

## Research Article

DOI: <http://dx.doi.org/10.18203/2349-3291.ijcp20160151>

# Targeted hearing screening in newborns

Veerendra Mehar<sup>1\*</sup>, Pavan Somani<sup>1</sup>, Kuldeep Singh<sup>2</sup>, Vishal R. Munjal<sup>3</sup>

<sup>1</sup>Department of Pediatrics, Sri Aurobindo Medical College and PG Institute, Indore Ujjain Highway, Indore, Madhya Pradesh, India

<sup>2</sup>Department of Pediatrics, All India Institute of Medical Sciences, Jodhpur, India

<sup>3</sup>Department of, Otorhinolaryngology & Head-Neck Surgery, Sri Aurobindo Medical College and PG Institute, Indore Ujjain Highway, Indore, Madhya Pradesh, India

**Received:** 20 October 2015

**Accepted:** 17 December 2015

**\*Correspondence:**

Dr. Veerendra Mehar,

E-mail: dr.veerendramehar@gmail.com

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ABSTRACT

**Background:** Hearing is important for learning to talk. With-out speech and hearing it is difficult for interpersonal relationships to develop and thrive. The aim of this study was to screen high risk newborn for hearing loss by TEOAE and ABER technique and to find out the risk factor associated with hearing loss in newborn infants.

**Methods:** A total of 103 high risk neonates were randomly selected from NICU of this hospital after clinical stabilization. Transiently evoked otoacoustic emissions were performed in all the neonates. Neonates who passed transiently evoked otoacoustic emissions test were subjected to Auditory Brainstem Evoked Response (ABER) test for confirming hearing loss.

**Results:** Hearing assessment done in all 103 patients and a total of 8 neonates were found to have hearing abnormalities, out of these 8 new-borns 5 had conductive hearing loss and 3 had sensorineural hearing loss. Low Birth weight and ventilator support were observed significantly associated with occurrence of hearing loss. No significant association of hearing loss was observed with gestational age, sex, infection, and associated diseases.

**Conclusions:** Low Birth weight and mechanical ventilator were significantly associated with hearing loss.

**Keywords:** Hearing loss, Neonates, Low birth weight

## INTRODUCTION

Hearing is important for learning to talk. With-out speech and hearing it is difficult for interpersonal relationships to develop and thrive.<sup>1</sup> Impaired hearing can lead to delayed speech which may not be recognized till age of 2-3 years, when negative impact on speech language cannot be minimized. Compared with children with normal hearing, those with hearing loss have more difficulty in learning vocabulary, grammar, word order, idiomatic expressions and other aspects of verbal communication.<sup>2</sup> Hearing disorder increases psychosocial problems, behavioral problem, adaptive skills in children.<sup>3,4</sup>

It has been estimated that 1-3 per 1000 infant suffers from congenital and perinatally acquired hearing impairment.<sup>5,6</sup> In India 4 out of every 1000 children born have hearing loss with varying severity.<sup>7</sup> The prevalence of neonatal hearing disorder has been reported to be increased by 10-50 folds in high risk newborns.<sup>8</sup>

In many developing countries, diagnosis may not occur until children are two years of age or older as the main approach of detection of childhood hearing impairment is only family notion for hearing impairment.<sup>9</sup> Screening programmers in developed countries have been stimulated by the advent of reliable screening techniques.

In particular, the introduction of two objectives, rapid and physiological tests of auditory function otoacoustic emission recording and automatic auditory brain response measures have enabled newborn hearing screening to be very widely adopted. In many developed countries newborn screening with one of these tests is now mandatory, or at least strongly encouraged, prior to hospital discharge. Average age of detection of hearing loss has decreased significantly in countries where universal newborn hearing screening is adopted.<sup>10</sup>

National Neonatology Forum of India has just completed the guidelines for neonatal hearing screening in India. However, for hearing care professionals in India, the implementation of neonatal screening is not so straightforward. There are many barriers to the introduction of physiological screening measures. The equipment can be relatively expensive and personnel with the expertise are scarce. There is a global shortage of skilled maternal and newborn health workers, particularly in rural areas.<sup>11</sup> With technological advances it is expected that identification of all newborn with hearing loss before 6 months may become an attainable goal. There are two methods of screening hearing loss in neonates first is transient evoked oto-acoustic emission (TEOAE) and second is auditory brainstem evoked response (ABER) technique.<sup>12</sup> Both these test have good sensitivity with TEOAE 85-99% and ABER 80-92%, respectively.<sup>13</sup> A study from Kuwait has found both ABER and TEOAE as reliable tools in high risk newborns.<sup>14</sup> Many studies have shown the utility of TEOAE as a cost-effective screening tool as well. Universal hearing screening is a 2 stage testing of all newborns. It has been found that universal screening increases the direct as well as indirect cost by increasing the cost of expenditure on false positive cases.<sup>15</sup>

