Indian Journal of Basic and Applied Medical Research; June 2020: Vol.-9, Issue- 3, P. 133-141
DOI: 10.36848/IJBAMR/2020/12225.51580

Original article:

A study of assessment of prevalence of hearing impairment in high risk infants in a tertiary care center of north west Rajasthan

DR. VIMAL KUMAR [1], *DR. P.K. BERWAL[2], DR. SARIKA SWAMI[3], DR. T. C. SAINI[4], DR. VISHWAJEET SINGH [5]

[1] Resident Doctor, [2] Sr. Professor,[3]Associate Professor, [4]Principal Specialist,[5] Resident Doctor
DEPARTMENT OF PEDIATRICS, S.P. MEDICAL COLLEGE AND P.B.M. ASSOCIATED GROUP OF HOSPITALS, BIKANER (RAJASTHAN)
Corresponding author*

ABSTRACT

INTRODUCTION: An important aspect of child's development is the acquisition of and production of spoken language. Language is the key to express our thoughts, feelings and needs and by which we understand others. Hearing impairment is a common treatable disability in childhood if diagnosed early and appropriate intervention instituted. The Joint Committee on Infant Hearing (JCIH) of American Academy of Paediatrics (AAP) defines target hearing loss as "congenital permanent bilateral, unilateral, sensory, permanent conductive, or neural hearing loss (auditory neuropathy/dyssynchrony), averaging 30–40 dB or more in the frequency region important for speech recognition (about 500–4,000 hertz)," which will interfere with the normal development of speech and language.

MATERIAL AND METHODS: We conducted a hospital based, prospective, observational study in Department of Paediatrics, Sardar Patel Medical College, Bikaner from February 2019 to October 2019 with the objectives to evaluate the hearing in high-risk neonates using otoacoustic emission and Brainstem Evoked Response Audiometry (BERA) and to confirm the hearing impairment, its magnitude, nature of deafness in the abnormal study subjects using a follow-up BERA at the third month, and sixth month.

RESULTS: A total 200 high risk neonates who fulfil the inclusion criteria were screened. 56 neonates were referred by OAE 1st to OAE 2nd; 14 neonates were referred to BERA by OAE 2nd. These 14 neonates were subjected to BERA of which 8**(4.0%)** neonates were found to have abnormal BERA i.e. hearing impairment. Prematurity was strongly associated hearing loss (F value 7.682) followed by Hyperbilirubinemia (F value 3.698),Birth Weight(<1.5 Kg),(F value 2.226),HIE-II&III(F value 1.959),Birth Asphyxia(F value 1.767),NICU Stay (>5days),(F value 0.988),Intracranial haemorrhage(F value 0.536),Intrauterine infection (TORCH)(F value 0.105),Bacterial Meningitis (F value 0.087),Sepsis(F value 0.026). Hearing impairment increases from cases with one risk factor (0%), 2 risk factors (3.3%), 6 risk factors (4.6%), 7 risk factors (57.1%) to 8 risk factors (100%).

CONCLUSION: This study highlights the need for OAE and BERA for early identification of hearing loss so that timely intervention can be done .The incidence of hearing impairment was 4%. Prematurity was a significant risk factor.

KEYWORDS: hearing impairment.

Indian Journal of Basic and Applied Medical Research; June 2020: Vol.-9, Issue- 3, P. 133-141
DOI: 10.36848/IJBAMR/2020/12225.51580

INTRODUCTION

An important aspect of child's development is the acquisition and production of spoken language. Language is the key to express our thoughts, feelings and needs by which we understand others. According to UNICEF analysis, each year approximately 126,000-500,000 infants are born with significant hearing loss and about 90% of them live in developing countries[1]. The intact hearing is an essential requirement for speech and language development, so children with hearing loss will be unable to develop speech and this puts such children at a disadvantage socially, emotionally, educationally, and economically among their peers[2,3]. Hearing impairment is a common treatable disability in childhood if diagnosed early and appropriate intervention instituted. The Joint Committee on Infant Hearing (JCIH) of American Academy of Paediatrics (AAP) defines target hearing loss as "congenital permanent bilateral, unilateral, sensory, permanent conductive, or neural hearing loss (auditory neuropathy/dyssynchrony), averaging 30–40 dB or more in the frequency region important for speech recognition (about 500–4,000 hertz)," which will interfere with the normal development of speech and language[4]. Causes of hearing loss can be broadly classified as causes for conductive hearing loss and sensorineural hearing loss.

