Acta oto-rhino-laryngologica belg., 1996, **50**, 203-209

Neonatal hearing screening with otoacoustic emissions : an evaluation

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Key words. Neonatal hearing screening ; otoacoustic emissions

Abstract. *Neonatal hearing screening with otoacoustic emissions : an evaluation.* For several years now, it is possible to test the cochlear function immediately after birth in an easy way by means of click evoked otoacoustic emissions. Thanks to this early detection, hearing aid fitting and appropriate hearing rehabilitation can now be started at a very young age, which significantly enhances the possibility of integration of the congenitally hard of hearing in society. An international consensus is growing to endorse a universal neonatal hearing screening in western societies. Setting up screening programs necessitates good preparation, continuous quality control and regular analysis of procedures and results. The present paper evaluates the procedure as organised from January 1993 till December 1994 in the University ENT-Department of the Sint-Augustinus Hospital. Of the 907 included neonates who were considered not to be at risk for hearing loss, 81% passed the test immediately, and 93% passed after maximum 3 tests. Some changes in the initial procedure increased the prevalence of emissions from 69% to 84%. The practical problems of the screening program and especially the importance of a stringent follow-up procedure in case of failure, are discussed.

Introduction

Epidemiological studies teach us that the incidence of congenital bilateral neurosensory deafness in Western countries can be placed between 1/1000 and 1/2000. Less acute hearing loss undoubtedly occurs more at the rate of 1.5 to 6 neonates per 1000 (1, 2, 5). The effect of such disorders on the speech and language development of the child and on the social and professional situation is important. Because of auditory deprivation, learning processes become severely hampered. The influence is not only evident in the learning of speech and language. Because written and spoken language are the most important means in our society for the transfer of knowledge, hearing loss also influences the social, emotional and cognitive development. Detection, equipment and follow-up before the age of 6 months, are essential to obtain optimum development (3).

For the moment, screening in Belgium is carried out by means of the Ewing test, which is performed at the age of about 9 months by the Well Baby Clinics. This form of screening has been applied since 1976 and has the great distinction of having made possible the first structured detection. The greatest disadvantage is the lateness in terms of equipment. Another problem is the relatively limited epidemiological coverage ; only 78% of the fractionalised number of births was screened in 1993. This, however, is not a problem typically related to Ewing, rather a problem of every screening examination which is not carried out during maternity. The problem of follow-up is similar in nature ; parents are encouraged to repeat the Ewing test or to investigate further, but they do not always respond to this or possibly do not inform the Well Baby Clinic of the results. Therefore follow-up is lacking in 30% of children who failed a maximum of 3 Ewing tests during the

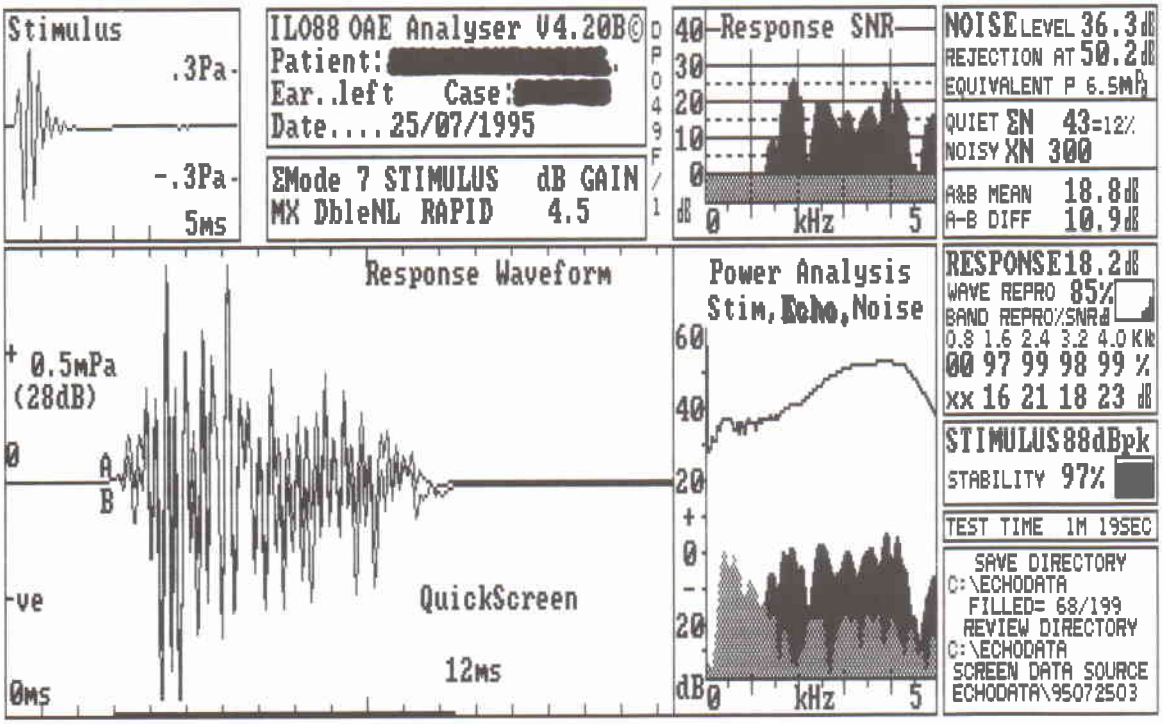

Fig. 1

Print-out of the computer screen of the ILO 88. In the window "stimulus" we observe a representation of the sound measured by the microphone of the probe. The window "power analysis stimulus" shows the frequency spectrum of the stimulus. Below this the response is depicted. In this window we can see by how many dB the stimulus exceeds the noise level (S/R ratio) for each frequency band, with centre frequencies 0.8, 1.6, 2.4, 3.2 and 4.0 kHz (stimulus = black ; noise level = grey).

could, in exceptional cases, last longer than a quarter of an hour.

