Received: 31 May 2020 | Accepted: 9 September 2020

DOI: 10.1016/j.wjorl.2020.09.002

RESEARCH PAPER

World Journal of Otorhinolaryngology-Head and Neck Surgery

Screening strategy and time points for newborn hearing re-screening with high risk factors

Qing-Xiang Zeng | Ren-Zhong Luo | Sheng-Bao Yan | Yi-Quan Tang | Rui-Jin Wen | Wen-Long Liu

Department of Otolaryngology, Guangzhou Women and Children's Medical Center, Guangzhou Medical College, Guangzhou, China

Correspondence

Wen-Long Liu, Department of Otolaryngology, Guangzhou Women and Children's Medical Center, Guangzhou Medical University, No. 9, Jinsui Road, Guangzhou 510623, China.
Email: lwl20103@163.com

Funding information

This study was supported by grants from Key Clinical Speciality of Guangzhou Women and Children's Medical Center.

Abstract

Objective: To compare and analyze the pass rate and screening strategy of hearing rescreening for newborns with high risk factors.

Methods: Retrospective chart review of high-risk newborns who failed their initial newborn hearing screen and subsequently underwent secondary hearing tests from June 2011 to June 2018 in Guangzhou Women and Children's Medical Center were performed.

Results: Eight hundred and sixty-eight newborns with high risk factors were included in the study. The 57-70 days (83.5%) and 71-84 days (83.4%) group had the highest pass rate compared with 42-56 days (75.8%) and < 42 days (68.3%) group. As for different screening strategies, the pass rate of OAE(otoacoustic emissions), AABR (auto auditory brainstem response) and OAE + AABR was the highest in 57–70 days group and 71-84 days group, respectively. The OAE + AABR had the lowest pass rate compared to the other two modalities. When the pass rate was compared as different risk factors, the 57–70 days and 71–84 days group also had the highest pass rate compared with 42–56 days and < 42 days group and the pass rate had no significant differences among various risk factors group.

Conclusion: Our results showed that all the pass rate of OAE, AABR and OAE + AABR was the highest in 57–70 days group and 71–84 days group with significant difference, suggesting that the delayed screening time (>57 days) may increase the re-screening pass rate and reduce anxiety of parents, which is of great significance for clinical work.

KEYWORDS

Auto auditory brainstem response, Hearing screening, Newborns, Otoacoustic emissions

Qing-xiang Zeng, Ren-zhong Luo and Sheng-bao Yan contribute equally to this study.

INTRODUCTION

Hearing is an essential part of the newborn's contact with the outside world and is essential for language development.[1] Hearing loss is one of the common neonatal congenital diseases, which poses a significant threat to the healthy development of newborns.[2] Previous studies have shown that the incidence of hearing loss in newborns is 0.1%-0.3%.[3] The American Association of Infant Hearing (JCIH) proposed high risk factors in 2007 as an important cause of hearing loss in newborns, such as family history, long-term intensive care, uterine infection, craniofacial deformity, sensorineural or permanent conductive hearing loss related syndrome, neurodegenerative diseases, postpartum infection, head trauma, chemotherapy and so on.[4] For high risk populations, this incidence could increase 10-50 fold.[3]

Newborn hearing screening is the main way to quickly detect neonatal hearing impairment in the early stage. In the absence of hearing screening, moderate to severe hearing loss is usually detected between 1 and 2 years of age, while mild hearing loss is only detected before school age.[5,6] However, the most worrying issue for newborn hearing screening is its false positive rate of 3%-8%, which may cause persistent anxiety and adversely affect parent-child relationships.[7–9] Therefore, the selection of appropriate re-screening strategy and time points are of great importance for newborns needed hearing re-screening. However, this issue was rarely investigated in previous studies.

In the present study, we retrospectively review the clinical data of newborns with high risk factors who failed the initial hearing screen and subsequently underwent secondary hearing tests from June 2011 to June 2018 in Guangzhou Women and Children's Medical Center. We aimed to compare and analyze the pass rate and screening strategy of hearing rescreening for newborns with high risk factors.