The prevalence of hearing impairment has been on an astronomical increase especially in the last three decades. World Health Organisation (WHO) reported 42 million people affected globally in 1985, which has increased to 360 million people by the year 2012[5,6]. Globally, about 796,000 infants suffer a permanent hearing loss within the neonatal period annually and the majority of these new-borns reside in developing countries where routine hearing screening is not readily available[6,7]. Studies have shown that children who had Early Hearing Detection and Intervention system (EHDI) before 6 months of age achieved higher vocabulary, articulation, cognitive, social and emotional development than those who have the same interventions but later[2,8-10]. A retrospective review of 6 years of Universal hearing screening in Qatar, showed that 95% coverage of all infants born was achievable which enabled identification of up to two-thirds of infants with hearing impairment by 6 months of age. This identification made it possible to offer interventions to the majority of them by 2.5 years of age[11]. Moderate permanent bilateral hearing loss (>40 dB) in early childhood can impede speech, language, and cognitive development[12,13]. It also has an adverse effect on social, emotional and academic development with a high cost to society[14,15]. Even children with a mild or unilateral permanent hearing loss may experience difficulties with speech, language, educational and psychosocial development[15-17]. The period from birth to 5 years is often viewed as the critical phase for the development of language[18]. Hearing during the first 6 months of life is also considered as crucial for a normal acquisition of language. Hence, infants with permanent congenital and early hearing loss identified by 6 months of age and given appropriate and timely support are reported to achieve better language outcomes than those identified later than 6 months of age[9]. Technological advancement in screening instrumentation within the last two decades have resulted in the introduction of two new objective tests namely Otoacoustic Emission and Auditory Brain Stem Response/ Brainstem Evoked Response Audiometry (BERA).

Universal newborn hearing screening; the goal is to achieve the highest possible yield from a wide screening coverage that is associated with a low referral rate. When only OAE is used infants with auditory neuropathy will be missed while ABR may miss infants with mild SNHL or with high-frequency hearing loss. The most preferred option is to combine both the tests in a two-stage screening programme[19]. With the ability to detect and diagnose an

infant with hearing loss soon after birth, there is now no reason why any infant born with a hearing loss should experience anything but normal speech and language development as a result of early intervention[20].

AIM:

To study prevalence of hearing impairment in high risk infants.

METHODS

We conducted a hospital based, prospective, observational study on 200 high risk infants fulfilling inclusion and exclusion criteria and admitted at NICU and opd, in Department of Paediatrics and ENT, Sardar Patel Medical College, Bikaner from February 2019 to October 2019. Detailed history taking, general and ENT examinations were done. OAE and BERA were done in all high risk infants included in the study. Syrup triclofos sodium 20mg/kg was given to sedate the infant half an hour before BERA. Intelligent hearing system BERA instrument was used. The morphology of the graph was noted until wave V is no longer identifiable. The minimum intensity at which wave V is identifiable was taken as the hearing threshold for that individual. Since threshold estimation was the only aim of the study, latencies and inter peak intervals was not be considered. The child's hearing sensitivity was assessed based on the following: Normal hearing sensitivity ≤25dB, Mild hearing impairment 26-40dB, Moderate hearing impairment 41-55dB, Moderately severe impairment 56-70dB, Severe hearing impairment 71-90dB, Profound hearing impairment 91+dB.

