ORIGINAL ARTICLE

Results of an Early Hearing Detection Program

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Received 24 February 2012; accepted 10 July 2012

KEYWORDS

Neonatal hearing loss;
Early detection;
Deafness

PALABRAS CLAVE

Hipoacusia neonatal;
Detección precoz;
Sordera

Abstract

Introduction and objectives: Neonatal hearing loss is a public health problem that meets the requirements for submission to universal screening. Our objective was to analyse the results of the early hearing detection and intervention program implemented at our centre between January 2007 and December 2010.

Methods: We studied 26,717 newborns during the period mentioned, using transient otoacoustic emissions (TOAEs) for the screening. The diagnostic phase was carried out at the hearing loss department.

Results: In our area, there were 27,935 births between January 2007 and December 2010. The screening was performed on 26,717 children. Of these, 24,173 had positive TOAEs, 1040 had no TOAEs and 1504 presented TOAEs in 1 ear with absence of TOAEs in the contralateral ear. Risk factors associated with hearing loss were found in 4674 infants. In a second phase of the program, TOAEs were given to 5156 children, of whom 4626 had positive otoacoustic emissions in both ears, 323 had no TOAEs in 1 ear and 207 failed this second phase. Of all children studied, 3.8% were referred to auditory brainstem response (ABR) testing and 26 children entered the cochlear implant program. The program achieved a coverage of 95.6%.

Conclusions: The early hearing detection and intervention program at our hospital is suitable for our environment, achieving 95.6% of coverage. We consider the relationship between effectiveness and efficiency to be positive.

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Resultados de un programa de detección precoz de la hipoacusia neonatal

Resumen

Introducción y objetivos: La hipoacusia neonatal es un problema de salud pública que cumple los requisitos para ser sometido a cribado universal. El objetivo de este artículo es analizar los resultados obtenidos en el Programa de Detección Precoz de la Hipoacusia implementado en nuestro centro desde enero de 2007 hasta diciembre de 2010.

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Introduction

Hypoacusis or hearing loss is one of the most common sensory alterations.\(^1\) In addition to being a pathology that meets all the requirements for universal screening, its early diagnosis and intervention enables an appropriate evolutionary, educational, emotional and communicative development.

The incidence of deafness at birth is much higher than that of other congenital diseases.\(^2\) According to data collected by several studies conducted in Spain,\(^3\) the United States\(^4\) and England,\(^5\) the incidence of permanent hearing loss is 1–3 per 1000 newborns. In Spain, this represents about 1900 children per year, with over 90% being born into families whose parents have normal hearing. Moreover, risk factors associated with hypoacusis can be identified in a high percentage of newborns.\(^6\)

At present, early detection of neonatal deafness is conducted at many health services of the different Spanish regions.\(^7\) The aim of this work is to analyse the results of the screening programme for hearing loss implemented at our hospital complex between January 2007 and December 2010.

Methods

Our programme for early detection of hearing loss is based on a universal screening system in 2 phases (Fig. 1). We studied all newborns at our hospital complex, thus working on an average 6900 births per year.

The first exploration was conducted at the maternity ward in the first 48h of life. The technique employed was the detection of transient otoacoustic emissions (TOAE) through automated and portable devices (Echo-Screen\(^8\)).

The criteria required to "pass" the screening was to present TOAE in both ears. In this case, the newborn was discharged from the screening programme. However, even with positive TOAE, children exhibiting any associated risk factors were moved to the second phase. Newborns without risk factors who did not "pass" the screening with both ears were also referred to the second phase of the protocol.

In the second phase, TOAE were conducted using inter-acoustic and intelligent hearing systems. Children without risk factors associated with hearing loss who "passed" this second phase were discharged. Those cases that did not "pass" the test with both ears were referred to the hearing loss unit for diagnosis and monitoring, regardless of whether or not they presented any risk factors for hypoacusis.

In cases where children did not "pass" with one ear, they were referred to the area specialist physician for monitoring.

Parents of children who "passed" the second phase but who presented a risk factor were given a follow-up questionnaire (Tanaka test), and a review appointment at 12 months of age. If this second test was normal they were discharged, but if there still remained a suspicion of hearing loss they were despatched to the hearing loss unit.