MATERIALS AND METHODS

Patients

The clinical data of newborns with high risk factors underwent secondary hearing screening from June 2011 to June 2018 in Guangzhou Women and Children's Medical Center were collected and analyzed. All tests and results were recorded electronically and identified by audiologists. The newborns with incomplete data are excluded from this study. All the newborn had at least one risk factor as defined by the JCIH: premature birth; low birth weight (<1 500 g); hyperbilirubinemia; children from hearing impaired families; craniofacial anomalies; syndromes known to be associated with hearing loss; and those hospitalized in neonatal intensive care unit. The study was performed with the approval of the local ethics committee and with the parents' written informed consent.

Testing equipment and strategy

Tests were performed when the baby was asleep or being calmly held by mother or nursemaid. All distortion product otoacoustic emission (DPOAE) screenings were performed by GSI 70 Automated OAE Screener system (GSI Audera, USA). The babies were given a bilateral DPOAE checking and the results were evaluated as “passed” or “failed” according to the test results.

Automated auditory brainstem response (AABR) testing was performed using MB11 AABR screener (MAICO, Germany). A 35 dB nHL alternating polarity click was given to evaluate the neural response of the auditory nerve. The detection result is automatically determined by the system.

OAE was performed on all newborns 24–48 hours after birth. If they fail the test, they will be recommended to see an otolaryngologist 30-42 days after birth. For secondary screening, all the parents of newborns were suggested to performed OAE and AABR. However, not all the newborns finished all the two tests due to un-cooperation, crying or other reasons. Therefore, three kinds of tests combinations were analyzed finally. The pass was defined as both ears passed both of the tests.

Statistical analysis

Analysis was performed using SPSS 13.0 software. The SNK test was performed for comparison of pass rate between groups. $P < 0.05$ was considered statistically significant.

RESULTS

Baseline characteristics for study population

The demographic characteristics of newborns with high risk factors were presented in Table 1. As shown in the Table 1, premature birth was the most commonly identified risk factor (347 cases, 347/868, 40.0%), followed by low birth weight (369 cases, 369/868, 42.5%), children from hearing impaired families (95 cases, 10.9%), hospitalized in neonatal intensive care unit (60 cases, 60/868, 6.9%),

TABLE 1 The prevalence of high risk factors in the studied population (total of 868 cases)

Risk factors	Number of cases	Percentage(%)
Premature birth	347	40
Low birth weight	369	42.5
Children from hearing impaired families	95	10.9
Hospitalized in neonatal intensive care unit	60	6.9
Hyperbilirubinemia	47	5.4
Craniofacial anomalies	10	1.2
Syndromes known to be associated with hearing loss	7	0.8

hyperbilirubinemia (47 cases, 47/868, 5.4%), craniofacial anomalies (10 cases, 10/868, 1.2%), and syndromes known to be associated with hearing loss (7 cases, 7/868, 0.8%).

OAE was performed on all newborn 24–48 hour after birth, and the results were as follows: 177 cases (177/868, 20.4%) passed the left ear, 148 cases (148/868, 17%) passed right ear, 403 cases (403/868, 46.4%) had both ears failed, 140 cases (140/868, 16.1%) passed both ears.

Different screening strategies and time points

As different time points, the 57-70 days (83.5%) and 71-84 days (83.4%) group had the highest pass rate compared with 42-56 days (75.8%) and < 42 days (68.3%) group (Table 2). The 42-56 days (75.8%) group had higher pass rate compared with < 42 days (68.3%) group (Table 2).

As for different screening strategies, the pass rate of OAE, AABR and OAE + AABR was the highest in 57-70 days group and 71-84 days group, respectively (Table 3). The 42-56 days group had higher pass rate compared with < 42 days group (Table 3).

We also found that the pass rate at different time points between OAE and AABR group had no significant differences, whereas the OAE + AABR had the lowest pass rate compared to the other two modalities (Table 3).

When the pass rate was compared as different risk factors, the 57-70 days and 71-84 days group also had the highest pass rate compared with 42-56 days and < 42 days group and the pass rate at different time points had no significant differences among various risk factors group (Table 4).

TABLE 2 Comparison of pass rate among different time points

Groups	Total cases	Passed cases	Pass rate(%)
<42 days	373	255	68.3
42-56 days	186	141	75.8[a]
57-70 days	158	132	83.5[b]
71-84 days	151	126	83.4[b]

[a]Compared with < 42 days group, $P < 0.05$.
[b]compared with < 42-56 days group, $P < 0.05$.