RESULTS

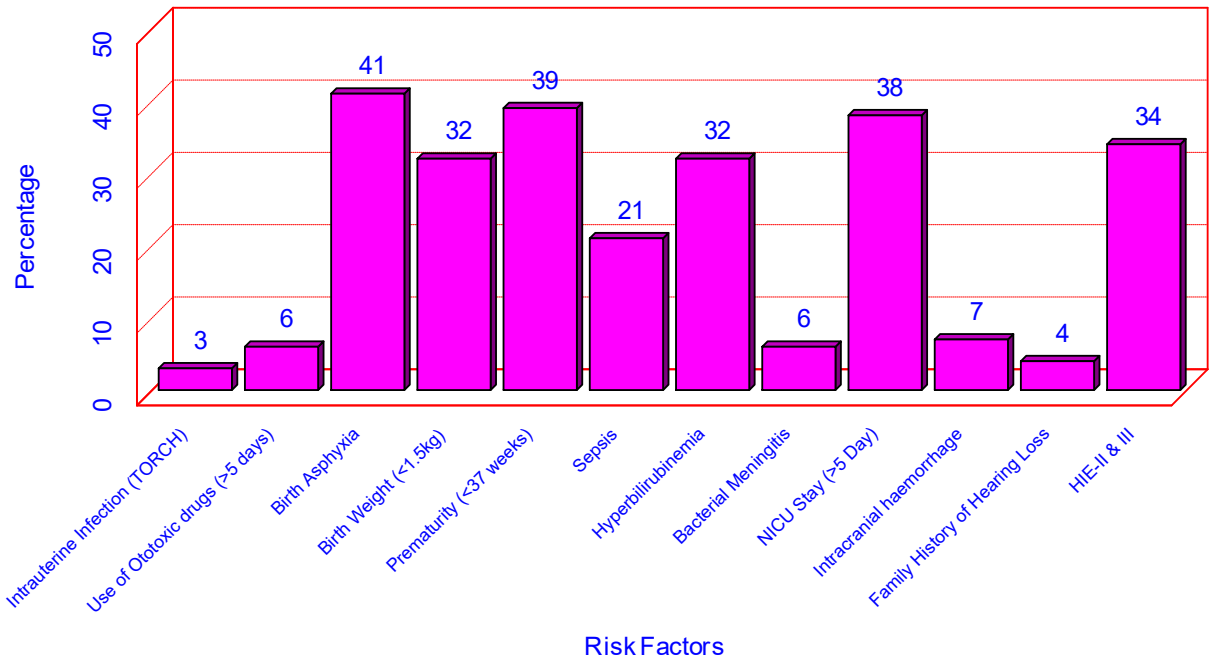
A total 200 high risk neonates who fulfil the inclusion criteria were screened. male infant (59.5%) while remaining 40.5% cases were female, 72.5% from rural area. 56 neonates were referred by OAE 1st to OAE 2nd; 14 neonates were referred to BERA by OAE 2nd. These 14 neonates were subjected to BERA of which 8**(4.0%)** neonates were found to have abnormal BERA i.e. hearing impairment. Prematurity was strongly associated hearing loss (F value 7.682) followed by Hyperbilirubinemia (F value 3.698),Birth Weight(<1.5 Kg),(F value 2.226),HIE-II&III(F value 1.959),Birth Asphyxia(F value 1.767),NICU Stay (>5days),(F value 0.988),Intracranial haemorrhage(F value 0.536),Intrauterine infection (TORCH)(F value 0.105),Bacterial Meningitis (F value 0.087),Sepsis(F value 0.026). Hearing impairment increases from cases with one risk factor (0%), 2 risk factors (3.3%), 6 risk factors (4.6%), 7 risk factors (57.1%) to 8 risk factors (100%).

Table: 1. sociodemographic profile

Gender	**No.**	**%**
Male	119	59.5
Female	81	40.5
Total	200	100
Residential Area		
Rural	145	72.5
Urban	55	27.5
Total	200	100

Indian Journal of Basic and Applied Medical Research; June 2020: Vol.-9, Issue- 3, P. 133-141
DOI: 10.36848/IJBAMR/2020/12225.51580

Graph 1 **Distribution of cases according to risk factors**



This graph shows risk factors for hearing impairment in infants. It shows that Birth Asphyxia (41%) has highest number of cases followed by Prematurity (<37 weeks), (39%), NICU Stay (>5 Day), (38%), HIE-II &III (34%), Birth Weight (<1.5kg), (32%), Hyperbilirubinemia (32%) and others.

