephalitis and sepsis were also considered.

**RESULTS**

The results of the OAE were tabulated as either normal or refer. Refer means absent OAEs at particular frequencies.

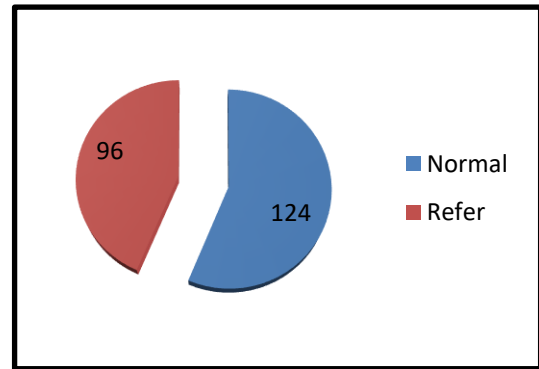
**Table 1: Number of neonates with absent OAEs with high risk conditions.**

High risk conditions in neonates	Number of neonates	Number of neonates with absent OAE
<b>Low birth weight babies alone</b>	92	49
>2kg – 2.5kg	24	4; 16.7%
>1.5 kg – 2kg	14	5; 35.71%
<b>Very low birth weight babies &lt; 1.5kg</b>	54	40; 74.07%
<b>LBW with Hyperbilirubinaemia</b>	55	18; 32.72%
<b>Hyperbilirubinaemia only</b>	32	2; 6.25%
<b>Birth asphyxia/delayed cry</b>	25	2; 8%
<b>Resp distress syndrome/Hyaline membrane disease</b>	20	2; 10%
<b>Meningitis/encephalitis</b>	8	2; 25%
<b>Meconium aspiration</b>	22	1; 4.54%
<b>Sepsis</b>	10	1; 10%
<b>Others</b>	11	4; 36.36%

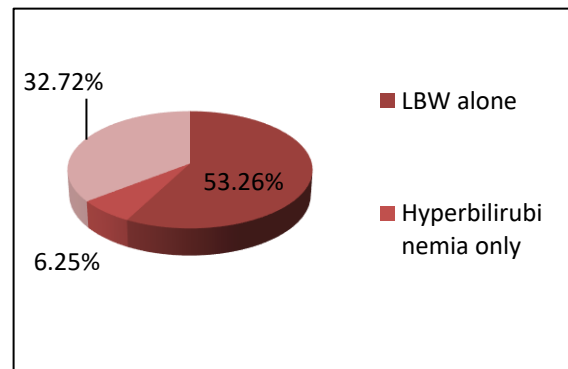
In our study, 124 infants showed pass and 96 showed refer at frequencies less than 3KHz. Refer means oto acoustic emissions were absent at frequencies below 3KHz.

Among 220 neonates and infants, 100 neonates were Full term babies and 120 were preterm babies. 92 were low birth weight babies. All infants had h/o NICU stay for more than 48 hours after birth. Among 55 neonates with LBW with hyperbilirubinaemia, 18 neonates showed absent OAE. 2 of 32 neonates with only hyperbilirubinemia showed absent OAE. 8% of 25 neonates with birth asphyxia had absent OAE and 10 % of 20 neonates with Respiratory distress syndrome (RDS) showed absent OAE. 2 neonates out of 8 with meningitis showed absent OAE. Neonate with meconium aspiration and sepsis each showed absent OAE. Other factors like infantile seizures, cardiac

anomaly, hydrocephalus and intra cranial cyst together accounted for 11 of all neonates of which 4 showed absent OAE.



**Figure 1: OAE result of high risk neonates and infants.**



**Figure 2: Percentage of neonates with LBW and hyperbilirubinaemia with absent OAEs.**

**DISCUSSION**

Hearing loss of any type or degree that occurs in infancy or childhood can interfere with the development of a child’s spoken language, reading and writing skills, and academic performance (Davis et al, Ling et al). Most people think that reading is a visual skill, but recent research on brain mapping shows that primary reading centres of the brain are located in the auditory cortex – in the auditory portions of the brain (Chermak et al, Kraus and Hornickel, Pugh, Sandak and Frost et al, Talal et al). That is why many children who are born with hearing losses, and who do not have access to auditory input when they are very young, tend to have a great deal of difficulty in reading, even though their reading is fine.<sup>8</sup>