DISCUSSION

According to guidelines for examination of and intervention for infants and young children's hearing, the routine re-screening time point for hearing in China is 30-42 days after birth, which is also the best period for maternal rehabilitation.[10] The main targets of hearing re-screening were newborns who did not pass the primary screening or with high-risk factors. This study mainly analyzed the re-screening pass rate, re-screening time points and strategy for newborns with high-risk factors.

Our results showed that the first time OAE pass rate in 868 newborns with high risk factors was only 16.1%, implying the importance of rescreening for newborns with high risk factors. Our result is significantly different from the initial screening rate of normal newborns. A systematic review by Akinpel et al.[11] summarized 119,714 newborn screening populations in 10 literatures with an abnormal rate of OAE of 5.5% (1.3%-39%). For newborns with high risk factors, few studies were reported. Sun et al.[12] and

TABLE 3 Comparison of pass rate among different screening strategies [cases(%)]

Screening strategies	<42 days group	42-56 days group	57-70 days group	71-84 days group
OAE	105/150 (70.0)	58/73 (79.5)[a]	44/52 (84.6)[b]	41/48 (85.4)[b]
AABR	103/145 (71.0)	53/68 (77.9)[a]	59/67 (88.1)[b]	55/63 (87.3)[b]
OAE + AABR	47/78 (60.3)[c]	30/45 (66.7)[a,c]	29/39 (74.4)[b,c]	30/40 (75.0)[b,c]

[a]Compared with < 42 days group, $P < 0.05$.
[b]compared with < 42-56 days group, $P < 0.05$.
[c]compared with OAE or AABR group, $P < 0.05$.

TABLE 4 Comparison of pass rate of newborns with different risk factors at different time points(%)

Groups	Premature birth	LBW	Family history	NICU	Hyperbilirubinemia
<42-days	66.5	69.3	64.1	59.2	63.2
42-56 days	73.2[a]	77.5[a]	73.1[a]	68.7[a]	78.7[a]
57-70 days	85.6[b]	87.1[b]	81.4[b]	77.6[b]	88.6[b]
71-84 days	84.8[b]	86.5[b]	82.9[b]	81.2[b]	87.1[b]

LBW: low birth weight; NICU: hospitalized in neonatal intensive care unit.
[a]compared with < 42-day group, $P < 0.05$.
[b]compared with < 42-56 days group, $P < 0.05$.

Xia et al.[13] reported that the fail rate of premature infants was as high as 34.09% and 38.4%, respectively. However, no studies reported the whole pass rate of primary screening for newborns with different high risk factors.

Apart from a small proportion of permanent hearing loss, most newborns passed the rescreening. Several factors that may affect the screening rate include: vernix caseosa in the ear canal of individual newborn may last for more than a month, screening operation technical problems, the status of the newborn and the impact of the screening environment. Therefore, there is an urgent need to search for appropriate strategy to improve the pass rate of rescreening, which will be helpful to reduce persistent anxiety of parents.

To raise the pass rate of rescreening, we compared different screen strategy and time points. We found that all the pass rate of three screen strategy was highest among 57-70 days group and 71-84 days group with significant difference, suggesting that the delayed screening time (>57 days) may obtain higher re-screening pass rate, which is of great significance for clinical work. However, the pass rate between 57-70 days group and 71-84 days group had no significant difference, which implied that the natural development of hearing system is finished at this stage and the failure of pass may contribute to irreversible damage to hearing system. Since failed hearing screening may cause persistent anxiety and adversely affect parent-child relationships,[7–9] delayed screening and higher pass rate may reduce anxiety of parents as a whole.

As for various screening strategies, OAE + AABR had the lowest pass rate compared to OAE or AABR. These results are understandable since more tests methods may reduce pass rate compared with single test. We also found that newborns with different risk factors showed similar higher pass rate in 57-70 days and 71-84 days group compared with 42-56 days and < 42 days group, suggesting that most risk factors may have similar impact on the development of hearing system.

Our study had some limitations. First, we did not analyze the confirmed outcomes of all newborn since we only concentrated on hearing screening strategy. Further follow up on those infants would be the aim of our next study. Secondly, the study was limited by the sample size and one center. Hearing tests are only techniques to help to recognize early hearing problems. Clinical features such as family history, infants' reaction to different sounds in daily life are still important information in clinical setting. All results should be interpreted carefully by audiologists to identified those who need early diagnose test and those who with true hearing loss for rehabilitation.

