International Journal of Pediatric Otorhinolaryngology (2005) 69, 839–842

ELSEVIER

International Journal of Pediatric Otorhinolaryngology

www.elsevier.com/locate/ijporl

# Neonatal hearing screening with transient evoked otoacoustic emissions in Western Saudi Arabia

H.S. Habib [a,*], H. Abdelgaffar [b]

[a] Pediatric Department, Faculty of Medicine, King Abdulaziz University, P.O. Box 6597, Jeddah 21452, Saudi Arabia
[b] Dr. Soliman Fakeeh Hospital, Jeddah, Saudi Arabia

Received 24 July 2004; received in revised form 24 January 2005; accepted 24 January 2005

KEYWORDS
Universal;
Neonatal screening;
Hearing loss;
Incidence;
Congenital;
Screening program

Summary

*Objective:* To study the incidence of congenital hearing impairment in the Saudi population and to evaluate the need of establishing a Saudi universal neonatal hearing screening program based on transient evoked otoacoustic emission.
*Methods:* A total of 11986 well non-high-risk neonates were screened by transient evoked otoacoustic emission over period of 8 years from September 1996 to February 2004. The universal hearing screening was consequently done in a daily base before discharge from nursery. Those who failed the initial screening were followed up diagnostically until hearing loss was confirmed or excluded.
*Results:* From the total number of 11,986 neonates (41.4% male and 58.6% females) examined in this study 10943 (91.3%) neonates passed the first screening step while 1043(8.7%) neonates failed. From the 1043 neonates examined in the second screening step in the 5th day of life, 300 (29%) neonates failed. At the age of 5 months, all the 300 infants that failed the second screening step underwent a comprehensive audiological assessment to confirm the existence of hearing loss. The 278 infants that passed the assessment were considered as normal; while 22 failed and were confirmed to have congenital hearing loss. Of these 22 infants, 2 had unilateral sensorineural hearing loss, and the remaining 20 had bilateral sensorineural hearing loss. The incidence of sensorineural hearing loss was estimated to be 0.18% while the incidence of bilateral sensorineural hearing loss was 0.17%. No significant difference between males and females was found. The average age at confirmation of congenital hearing loss was 5.5 months.
*Conclusion:* The incidence of congenital hearing loss in the western region of Saudi Arabia is relatively high compared with international figures. Hearing screening for all neonates using transient evoked otoacoustic emission should be part of the standard medical care in Saudi Arabia.


* Corresponding author. Tel.: +966 26726056; fax: +966 26701621; mobile: +966 5050611935.
*E-mail addresses:* hamedhabib@hotmail.com (H.S. Habib), hossam149@hotmail.com (H. Abdelgaffar).

0165-5876/$ – see front matter © 2005 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.ijporl.2005.01.018

## 1. Introduction

Significant hearing loss is one of the most common major abnormalities present at birth and, if undetected, will impede speech, language, and cognitive development [1–3]. Bilateral hearing loss is present in ~1–3 per 1000 newborn infants in the well-baby nursery population, and in ~2–4 per 100 infants in the intensive care unit population. Currently, the average age of detection of significant hearing loss is ~14 months [4]. In 1994, the Joint Committee on Infant Hearing (JCIH) stated that all infants with hearing loss should be identified before 3 months of age and receives intervention by 6 months [5]. In their 2000 position statement, the JCIH set principles and guidelines for early hearing detection and intervention programs [6]. The World Health Organization (WHO) recommended that a policy of universal neonatal hearing screening has to be adopted in all countries and communities with available rehabilitation services. That policy should be extended to other countries as rehabilitation services are established [7]. Currently, there are three available methods of universal neonatal hearing screening programs: transient evoked otoacoustic emissions (TEOAE), automated auditory brainstem response (AABR), and a combination, all can be used for universal neonatal hearing screening [8]. The total costs of newborn hearing screening and diagnosis are similar among the three methods [9]. The goal of this study is to propose a Saudi universal neonatal hearing screening (UNHS) program based on transient evoked otoacoustic emission reporting the incidence of hearing impairment in this population and exploring the morbidity of hearing impaired infants. The first 3000 neonates of this series was published [10] among many scientific trials evaluating TEOAE as neonatal hearing screening tool which concluded that a neonatal hearing screening based on TEOAE is an appropriate, feasible, accurate screening program.