The hearing loss unit performed the control and monitoring of all patients referred from the early screening programme using auditory brainstem responses (ABR) and auditory steady-state responses (ASSR). This included cases presenting risk factors for retrocochlear hearing loss, which underwent these tests despite having "passed" the TOAE test in order to avoid false negatives associated with the existence of an auditory neuropathy.

The data for each newborn and the results of the examinations performed during the different stages were recorded in a computer programme developed for the early detection of hearing loss, which managed the monitoring, control and recovery of patients included in any of its phases.

Results

A total of 27,935 children were born during the period between January 2007 and December 2010. During this same
period, we studied a total of 26,717 newborns, thus representing coverage of 95.64% of the total live births at our centre.

A total of 24,173 children "passed" the first phase (Fig. 2), whilst 1040 newborns did not "pass" (Fig. 3). The mean age at which the first phase of the screening test was performed was 5 days. Those born on weekends or holidays underwent the screening test after consultation.

In total, 4674 children presented risk factors associated with hearing loss, thus corresponding to 17.49% of all newborns studied (Fig. 4), with the most common risk factors being direct or indirect exposure to ototoxic agents (2992 children), family history of hearing loss in childhood (857 children) and hyperbilirubinemia (704 children). In the second phase of the programme we studied a total of

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**Figure 1** Flow diagram used in the programme for early detection of hypoacusis at our hospital complex.

**Figure 2** Children who "passed" the first phase in relation to the total number of newborns studied.

**Figure 3** Children who "did not pass" the first phase in relation to the total number of newborns studied.

**Figure 4** Children with risk factors associated to hypoacusis in relation to the total number of births.
5156 children, of whom 4626 ‘‘passed’’ the test. A further 207 subjects did not ‘‘pass’’ the test and 323 children only ‘‘passed’’ it for 1 ear. The mean age in this phase was 52 days.

In the diagnostic phase, the percentage of referrals for ABR was 3.8%. Of the total patients studied in this time period, 22 children were diagnosed with bilateral, profound, sensorineural hearing loss and underwent implantation at ages between 9 and 16 months, whilst a further 4 children are currently in the cochlear implantation programme.

The rate of case losses occurring during the first phase was 2.9%, due to the refusal of parents to carry out the test, hospital discharges or children born on weekends or holidays who later did not attend the scheduled consultation, as well as children of immigrants who were unreachable according to data provided by their parents.

Discussion

Hearing loss does not only cause permanent effects on oral language development, but may also have implications in the evolutionary, educational, emotional and social development of children.8 It has been shown that early intervention in hearing loss results in correct language acquisition,9-11 thus taking advantage of the period of brain plasticity in the early years of life. Therefore, early and universal screening is the only reasonable strategy for early detection of hearing loss in infancy.12

Three scientific committees, the Joint Committee on Infant Hearing Position Statement, the Commission for Early Detection of Hearing Loss (CODEPEH) and the European Consensus Statement on Neonatal Hearing Screening, have advocated the use of objective tests in screening programmes, with the more widespread being TOAE and automated auditory evoked potentials (aAEP).13,14

Our screening programme is universal and in 2 stages, thus reducing the proportion of possible false positives. We reached 95.6% coverage, referring 3.8% of newborns to the diagnostic phase. These values were highly satisfactory considering the recommendations of CODEPEH15 and the American Academy of Paediatrics.16

Computerized storage and monitoring of data are essential to track children in any phase of the programme, enforce quality checks and assess whether or not the desired objectives are fulfilled.10-17

It is considered appropriate for the diagnosis of hearing loss to take place within the first 6 months of life, in order to meet the ultimate goal of a screening programme for early detection of deafness, which is early intervention and initiation of rehabilitation in this age, by including candidates within a cochlear implant programme.

Conclusions

- The programme for early detection of hearing loss at our hospital complex is a universal screening programme in 2 phases which, during the study period, achieved coverage values above 95%. This implies a positive relationship between effectiveness and efficiency.
- The percentage of referrals to the diagnostic phase was below the recommendations of CODEPEH.
- The diagnosis of hearing loss took place within the first 6 months of life. Patients with profound sensorineural hearing loss were included in a cochlear implant programme.

Conflict of Interests

The authors have no conflict of interests to declare.

References

15. Marco J, Almenar A, Alzina V, Bixquert V, Jaudenes MC, Ramos A. Control de calidad de un programa de detección,
