



The effectiveness of the promotion of newborn hearing screening in Taiwan



Chih-Ming Huang^a, I-Ying Yang^{b,c}, Ying-Chuan Julie Ma^d, Grace Su-Feng Lin^d,
Cheng-Chien Yang^{e,f}, Hsen-Tien Tsai^f, Hung-Ching Lin^{e,f,g,*}

^a Department of Otolaryngology, Mackay Memorial Hospital, Taitung, Taiwan

^b Graduate Institute of Audiology and Speech Therapy, National Kaohsiung Normal University, Taiwan

^c Department of Otolaryngology, Taipei Medical University Hospital, Taiwan

^d Children's Hearing Foundation, Taiwan

^e Department of Audiology & Speech Language Pathology, Mackay Medical College, Taipei, Taiwan

^f Department of Otolaryngology, Mackay Memorial Hospital, Taipei, Taiwan

^g Department of Medicine, Mackay Medical College, Taipei, Taiwan

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ABSTRACT

Objective: Hearing is a critical ability for the development of a child's speech and language. Many studies in different countries have shown the universal newborn hearing screening and early intervention has greatly reduced the negative impact caused by congenital hearing loss. The first universal newborn hearing screening program in Taiwan took place in MacKay Memorial Hospital in 1998 and was subsequently endorsed by the government. The incidence of bilateral congenital hearing impairment in Taiwan is approximately 2.6 per 1000 live birth. The aim of this paper is to analyze the age of diagnosis, hearing aid fitting, and intervention of congenitally hearing impaired children with and without hearing screening after public awareness and government endorsement of newborn hearing screening.

Materials and methods: There were 263 hearing impaired children participated in this study, receiving their auditory habilitation therapy at Children's Hearing Foundation from 2006 to 2010. 114 of those children went through newborn hearing screening and 149 without it. The age of diagnosis, hearing aid fitting, and auditory intervention were compared between these two groups. The age of diagnosis and intervention of congenitally hearing impaired children among different years were analyzed too.

Results: The average age of diagnosis was 8.7 months, the age of hearing aid fitting was 12.4 months and age of auditory intervention was 18.8 months for the group of hearing impaired children with newborn hearing screening. For hearing impaired children without newborn screening, their average age of diagnosis was 27.5 months; age of hearing aid fitting was 31.3 months and age of auditory intervention was 40.5 months. There were significant differences in the age of diagnosis, hearing aid fitting and auditory intervention between congenitally hearing impaired children with and without hearing screening.

Conclusions: This research indicates that newborn hearing screening facilitates early identification, diagnosis and intervention of congenitally hearing impaired children in Taiwan. The age of identification, diagnosis and intervention of congenital hearing impaired children has also been reduced gradually over the years after government endorsement of newborn hearing screening in Taiwan.

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1. Introduction

The rapid improvement in technologies has made it possible to have a better and more cost-effective newborn hearing screening

tool that is easier to implement and demonstrate greater accuracy in the test results [1]. The importance of universal early diagnosis and early intervention in reducing the negative impact of congenital hearing loss has also been demonstrated [2,3]. This has also been shown in Mandarin-speaking deaf children [4]. The negative impact of congenital hearing loss could be language and speech delay. Due to several studies regarding the importance of universal newborn hearing screening and benefit of early intervention for congenital hearing-impaired children, Joint Committee on Infant Hearing (JCIH) of U.S. in 2007 [5] and American Academy of Pediatric (AAP) in 2008 [6] both recommend

* Corresponding author at: Department of Audiology and Speech language pathology, Mackay Medical College, No.46, Sec. 3, Zhongzheng Rd., Sanzhi Dist., New Taipei City 252, Taiwan.

Tel.: +886 2 25433535/2209; fax: +886 2 25433642.

E-mail address: hclin59@ms29.hinet.net (H.-C. Lin).

newborn hearing screening (NHS) should be conducted as early as one month, confirmation of its congenital hearing loss should be achieved in three months and their intervention and rehabilitation plans should be begun as early as six months. Initiation of NHS program in Taiwan started in 1998 using TEOAE [7]. Mackay Memorial Hospital and the Children's Hearing Foundation established a pilot hospital-based program for universal newborn hearing screening (UNHS) at Mackay Memorial Hospital in November 1998 [7]. Community-based NHS program in southern Taiwan was also developed in 2000 using DPOAE [8]. During 2003–2013, there were three major stages of promotion of UNHS in Taiwan by Bureau of Health Promotion (the health headquarter of government). These included (1) establishment of “2004 The Guidance of newborn hearing screening” (using OAE or aABR at parent's own expense) for public awareness of the importance of UNHS and for guiding maternity hospitals to do UNHS, (2) documentation of “2008 Taiwan newborn hearing screening consensus document” (using aABR to reduce false-positives, still at parent's own expense) for further public awareness of the importance of UNHS and to conduct maternity private clinic to do UNHS, and (3) the implementation of free national program of UNHS since 2012 (using aABR, at government expense, free of charge to parents). In Taiwan, the former stage of NHS using OAE or aABR at parent's own expense, the consent of the parents was needed prior to the babies with NHS. In the later stage of free national program of UNHS using aABR since 2012, at government expense, free of charge to parents, the babies were automatically enrolled in the UNHS without the consent of the parents.