To take advantage of plasticity of the developing sensory system (0-3 years), hearing loss should be recognized in time and appropriate otological and audiological rehabilitation should be instituted early. Even after availability of trained audiologist and pediatrician the age of detection of congenital hearing loss often exceeded by 2 years, by which time hearing impaired children were left far behind in speech and language skills. Thus it is essential that hearing screening be instituted at an early age to give full advantage to child in terms of social, adoptive, better carrier opportunities and quality of life.<sup>16</sup> This study was planned to evaluate the value of targeted hearing screening of high risk newborn by TEOAE and ABER technique admitted in our neonatal intensive care unit (NICU).

## METHODS

This hospital based observational prospective study was conducted over the period of 12 months from August 2012 to July 2013 in the NICU of Department of Pediatrics SAIMS hospital Indore, Madhya Pradesh

India. 103 high risk neonates were randomly selected from NICU of this hospital after clinical stabilization as per joint committee on infant hearing (JCIH) criteria 2000 position statement.

## RESULTS

During the study period a total of 103 newborn (57 male, 46 female) were recruited for the study. The mean age of newborns was  $3.07 \pm 3.2$  days. Out of these 103 newborns 64 newborns were delivered vaginally (62.1%), of which, 4 delivered by breech presentation, 2 were twins, 6 delivery required ventouse extraction. While 39 were delivered through lower segment cesarean section. 4 babies delivered by Rh negative mother, 1 baby was delivered by TORCH positive mother. We observed 12 newborns were small for gestational age, 88 were appropriate for gestational age, while 3 were large for gestational age. Seven were extremely low birth weight, 51 were very low birth weight, 27 were low birth weight and 18 babies were born with normal weight ( $>2.5$ kg) (Table 1).

**Table 1: Different birth parameters in normal and diseased patients.**

|                                 | Normal    | Hearing Loss | P value |
|---------------------------------|-----------|--------------|---------|
| Age                             | 5.8       | 2.75         |         |
| Sex                             |           |              |         |
| Male                            | 52 (54.7) | 5 (62.5)     | 0.957   |
| Female                          | 43 (45.3) | 3 (37.5)     |         |
| Modes of delivery               |           |              |         |
| Vaginal delivery                | 58 (61)   | 6 (75)       | 0.688   |
| LSCS                            | 37 (39)   | 2 (25)       |         |
| Preterm                         | 55 (57.8) | 7 (87.5)     | 0.205   |
| Term                            | 40 (42.2) | 1 (12.5)     |         |
| AGA                             | 81 (85.2) | 7 (87.5)     | 0.262   |
| SGA                             | 11 (11.5) | 1 (12.5)     |         |
| LGA                             | 3 (3.1)   | 0 (0)        |         |
| Weight                          |           |              |         |
| <999 gm                         | 4 (4.2)   | 3 (37.5)     | 0.0032  |
| 1000-1499 gm                    | 48 (50.5) | 3 (37.5)     |         |
| 1500-2499 gm                    | 25 (26.3) | 2 (25)       |         |
| >2500 gm                        | 18 (18.9) | 0 (0)        |         |
| Disease                         |           |              |         |
| Hyperbilirubinemia              | 49 (51.5) | 3 (37.5)     | 0.6916  |
| Respiratory distress syndrome   | 18 (18.9) | 3 (37.5)     | 0.427   |
| Hypoxic-ischemic encephalopathy | 20 (21)   | 2 (25)       | 0.7936  |
| Ventilator support              | 15 (15.7) | 5 (62.5)     | 0.0061  |
| Infection                       |           |              |         |
| Present                         | 35 (36.8) | 2 (25)       | 0.7743  |
| Absent                          | 60 (63.1) | 6 (75)       |         |

Neonatal hyperbilirubinemia was most common cause of admission of newborn in NICU which was observed in 42 cases. Out of these 42 babies 8 babies required exchange transfusion due to hyperbilirubinemia. The second common disorder was hypoxic ischemic encephalopathies which were 22 newborns. 21 newborns were admitted with the diagnosis of hyaline membrane disease out of which 19 were required ventilator support. Pneumonia was diagnosed in 6 patients while 5 were diagnosed as hyponatremic dehydration, 5 were Meconium Aspirated syndrome and 1 baby had Down syndrome.