Table: 2. **Result of screening (OAE)**

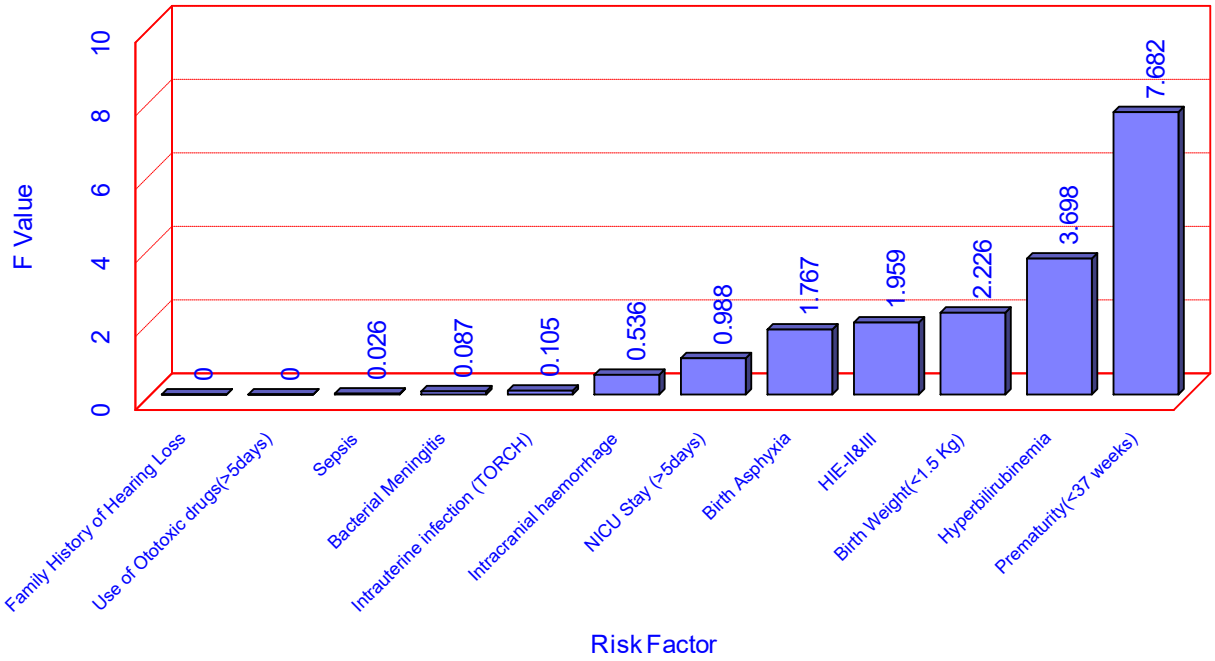
OAE first result	**No. of Cases**	**%**
Pass	144	72.0
Refer	56	28.0
Total	200	100
OAE Second Result		
Pass	42	75.0
Refer	14	25.0
Total	56	100

Indian Journal of Basic and Applied Medical Research; June 2020: Vol.-9, Issue- 3, P. 133-141
DOI: 10.36848/IJBAMR/2020/12225.51580

Table: 3. **Result and laterality of BERA**

BERA Result	**No. of Cases**	**%**
Pass	6	42.9
Fail	8	57.1
Total	14	100
Laterality		
Bilateral Fail	4	50
Left Fail	2	25
Right Fail	2	25
Total	8	100

Graph: 2 Multivariate analysis of various risk factors affecting hearing in infants:



Indian Journal of Basic and Applied Medical Research; June 2020: Vol.-9, Issue- 3, P. 133-141
DOI: 10.36848/IJBAMR/2020/12225.51580