The baby coverage rate of newborn hearing screening in Taiwan in 2002 was estimated to be about 10% [9], and it had increased to 50% in 2007–2008 and about 90% in 2012 [10]. The benefit of the promotion of newborn hearing screening in early identification and intervention of congenital hearing impaired children were ever demonstrated in different countries, such as: Singapore [11], Germany [12] and U.S. [13]. The aim of this study was to assess its effectiveness of the promotion of newborn hearing screening program in Taiwan. We will compare their average age of hearing loss confirmation, hearing aid fitting and intervention with aural habilitation between congenital deaf children with NHS and without it.

2. Materials and methods

During 2003–2013, there were three major stages of public promotion of UNHS in Taiwan by Bureau of Health Promotion. These included (1) establishment of “2004 The Guidance of newborn hearing screening” (using OAE or aABR at parent's own expense) for public awareness of the importance of UNHS and for guiding maternity hospitals to perform UNHS, (2) documentation of “2008 Taiwan newborn hearing screening consensus document” (using aABR to reduce false-positives, still at parent's own expense) for further public awareness of the importance of UNHS and to conduct maternity private clinic to do UNHS, and (3) the implementation of free national program of UNHS since 2012 (using aABR, at government expense, free of charge to parents). During these periods of public promotion of UNHS in Taiwan, many congenital deaf children were identified. We analyzed their successive change of three related age (of hearing loss confirmation, hearing aid fitting and auditory rehabilitation) among different born years from 1997 to 2008 to assess the effectiveness of promotion of UNHS in Taiwan.

All hearing-impaired children (born from 1997 to 2008) enrolled into the auditory-verbal therapy (AVT) program of Children's Hearing Foundation (CHF) from January 2006 to March 2010 were collected for our study by the cooperate effort between the study project sponsored by Bureau of health promotion

(Department of health, Taiwan) and the Children's Hearing Foundation [10]. The study data was got from the confidential file of Children's Hearing Foundation via the collaborative program between it and the Bureau of health promotion with sufficient ethical consideration. The mission of CHF is “In the 20 year' time virtually all of Taiwan's deaf and hearing-impaired children will be able to listen and speak” [14]. The objective of the CHF is to develop hearing impaired children's listening and speaking capabilities through the approach known as auditory-verbal therapy (AVT). CHF received clients with confirmed or suspected congenital deaf children referred from other hospitals. Some of referred congenital deaf children had been fitted with hearing aid and were arranged for AVT soon. CHF also can provide hearing aid service for these without it before AVT. CHF is the only organization worldwide that has introduced auditory verbal therapy into Mandarin in Taiwan. It is also the only organization experienced in applying the theory and practice of Mandarin AVT to hearing impaired children in Mandarin speaking countries [14]. CHF had served more than 2500 hearing-impaired children and their families via four branches service areas including northern, southern and eastern Taiwan. CHF is therefore the most known auditory rehabilitation center for hearing impaired children in Taiwan. It is estimated that Children's Hearing Foundation (CHF) had provided deaf education service to more than half of congenital deaf children in Taiwan. The study of Children's Hearing Foundation (CHF) subjects nearly can reflect the current status of UNHS in Taiwan.

A total number of 263 congenital hearing impaired children were included in our study. Among these children, there were 114 with NHS and 149 without it.

SPSS17.0 was used for statistical analysis. Independent samples and *t*-test were used to compare the age of diagnosis and intervention between congenital deaf children with and without NHS. ANOVA single factor variable analysis was used to compare the age of diagnosis and intervention of congenital hearing loss children among different years from 2000 to 2008. We will also compare our results with different countries in Asia, Europe and America to analyze the effectiveness of promotion of NHS around the world.

3. Results

All these 263 hearing-impaired children were born from 1997 to 2008 (Fig. 1). The incidence of having NHS among all the subjects by different birth year is shown in Fig. 2. Among the total of 263 hearing impaired subjects, their average age of hearing loss confirmation was 19.72 months. Their average age of hearing aid fitting was 22.98 months. Their average age of intervention with aural habilitation was 31.30 months.

The age of diagnosis, hearing aid fitting and start of intervention between congenital deaf children with NHS and without it is shown in Fig. 3.

Independent samples and *t*-test were used to compare the age of hearing loss confirmation between 114 hearing impaired children with NHS and 149 without it (Fig. 3). The average age of hearing loss confirmation was 8.69 months ($N=98$) for the subjects with NHS and was 27.50 months ($N=139$) for those without it. There was a significant difference in the average age of hearing loss confirmation between the hearing-impaired children with NHS and those without it ($t=-9.430$, $p=.000$). The average age of hearing aid fitting was 12.35 months ($N=105$) for the subjects with NHS and was 31.30 months ($N=134$) for those without it. There was also a significant difference in average age of hearing aid fitting between the hearing-impaired children with NHS and those without it ($t=-9.143$, $p=.000$). The average age of auditory habilitation was 18.75 months ($N=114$) for the subjects

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