Out of these 103 newborns, 37 were blood culture positive and from these 37 patients, 15 were Klebsiella positive, 6 were methicillin resistant *Staphylococcus aureus* (MRSA), 6 were staphylococcus positive, 3 were *Candida albicans* and 2 were *Candida krusei*, while 5 were *E. coli* positive sepsis.

Hearing assessment done in all 103 patients, which is suggestive of total 8 babies, had hearing abnormalities, out of these 8 newborns 5 babies had conductive hearing loss and 3 babies had sensorineural hearing loss. Five babies affected their bilateral ears, 2 babies affected their left ear and 1 affected right ear. We analysed distribution pattern of different birth parameters in two groups and found: as the birth weight of babies decreases, the incidence of hearing loss increases significantly. We also observed that babies put on ventilator support had higher prevalence of hearing loss. No significant association of hearing loss was observed with gestational age, sex, infection, and associated diseases.

## DISCUSSION

Hereditary hearing loss is managed by a team that includes an otolaryngologist, an audiologist, a clinical geneticist, and a pediatrician, and sometimes an educator of the Deaf, a neurologist, and a pediatric ophthalmologist. Treatment includes determining the appropriate habilitation option such as hearing aids and vibrotactile devices; cochlear implantation is considered in children over age 12 months with severe-to-profound hearing loss. Early auditory intervention through amplification, otologic surgery, or cochlear implantation is essential for optimal cognitive development in children with prelingual deafness. In this study we evaluated the value of targeted hearing screening of high risk newborn by TEOAE and ABER technique.

Declau et al, published data on confirmatory diagnostic evaluation after positive UNHS in a large group of children: Of 170 children with a positive UNHS result (corresponding to ca. 87 000 newborns screened), 5 had a tympanic effusion that regressed during the observation period.<sup>17</sup> Permanent hearing impairment was confirmed in 116 children, bilateral in 68 cases and unilateral in the other 48 neonates. The average absolute threshold of

hearing was 70 to 80 dB HL. The initial (screening) AABR result was confirmed in full in 60.4% of cases. Interestingly, 11.6% of the newborns thought to have a unilateral hearing impairment on UNHS were found to have a bilateral impairment when assessed in more detail. Korres et al, compared results of newborn hearing screening tests of 1714 infants 36 weeks or older in an NICU and 25 288 infants from the well-baby nursery.<sup>18</sup> Patients were considered to have failed their OAE screening test when either one or both ears had hearing loss. Seven percent of infants from the NICU failed the test, whereas only 1.9% of the infants from the well-baby nursery failed. Among the infants from the NICU, those with VLBW had a failure rate of 31.6%.

Conolly et al, in their study showed that 1 out of 75 high risk registered newborns had hearing loss.<sup>19</sup> Study from Saudi Arabia stated that 13.5% of their NICU graduates found to have hearing loss using TEOAE.<sup>20</sup> Using ABR as a screening tool, Sun et al, from Shanghai reported 29.3% of high risk NICU graduates to have hearing loss.<sup>21</sup> Chadha et al, have shown a significant auditory impairment in 18% of high risk neonates.<sup>22</sup>