Table: 3. **Distribution of cases according to number of risk factors involved**

No. of Risk Factor Involved	BERA				Total	
	Pass		Fail			
	No.	%	No.	%	No.	%
1	86	100	0	-	86	43.0
2	29	96.7	1	3.3	30	15.0
3	32	100	0	-	32	16.0
4	10	100	0	-	10	5.0
5	11	100	0	-	11	5.5
6	21	95.4	1	4.6	22	11.0
7	3	42.9	4	57.1	7	3.5
8	0	0	2	100	2	1.0
Total	192	96.0	8	4.0	200	100

DISCUSSION

In our study, out of 200 high risk infants 119(59.5%) were male and 81(40.5%) were female and the male female ratio was 1.47:1 [Table 1] whereas Bhat et al[21] has 95(48.7%) male and 100 (51.3%) female. Maqbool et al[22] also enrolled 200 cases comprising 118 males (59%) and 82 females (41%).

In this study 145 (72.5%) cases were from rural background and 55(27.5%) were from urban background. In this study Birth Asphyxia (41%) has highest number of cases followed by Prematurity (<37 weeks), (39%), NICU Stay (>5 Day) (38%), HIE-II & III (34%), Birth Weight (<1.5kg) (32%), Hyperbiliru-binemia (32%) and others [graph 1] which is consistent with the study conducted by Bhat et al[21], Zamani et al[23], Meyer et al[24] and Maqbool et al[22] had use of ototoxic medications, hyperbilirubinemia requiring exchange transfusion and perinatal asphyxia cases occurring in 45%, 30% and 26% at risk infants respectively; bacterial meningitis was present in 10% of infants. None of the study infants had family history of hearing loss.

In this study, 200 at risk infants were screened for hearing impairment using OAE and who fail the OAE test were screened by BERA. In OAE 1st 56 infants were referred to OAE 2nd and after OAE 2nd 14 infants were referred for BERA [Table 2]. BERA showed 8 cases (4%) had hearing impairment [Table 3]. Similar results have been obtained in the studies done by Zamani et al[23] (8%), Bhat et al[21] (6.5%) and Maisoun and Zakzouk[25] (13.5%). Out of total 8 cases who failed in BERA examination, 4 (50%) had bilateral fail, 2 (25%) each had right and left fail [Table 3]. Labaeka et al[26] study showed out of total 19 cases who failed in BERA examination, 18 (94.7%) had bilateral fail, 1 (5.3%) each had unilateral fail.

Newborn screened were having multiple risk factors, confounding of risk factors might have occurred, to overcome the confounding all statistically significant risk factors were analyzed using multivariate logistic regression which showed that Prematurity (<37 weeks) with P value 0.008 was the only risk factor which was absolutely significant in

causing hearing loss. As the F value increasing from sepsis to prematurity, the association between hearing loss and risk factor increases. Hence the prematurity was strongly associated hearing loss (F value 7.682) followed by Hyperbilirubinemia (F value 3.698),Birth Weight (<1.5 Kg), (F value 2.226), HIE-II&III (F value 1.959), Birth Asphyxia (F value 1.767), NICU Stay (>5days), (F value 0.988), Intracranial haemorrhage (F value 0.536), Intrauterine infection (TORCH) (F value 0.105), Bacterial Meningitis (F value 0.087), Sepsis (F value 0.026).

Bhat et al[21] showed Apgar score <4 at 1 min and <6 at 5 min (p=0.006), stigmata and/or syndrome associated with hearing loss (p=0.020), craniofacial anomalies (P = 0.020), and hyperbilirubinemia (p=0.012) were significant independent clinical risk factors for predicting hearing impairment in high-risk infants. Al-Meqbel and Al-Baghli[27] found premature birth (gestational age ≤34 weeks), positive family history of hearing loss, hyperbilirubinemia, severe perinatal asphyxia, ototoxic medication, and syndromes associated with hearing loss as a significant risk factors for hearing impairment. Meyer et al[24] have reported craniofacial anomalies, familial hearing disorders, and bacterial meningitis as significant factors associated with pathologic BAER. Kumar et al[28] have reported major risk factors are NICU admission, LBW, hypoxia, and jaundice. Gouri et al[16] found low Apgar score and family history of SNHL as an independent risk factor. Similar findings were reported by Maisoun and Zakzouk[25] and Chan et al[29].