CONCLUSION

Our study provided evidence that the delay of hearing rescreening to 57 days or above after birth may acquire higher re-screening pass rate, which is very meaningful for the policy maker.

Edited by Xin Jin

AUTHOR CONTRIBUTIONS

Dr Wen-long Liu and Ren-zhong Luo conceptualized and designed the study, drafted the initial manuscript, and approved the final manuscript as submitted. Dr Qing-xiang Zeng, Sheng-bao Yan, Yi-quan Tang, and Rui-jin Wen collected the sample, performed the experiment, data collection and statistics, reviewed and revised the manuscript, and approved the final manuscript as submitted.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ETHICAL APPROVAL

The study was performed according to the principles expressed in the Declaration of Helsinki. The study was performed with the approval of the Guangzhou Women and Children's Medical Center's ethics committee.

INFORMED CONSENT

The patients' written informed consent was obtained from parents.

ACKNOWLEDGEMENTS

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Data are available from the authors upon reasonable request.

REFERENCES

1. Chapman DA, Stampfel CC, Bodurtha JN, et al. Impact of co-occurring birth defects on the timing of newborn hearing screening and diagnosis. *Am J Audiol*. 2011;20:132-139.
2. Borton SA, Mauze E, Lieu JE. Quality of life in children with unilateral hearing loss: a pilot study. *Am J Audiol*. 2010;19:61-72.
3. Meyer C, Witte J, Hildmann A, et al. Neonatal screening for hearing disorders in infants at risk: incidence, risk factors, and follow-up. *Pediatrics*. 1999;104:900-904.
4. American Academy of Pediatrics, Joint Committee on Infant Hearing. Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs. *Pediatrics*. 2007;120:898-921.
5. Chary G, Manjunath MK, Channakeshava TA, Shadab MD. Factors influencing delayed presentation of congenitally hearing impaired children in Rural India. *Indian J Otolaryngol Head Neck Surg*. 2012;64:330-332.
6. Martínez-Pacheco MC, Ferrán de la Cierva L, García-Purriños FJ. Delayed diagnosis of childhood deafness: the value of false negatives in the Programme for Early Detection of Neonatal Hearing Loss. *Acta Otorrinolaringol Esp*. 2016;67:324-329.
7. Saunders GH, Frederick MT, Silverman SC, et al. Hearing screening in the community. *J Am Acad Audiol*. 2019;30:145-152.
8. Clemens CJ, Davis SA, Bailey AR. The false-positive in universal newborn hearing screening. *Pediatrics*. 2000;106:E7-e7.
9. Lam M, Wong E, Law CW, Lee H, McPherson B. Maternal knowledge and attitudes to universal newborn hearing screening: Reviewing an established program. *Int J Pediatr Otorhinolaryngol*. 2018;105:146-153.

10. Audiology Division, Chinese Otorhinolaryngoglogy Head and Neck Surgery Society, Chinese Medical Association; Editorial Board of Chinese Journal of Otorhinolaryngoglogy Head and Neck Surgery. Guidelines for examination of and intervention for infants and young children's hearing. *Chin J Otorhinolaryngol Head Neck Surg*. 2009;44:883-887.
11. Akinpelu OV, Peleva E, Funnell WR, Daniel SJ. Otoacoustic emissions in newborn hearing screening: a systematic review of the effects of different protocols on test outcomes. *Int J Pediatr Otorhinolaryngol*. 2014;78:711-717.
12. Sun JH, Li J, Huang P, et al. Early detection of hearing impairment in high-risk infants of NICU. *Chin J Pediatr*. 2003;41:357-359.
13. Xia YF, Liu CQ, Li HX, Su JZ, An HB. Investigation of risk factors for hearing impairment in premature infants. *Chin J Contemp Pediatr*. 2013;15:1050-1053.

How to cite this article: Zeng Q-x, Luo R-z, Yan S-b, Tang Y-q, Wen R-j, Liu W-l. Screening strategy and time points for newborn hearing re-screening with high risk factors. *World J Otorhinolaryngol Head Neck Surg*. 2022;8:257-261. doi:10.1016/j.wjorl.2020.09.002