Another study evaluated the prevalence of hearing impairment in a cohort of 337 VLBW infants who were cared for in the NICU and survived to discharge, as well as 1205 healthy newborns.<sup>23</sup> The OAE hearing screening test fail rate was 7.8% in the healthy control group and 12.4% for the VLBW children. On follow-up ABR testing several weeks after discharge, only 3% of the VLBW patients were found to have hearing loss. The hearing loss was conductive in 2.7% of the VLBW patients (compared with 0.06% of the healthy newborns), and one VLBW patient (0.3% of all VLBW children) had bilateral moderate to severe sensorineural hearing loss. This study found no statistically significant differences in the prevalence of sensorineural hearing loss in the VLBW group (0.3%), the higher weight NICU group (0.99%) and the well-baby nursery group (0.1%). Caveats of this study are the fact that about 30% of its VLBW population was small for gestational age but not premature, and thus this cohort was neurologically more mature than those of prior studies. This may account for better performance on the newborn hearing screening tests. Furthermore 1.5% of the VLBW cohort was found to have abnormal prolongation of ABR waveform latency despite normal auditory thresholds, suggesting that even though cochlear function may have been normal, there may have been abnormal ascending brainstem pathways. Lastly, hearing testing was performed in 2995 infants at birth and at 8-12 months of age.<sup>24</sup> In 535 infants with VLBW alone or with other risk factors, hearing testing at birth showed normal hearing in 92%, transient hearing loss in 7.8%, and permanent hearing loss in 2%. On follow-up audiology at 8-12 months of age, the percentage of VLBW children with permanent hearing loss was unchanged.

In 1989, Epstein and Reilly, investigated the incidence of the known risk factors for hearing loss among all babies born in the USA.<sup>25</sup> They found that 10-12% of all babies had at least one established factor. The rate of sensorineural hearing loss among patients with one or more risk factors was 2-5%, which is at least tenfold greater than in the general population of children. The United States Joint Committee on Infant Hearing listed VLBW as a risk factor for neonatal hearing loss in four position statements from 1973 to 1994. However, VLBW was not specifically listed as a risk factor in the statements in 2000 and 2007.<sup>26</sup> Instead, other risk factors commonly found in neonates with VLBW are listed. This reflects the growing understanding that VLBW by itself probably does not cause hearing loss. A large NIH-sponsored multi-centre study conducted between 1994 and 1996 evaluated the performance of newborns on OAE and ABR hearing screening and also reported the incidence of risk factors for neonatal hearing loss.<sup>27</sup> A total of 4478 graduates from NICUs, 353 well babies with one or more of the risk factors for hearing loss established by the joint committee on Infant Hearing in 1994 (which included VLBW), and 2348 well babies with no risk factors were assessed.<sup>28</sup> One risk factor was found in 33.2% of NICU infants, and two or more in 26.2%. Within the NICU population, the most common risk factors were aminoglycoside use (44.4%), VLBW (17.8%), mechanical ventilation for more than 5 days. (16.4%), and low Apgar scores (13.9%). In our study we also found that a very low birth weight and mechanical ventilation are the risk factors for hearing loss in newborns.

## CONCLUSION

Congenital hearing loss can be considered as the most common birth defect with an incidence of 1-2/1000 live births, higher than congenital hypothyroidism and phenylketonuria combined. Early identification and rehabilitation of hearing impairment is important for the development of speech, language and cognitive ability in affected babies. The purpose of this study was the evaluation of transient evoked otoacoustic emission (TEOAE) for the screening of neonatal hearing disorders in high risk new-borns at a tertiary care neonatal intensive care unit.

The present study reveals following facts like the prevalence of hearing loss in new-borns was 6.13%, the VLBW and ELBW were the significant risk factor for hearing loss, mechanical ventilator were also significantly associated with hearing loss and mode of delivery, gestational age, infections, gender, hyperbilirubinemia and other diseases did not affect hearing impairment in our study.