In our study as the number of risk factors increases from 1 to 8, the cases with failure to BERA i.e. hearing loss cases increases. There were 86 cases with 1 risk factor out of which none have hearing loss, 30 cases with 2 risk factor out of which 1(3.3%) have hearing loss, 32 cases with 3 risk factors out of which none have hearing loss,10 cases with 4 risk factors out of which none have hearing loss,11 cases with 5 risk factors out of which none have hearing loss, 22 cases with 6 risk factor out of which 1(4.6%) have hearing loss,07 cases with 7 risk factor out of which 4(57.1%) have hearing loss,2 cases with 8 risk factor out of which 2(100%) have hearing loss [Table 21]. Bhat et al[70] also showed similar results i.e.hearing impairment increased from 0.917% for one risk factor, 6.66% for two risk factors, 10.52% with three risk factors, 28.57% with four risk factors, and 25% with five risk factors. Maqbool et al[30] study showed Infants with single, two and three risk factors had BAER abnormality rate of 4.28%, 22.2% and 33.3% respectively. Srisuparp et al[31] and Zamani et al[23] studies were also in accordance to our study.

CONCLUSION

This study highlights the need for OAE and BERA for early identification of hearing loss so that timely intervention can be done. The incidence of hearing impairment was 4%. Prematurity was a significant risk factor.

REFERENCES

1. Mencher GT, Davis AC, De Voe SJ, Bresfor D, Bamford JM. Universal neonatal hearing screening: Past present and future. Am J Audiol 2001;10(1):3-12.
2. Global estimates on the prevalence of hearing loss. [Internet] World Health Organisation. 2012 [cited 14th January 2017]. Available online at: www.who.int/pbd/deafness/WHO_GE_HL.pdf
3. Primary Ear and Hearing care training resources. Advance Level. [Internet] World Health Organisation. 2006 [Cited January 14, 2017]. Available online at: http://who.int/entity/pbd/deafness/ activities/hearing_care/ advanced.pdf?ua=1s.
4. Olusanya BO, Newton VE. Global burden of childhood hearing impairment and disease control priorities for developing countries. Lancet 2007; 369:1314-7.