## 2. Material and methods

This study was conducted in Dr. Soliman Fakeeh Hospital in Jeddah over a period of 8 years from September 1996 to February 2004. Transient evoked otoacoustic emission was obtained from 11,986 neonates representing 91.7% of the deliveries in our hospital without identifying the risk factors for hearing loss. High-risk registers according to the 1994 position statement of joint committee on infant hearing [5] were excluded. The screening is a part of the routine medical services provided to all newborns delivered in our hospital which needs verbal consent from parents. Both ears were screened for each neonate. The screening test was consequently done in daily bases (including weekends) by one audiology technician and the interpretations were done by a consultant of hearing and balance disorders. The screening program consists of two steps protocol and diagnostic follow-up. The neonates were screened in the first 48 h of life, those who did not fulfill the pass criteria at the first step, were screened again in the 5th day of life before they were discharged from nursery. To be considered a response, OAEs reproducibility should be, at minimum, more than 50%. Response amplitude should be at least 1 dB SPL per octave. Impedance audiometery was performed before the second screening step using Impedance meter Interacoustics AZ26. Infants that did not fulfill the pass criteria after the second step were referred for comprehensive audiologic assessment to confirm the existence of hearing loss by ABR at the age of 5 months using ICS auditory brainstem response audiometery. ILO88 otodynamics analyzer quick screen program was used for all testing of transient otoacoustic emissions. Well-fitted probe was used with no significant change in fit over recording interval. The stimulus clicks were between 75 and 100 pps and the stimulus level (ppe) was ranging between 80 to 88 dB peak SPL into the babies ear canal with Variation of stimulus level between probes ±2 dB. The data reject level was at or below 55 dB peak SPL. The minimum number of responses averaged (260) sweeps at low stimulus level equivalent and the maximum recording time 6 min. Hearing loss is graded as mild (26–40) dB, moderate (41–55) dB, moderately severe (56–70) dB, severe (71–90) dB and profound >90 dB [11] (Table 1).

**Table 1** The degree of hearing loss in the 22 neonates that was picked by the screening program

| Total number | Male | Female | Degree of hearing loss |
|---|---|---|---|
| 2 | 1 | 1 | Mild loss |
| 4 | 1 | 3 | Moderate loss |
| 7 | 3 | 4 | Severe loss |
| 9 | 4 | 5 | Profound loss |

## 3. Results

11986 non-high-risk neonates (41.4% males and 58.6% females) were examined in this study. From the total number of neonates, 10943 (91.3%) passed the first screening step while 1043 (8.7%) neonate failed. From the 1043 examined in the second screening step before discharge from nursery, 300 (29%) neonate

Table 2 Sex specific incidence

| | Male | Female | Total |
|---|---|---|---|
| Number of screened neonates | 4,962 | 7,029 | 11,986 |
| Neonates with hearing loss | 9 | 13 | 22 |
| Incidence of hearing loss (%) | 0.18 | 0.18 | 0.18 |

failed. All the 300 infants that failed the second screening step underwent a comprehensive audiologic assessment to confirm the existence of hearing loss. The 278 infants that passed the assessment were considered as normal; while 22 failed and were confirmed to have congenital hearing loss 9 males (41%) and 13 females (59%). Of these 22 neonates, 2 had unilateral sensorineural hearing loss and the remaining 20 had bilateral sensorineural hearing loss. The incidence of sensorineural hearing loss was estimated to be 0.18% while the incidence of bilateral sensorineural hearing loss was 0.17%. No significant difference between males and females was found as shown in Table 2. The average confirmation age of congenital hearing loss was 5.5 months. The false positive of the first screening step was 278 (2.3%) and sensitivity value was 92% but the two-step screening sensitivity value was 98%.

## 4. Discussion

Bilateral hearing loss is one of the most common and major abnormalities present at birth, which if undetected might cause permanently impaired speech, language, and cognitive development. Severely and profoundly hearing impaired infants can follow a normal pattern of communicative and linguistic development when hearing impairment is identified within the 1st months of life and appropriate interventions are in place [12] Research outcomes provide evidence that age of identification of hearing loss is reduced, that age of intervention initiation is lowered, and that the outcomes of intervention are better because of the establishment of a screening program [13]. Application of a risk register based screening makes it possible to identify congenital deafness in only 50–60% of the cases [14,15]. Reliance on physician observation and parental recognition has not been successful in the past in detecting significant hearing loss in the 1st year of life. A survey of childhood hearing impairment in Saudi Arabia reported a prevalence of 13%; the survey also disclosed that 1.5% of the children suffered from sensorineural permanent hearing loss which was either unilateral or bilateral with a familial pattern and link to consanguinity [16]. Transient otoacoustic emissions fulfill most of the criteria of screening test as non invasive time saving and easy application method of universal hearing screening [4]. The incidence of bilateral congenital hearing loss for non-high-risk neonates in this study was higher than the incidence of other reported studies in different countries which ranged from 0.09 to 0.13% using the same criteria [17,18]. Although other literature [4] reported an incidence of [1–3] per 1000, this is primarily the result of the differences in the age ranges of the children studied, the extent of loss and the severity required to meet the case definition and the method used to identify cases. The relatively higher incidence in our study might be explained by the high prevalence of consanguineous marriage in the Saudi community which was shown to be linked with hearing impairment [16]. We did not find any gender hearing loss difference, while the difference in the absolute number of affected males and females is corrected by the sex specific incidence.