If a child has a hearing impairment, it must be corrected before the child reaches 6 months of age. Studies by many scientists, especially that of Cowkey et al in 2004, here confirmed that access to sound through devices such as cochlear implants/hearing aids at the youngest age possible ( preferably before 6 months) gives children the best opportunity to acquire communication skills (speech and language), which is similar to that of their normally

hearing peers. Hence, screening of all neonates and infants is a must to diagnose sensory neural hearing loss at the earliest.<sup>1</sup>

Hence in our study we have tabulated the neonates and infants with absent and present OAEs. Also we have found high risk factors, responsible for absent OAEs.

In our study, of 55 neonates with h/o hyperbilirubinaemia 32.72% showed absent OAEs. In an Iranian study conducted on 200 infants with history of hyperbilirubinaemia (bilirubin >20 mg/dl), 4.8% infants showed sensori-neural hearing loss.<sup>9</sup> Fourteen (6.0%) of the 234 infants with NNJ had SNHL. Sensorineural hearing loss in infants with neonatal jaundice in Lagos: a community-based study.<sup>10</sup>

In our study, out of 220 infants, 92 were low birth weight (<2kg weight) 57% infants showed absent OAEs. In our study, 25 neonates had h/o birth asphyxia, out of which 2 neonates showed absent OAE. i.e 8% neonates showed absent OAE. In a study conducted at KIMS, Karnataka Among the 150 neonates, prevalence of hearing impairment among term neonates with birth asphyxia was 9.9% (14/141).<sup>11</sup>

The pre-, peri- and postnatal histories for two infants who suffered respiratory distress syndrome (RDS) are presented. Each infant was diagnosed with RDS within 24 hours after birth, placed on high-frequency jet ventilation, and passed auditory brainstem response (ABR) screening prior to hospital discharge. Both infants were enrolled in a neonatal follow-up program with no report of hearing loss during the first year of life.<sup>12</sup> At 2.5 years of age, each infant was found to have severe-to-profound sensorineural hearing loss.<sup>12</sup>

In our study, out of 20 infants with history of RDS 10% neonates showed absent OAE. In a case-control study conducted by Keihani-Doust, Tabrizi, Amini, screening for hearing loss was carried out on 325 neonates aged 6-12 months referred to Pediatric Neurology Office of Vali-e-Asr Hospital, Tehran, Iran up to 2011. Hearing loss was confirmed using Auditory Brainstem Response screening test (ABR). They found that the prevalence of mildly and moderately hearing loss in neonates was determined as 3.6%. The most significant risk factors for hearing loss in neonates were neonatal icterus associated with phototherapy, respiratory distress syndrome (RDS) and lower Apgar score.<sup>13</sup>

Internationally, deafness and hearing impairment as a consequence of bacterial meningitis has been reported to be the most common serious complication of bacterial meningitis in the paediatric population; occurring in 6 to 31% of cases depending on the type of meningitis investigated and the type and severity of hearing impairment included. In our study, 25% neonates showed absent OAE.<sup>14</sup>

A study done at Oregon Health and Science University Doernbecher Children's Hospital Neonatal Care Center; Effect of sepsis and systemic inflammatory response syndrome on neonatal hearing screening outcomes following gentamicin exposure by Cross et al Hearing loss in neonatal intensive care unit (NICU) graduates range from 2% to 15% compared to 0.3% in full-term births, and the etiology of this discrepancy remains unknown. Our study showed absent OAE in 10% neonates.<sup>15</sup>

### Limitations

Few patients who are referred for BERA hardly turn up as the mother and child go back to their home town and also they are unaware about the importance of undergoing BERA if Oto Acoustic Emissions are absent. Hence, adequate and appropriate counselling has to be done to the parents of the child to undergo further investigations.

### CONCLUSION

Screening of Neonates and infants with high risk conditions enables us to detect hearing loss at the earliest stage when it can be corrected and the child can be benefitted maximally. Early detection of hearing loss, subjects the child to definitive treatment i.e cochlear implant at the right age. The child can regain his hearing and hence there will be hardly any delay in development of speech with good postoperative rehabilitation.

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*Ethical approval: The study was approved by the Institutional Ethics Committee*

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