5. Joint Committee on Infant Hearing. Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs. Pediatrics (2007) 120:898–921.
6. Khairi M, Din S, Shahid H, Normastura A. Hearing screening of infants in neonatal unit, Hospital Universiti Sains Malaysia using transient evoked otoacoustic emissions. J Laryngol Otl 2005; 119:678–83.
7. Moeller MP. Early intervention and language development in children who are deaf and hard of hearing. Paediatrics 2000; 106:e43.
8. Perez-Abalo MC, Gaya JA, Sario G, Ponce de Leon M, Perera M, Reigosa V. Early detection and intervention of hearing impairment in Cuba; Outcome after 20 years. Rev Neurol 2005; 41:556–63.
9. Yoshinga-Itano C, Sedey AL, Coulter DK, Mehl AL. Language of early–later identified children with hearing loss. Pediatrics 1998; 102:1161–71.
10. Hearing JCoI, Audiology AAo, Pediatrics AAo, Association AS-L-H, Speech Do, Health HPiS, et al. Year 2000 position statement: principles and guidelines for early hearing detection and intervention programs. Pediatrics 2000; 106:798–817.
11. Abdul Hadi K, Salahaldin A, Al Qahtani A, AlMusleh Z, Al SulaitinM, Bener A, et al. Universal neonatal hearing screening: six years of experience in Qatar. Qatar Med J 2012; 2:42–50.
12. Ramakalawan TW, Davis AC. The effects of hearing loss and age of intervention on some language metrics in young hearing impaired children. Br J Audiol. 1992;26(2):97-107.
13. Robinshaw HM. The pattern of development from non communicative behaviour of language by hearing impaired infants. Br J Audiol. 1996;30:177-98.
14. Mohr PE, Feldman JJ, Dunbar JL, McConkey-Robbins A, Niparko JK, Rittenhouse RK, et al. The societal costs of severe to profound hearing loss in the US. Int J Technol Assess Health Care. 2000;16(4):1120-35.
15. Culbertson J, Gilbert AM. Children with unilateral sensorineural hearing loss. Cognitive academic and social development. Ear Hear. 1986;7(1):38-42.
16. Davis JM, Elfenbein J, Schum R, Bentler RA. Effects of mild and moderate hearing impairments on language educational and psychological behavior of children. J Speech Hear Disord. 1986;51(1):53-62.
17. Bess FH, Dodd Murphy J, Parker RA. Children with minimal sensorineural hearing loss, prevalence. Ear Hear. 1998;19(5):339-54.
18. Carney AE, Moeller MP. Treatment efficacy Hearing loss in children. J speech Hear Res. 1998;41:361-84.
19. Olusanya BO, Luxon LM, Wirz SL. Benefits and challenges of newborn hearing screening for developing countries. Int J Pediatr Otorhinolaryngol. 2004;68(3):287-305.
20. Kemp DT. Stimulated acoustic emissions from within the human auditory systems. J Acoust Soc Am. 1978;64(5):1386-91.
21. Bhat JA, Kurmi R, Kumar S, Ara R, Mittal AK. Targeted screening for hearing impairment in neonates: A prospective observational study. Ind J Otology 2018; 24:42-6.
22. Tobe RG, Mori R, Huang L, Xu L, Han D, Shibuya K. Cost-effectiveness analysis of a national neonatal hearing screening program in China: conditions for the scale-up. PLoS One. 2013;8(1), e51990.
23. Zamani A, Daneshjou K, Aeni A, Takand J. Estimating theincidence of neonatal hearing loss in high risk neonates. Acta Medica Iranica 2004; 42(3):1-5.
24. Meyer C, Witte J, Hildmann A, Hennecke KH, Schunck KU, Maul K, et al. Neonatal screening for hearing disorders in infants at risk: Incidence, risk factors, and follow-up. Pediatrics 1999;104:900-4.
25. Maisoun AM, Zakzouk SM. Hearing screening of neonates at risk. Saudi Med J 2003;24:55-7.

26. Davis A, Hind S. The newborn hearing screening programme in England. Int J Pediatr Otorhinolaryngol. 2003;67 Suppl 1:S193–6.
27. Al-Meqbel A, Al-Baghli H. The prevalence of hearing impairment in high-risk infants in Kuwait. Aud Vest Res 2015;24:11-6.
28. Chapchap MJ, Segre CM. Universal newborn hearing screening and transient evoked otoacoustic emission: new concepts in Brazil. Scand Audiol Suppl. 2001; 53:33–6.
29. Chan KY, Lee F, Chow CB, Shek CC, Mak R. Early screening and identifications of deafness of high risk neonates. HK J Paediatr New Series 1998;3:131-5.
30. Tobe RG, Mori R, Huang L, Xu L, Han D, Shibuya K. Cost-effectiveness analysis of a national neonatal hearing screening program in China: conditions for the scale-up. PLoS One. 2013;8(1), e51990.
31. Srisuparp P, Gleebbur R, Ngerncham S, Chonpracha J, Singkampong J. High-risk neonatal hearing screening program using automated screening device performed by trained nursing personnel at Siriraj hospital: Yield and feasibility. J Med Assoc Thai 2005;88 Suppl 8:S176-82.

Date of Submission: 09 March 2020 Date of Peer Review: 04 April 2020
Date of Acceptance: 11 May 2020 Date of Publishing: 02 June 2020
Author Declaration: Source of support: Nil, Conflict of interest: Nil
Ethics Committee Approval obtained for this study? YES
Was informed consent obtained from the subjects involved in the study? YES
For any images presented appropriate consent has been obtained from the subjects: NA
Plagiarism Checked: Urkund Software

DOI: 10.36848/IJBAMR/2020/12225.51580