*Funding: No funding sources*

*Conflict of interest: None declared*

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

## REFERENCES

1. National Information Center for Children and Youth with Disabilities. Deafness and Hearing Loss. Washington, DC: Publication 2004.
2. National Information Center for Children and Youth with Disabilities. Deaf and Hearing Loss. Washington, DC: 2004. Publication FS3.
3. Davis A, Hind S. The impact of hearing impairment: a global health problem. *Int J Pediatr Otorhinolaryngol.* 1999;49(1):51-4.
4. Vostanis P, Hayes M, Du Feu M, Warren J. Detection of behavioural and emotional problems in deaf children and adolescents: comparison of two rating scales. *Child Care Health Dev.* 1997;23(3):233-46.
5. Ptak M. Early Diagnosis of Hearing Impairment in Newborns and Infants. 2004;98:265-70.
6. Vohr B. Overview: infants and children with hearing loss-part I. *Ment Retard Dev Disabil Res Rev.* 2003;9:62-4.
7. Rehabilitation Council of India. Status of Disability in India - 2000. New Delhi, 2000:172-85.
8. Wrightson S. Universal newborn hearing screening. *Am. Family Phys.* 2007;75(9):1349-52.
9. McPherson B, Olusanya BO. Screening for hearing loss in developing countries. In: McPherson B, Brouillet R, editors. *Audiology in developing countries.* New York: Nova Science Publishers; 2008:75-105.
10. McPherson B. Newborn hearing screening in developing countries: Needs & new directions. *Indian J Med Res.* 2012;135(2):152-3.
11. Maternal and Newborn Health. New York: UNICEF; 2009. UNICEF. *The State of the World's Children 2009.*
12. American Speech-Language Hearing Association. Newborns and infants.
13. Thompson DC, McPhillips H, Davis RL, Lieu TL, Homer CJ, Helfand M. Universal hearing screening summary of evidences. *JAMA.* 2001;286: 2000-10.
14. AL-Harbi M, BarkatN, AL-Khandary M. hearing screening in at risk newborn. *J Med Sci.* 2008;8(7):648-53.
15. Kemper AR, Downs SM. A Cost-effectiveness Analysis of Newborn Hearing Screening Strategies. *Arch Pediatr Adolesc Med.* 2000;154(5):484-8.
16. Ansari MS. Screening programme for Hearing impairment in newborns: A challenge during rehabilitation for all. *Asia Pacific Disability Rehabilitation Journal.* 2004;15(1):83-9.
17. Declau F, Boudewyns A, Van den Ende J, Peeters A, van den Heyning P. Etiologic and audiologic evaluations after universal neonatal hearing screening: Analysis of 170 referred neonates. *Pediatrics.* 2008;121:1119-26.

18. Korres S, Nikolopoulos TP, Komkotou V, Balatsouras D, Kandilorus D, Constantinou D, et al. Newborn hearing screening: effectiveness, importance of high-risk factors, and characteristics of infants in the neonatal intensive care unit and well-baby nursery. *Otol Neurotol.* 2005;26:1186-90.
19. Conolly JL, Caron JD, Roark SD. Universal newborn hearing screening. Are we achieving joint committee on Infant Hearing (JCIH) Objective? *Laryngoscope.* 2005;115(2):232-6.
20. Maisoun AM, Zakzouk SM. Hearing Screening of neonates at risk. *Saudi Med J.* 2003;24(1):55-7.
21. Sun JH, Li J, Huang P, Bu J, Xu ZM, Li J, et al. Early detection of Hearing Impairment in high risk infants in NICU. *Zhonghua Er ke Za Zhi.* 2003;41(5):357-9.
22. Chadha S, Bais AS. Auditory Brainstem recording in high risk and normal newborn. *Indian J Pediatr.* 1997;64(6):777-84.
23. Ari-Even RD, Hildesheimer M, Maayan-Metzger A, Muchnik C, Hamburger A, Mazkeret R, et al. Low prevalence of hearing impairment among very low birthweight infants as detected by universal neonatal hearing screening. *Arch Dis Child Fetal Neonatal Ed.* 2006;91(4):257-62.
24. Cone-Wesson B, Vohr BR, Sininger YS, Widen JE, Folsom RC, Gorga MP, et al. Identification of neonatal hearing impairment: infants with hearing loss. *Ear Hear.* 2000;21(5):488-507.
25. Epstein S, Reilly JS. Sensorineural hearing loss. *Pediatr Clin North Am.* 1989;36:1501-20.
26. Joint Committee on Infant Hearing, American Academy of Audiology, American Academy of Pediatrics, American Speech-Language-Hearing Association, and Directors of Speech and Hearing Programs in State Health and Welfare Agencies. Year 2000 position statement: principles and guidelines for early hearing detection and intervention programs. *Pediatrics.* 2000;106:798-817.
27. Norton SJ, Gorga MP, Widen JE, Folsom RC, Sininger Y, Cone-Wesson B, et al. Identification of neonatal hearing impairment: summary and recommendations. *Ear Hear.* 2000;21(5):529-35.
28. Vohr BR, Widen JE, Cone-Wesson B, Sininger YS, Gorga MP, Folsom RC, et al. Identification of neonatal hearing impairment: characteristics of infants in the neonatal intensive care unit and wellbaby nursery. *Ear Hear.* 2000;21:373-82.

**Cite this article as:** Mehar V, Somani P, Singh K, Munjal VR. Targeted hearing screening in newborns. *Int J Contemp Pediatr* 2016;3:159-63.