The large number of neonates that failed the first step screening and relatively low sensitivity can be explained by transient conductive hearing loss possibly caused by incomplete clearance of normal fetal middle ear fluid. This emphasized the importance of using the impedancemetry and two steps protocol in the screening program. Unilateral congenital hearing loss is a relatively minor disability in language and cognitive development. It is never the less educational disability that is easily managed, but only after adequate and early diagnosis. In this project we managed to confirm the diagnosis of congenital hearing loss and to initiate the proper rehabilitation program before the age of 6 months (average age of intervention was 5.8 month). Our rehabilitation program in the form of early amplification, auditory training and speech therapy was mainly focusing on infants with persistent bilateral hearing loss, since there is no accepted standard of interventions existing for infants with unilateral impairment. At school-age, children with UHL appear to have increased rates of grade failures, need for additional educational assistance, and perceived behavioral issues in the classroom. Speech and language delays may occur in some children with UHL, but it is unclear if children "catch up" as they grow older [19]. When identification of unilateral hearing loss was established in our series the parents were counseled and the infant was monitored every 6 months to ensure that the status of the normal hearing ear did not change. At school-age, children with unilateral hearing loss were provided with amplification or contra lateral routing of signal instrument. Teachers were

informed of the student's unilateral hearing loss and parents were reassured.

## 5. Conclusions

The incidence of congenital hearing loss in the western region of Saudi Arabia is relatively high compared with international figures. Hearing screening for all neonates using transient evoked otoacoustic emission should be part of the standard medical care in Saudi Arabia.

## Acknowledgments

We would like to thank Dr. Soliman Fakeeh and Dr. Mazin Fakeeh for their great help and support for this study and their collaborations with King Abdulaziz University.

## References

[1] M.P. Downs, C. Yoshingag-Itano, The efficacy of early identification and intervention for children with hearing impairment, Pediatr. Clin. North Am. 46 (1999) 79–87.
[2] M.P. Moeller, Early intervention and language development in children who deaf and hard of hearing, Pediatrics 106 (2000) 106–110.
[3] C. Yoshinaga-Itano, A.L. Sedey, D.K. Coulter, A.L. Mehl, Language of early- and later-identified children with hearing loss, Pediatrics 102 (1998) 1161–1171.
[4] American Academy of Pediatrics, Newborn and Infant Hearing loss, Detection and intervention Task Force on Newborn and Infant Hearing, Pediatrics 103 (1999) 527–530.
[5] American Academy of Pediatrics Joint Committee on Infant Hearing 1994 Position Statement, Pediatrics 95 (1995) 152–156.
[6] Joint Committee on Infant Hearing, Year 2000 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs, Pediatrics 106 (2000) 798–817.
[7] World Health Organization (WHO), Future Programme Developments for Prevention of Deafness and Hearing Impairment, Report of the Fourth Informal Consultation, Geneva, 17–18 February 2000, Centers for Disease Control and Prevention, National Center for Birth, 2000.
[8] S. Meier, O. Narabayashi, R. Probst, N. Schmuziger, Comparison of currently available devices designed for newborn hearing screening using automated auditory brainstem and/or otoacoustic emission measurements, Int. J. Pediatr. Otorhinolaryngol. 68 (7) (2004) 927–934.
[9] B.R. Vohr, W. Oh, E.J. Stewart, J.D. Bentkover, S. Gabbard, J. Lemons, L.A. Papile, R. Pye, Comparison of costs and referral rates of 3 universal newborn hearing screening protocols, J. Pediatr. 139 (2) (2001) 238–244.
[10] H. Habib, A. Jifrey, M. Jamal, K. Alnoury, Screening for newborn babies by transient evoked otoacoustic emissions in Jeddah, Saudi Arabia, Saudi J. Oto-Rhino-Laryngol. Head Neck Surg. 2 (2000) 18–20.
[11] J.L. Northern, M.P. Downs, Hearing in Children, fourth ed. Williams & Wilkins, Baltimore, MD, 1991, pp.1–31.
[12] H.M. Robinshaw, The pattern of development from non-communicative behavior to language by hearing impaired infants, Br. J. Audiol. 30 (1996) 177–198.
[13] C. Yoshinaga-Itano, Levels of evidence: universal newborn hearing screening (UNHS) and early hearing detection and intervention systems (EHDI), J. Commun. Disord. 37 (5) (2004) 451–465.
[14] R. Luppari, E. Arslan, Neonatal screening: risk factors and outcome in 4400 children, Acta Otorhinolaryngol. Ital. 16 (6) (1996) 501–507.
[15] P.M. Watkin, M. Baldwin, McEnery G, Neonatal at risk screening and the identification of deafness, Arch. Dis. Child. 66 (1991) 1130–1135.
[16] S. Zakzuk, K. Dagustani, T. Jamal, A. AL-Shaikh, M. Hajjaj, A survey of childhood hearing impairment, Saudi Med. J. 20 (10) (1999) 783–787.
[17] J.A. Mason, K.R. Herrmann, Universal infant hearing screening by automated auditory brain stem response, Pediatrics 101 (1998) 221–228.
[18] D. Aidan, P. Avan, P. Bonfiles, Auditory screening in neonates by means of transient evoked otoacoustic emissions: a report of 2842 recording, Ann. ORL 108 (1999) 25–31.
[19] J.E. Lieu, Speech–language and educational consequences of unilateral hearing loss in children, Arch. Otolaryngol. Head Neck Surg. 130 (5) (2004) 524–530.