The neonates were tested in a sound-proof cabin or a quiet room at the Audiological Centre of the University ENT department. The neonates were mostly brought to the test location by their mothers, about one and a half hours after feeding.

The opportunity to apply for an examination by otoacoustic emissions was given to the parents of every new-born child by means of a letter, which gave a brief explanation and included a simple registration slip. Newly-born children admitted to neonatology were systematically tested but, because they form another target group, they were not taken into consideration for the purpose of this paper.

From January until April 1993 the examination took place immediately after registration. From May 1993 emissions were systematically tested on the last working day before leaving hospital. This means that, at the earliest, the neonates were tested at the age of three days. This change in the procedure was important. In the rest of the report reference will be made to periods 1 and 2.

Until the end of 1993 the presence of emissions was assessed on the basis of a qualitative evaluation from the Fourier spectrum. A criterion was established that for frequencies between 1 and 4 kHz the average emission response had to significantly exceed the noise level. From February 1994 onwards, the new software (version 3.94) was at our disposal. With this, the signal to noise ratio (S/R ratio) in different frequency bands can be determined and thus the application of a numeric criterion became possible. We concluded that OAE's were present if in the case of the three frequency bands with centre frequencies 2.4 kHz, 3.2 kHz and 4 kHz, the S/R ratio exceeded 6 dB. Because in the frequency band

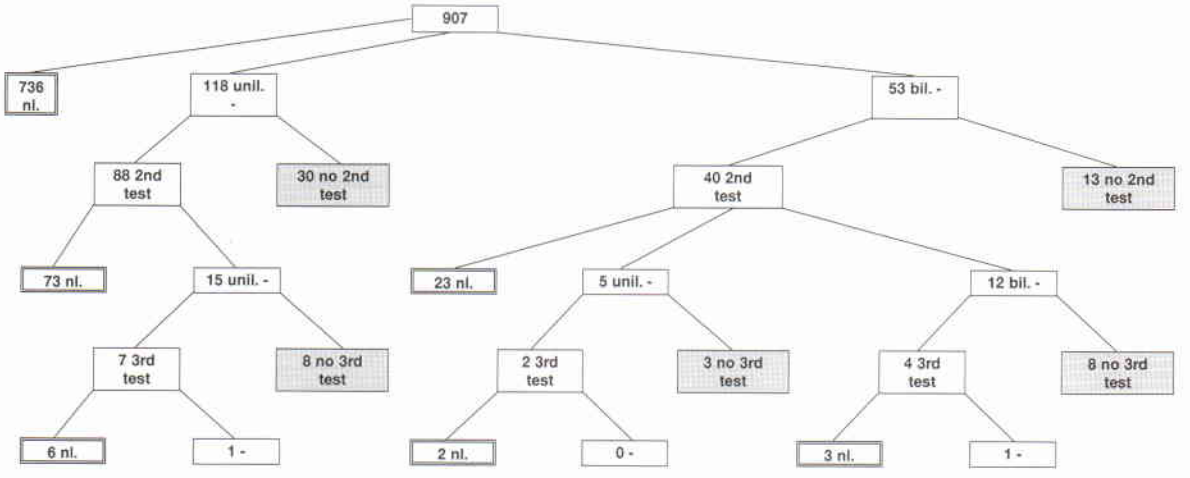

Fig. 2

Results of the first OAE examination and of the follow-up examinations of failures. viz : presence of OAE's, unil- : unilateral absence of OAE's, bil- : bilateral absence of OAE's. The shaded blocks indicate possible problem cases which were lost to further follow-up. A double frame indicates the final presence of OAE's and thus indicates normal hearing.

persistent bilateral emission failure was followed-up : it was a case of persistent glue. After the placing of diabolos a BERA was carried out, which showed normal levels.

The number of failures at the first test amounted to 171. This includes 118 unilateral and 53 bilateral failures. Of the 118 unilateral failures, 32.2% received no follow-up (4.2% of the total population of 907 neonates). Of the 53 bilateral failures, the number of neonates without follow-up was much higher, i.e. 45.3% (2.6% of the total population).

We must mention that three of those neonates who bilaterally failed the first test, failed unilaterally at the second test. This brings the actual percentage of bilateral failures without follow-up after the first or second failure to 39.6% (2.3% of the total population), and the percentage of unilateal failures without follow-up after the first or second failure to 34.7% (4.5% of the tested population).

Of the 907 neonates, 6.8% received no complete follow-up after failure in the first or second OAE examination.

Finally, this means that, after 2 or 3 tests, OAE's were present in 93% of the tested population.

Table 2 summarises the results after a maximum of 3 tests.

Discussion

About 2400 children are born annually in the Sint-Augustinus Medical Institute. Since 1993, the parents have been given the chance to have the hearing of their neonates tested. Since 1994 this has taken place systematically for children attending the neonatology department and whom we consider to be "children at risk". This group is not taken into consideration in the present report. Our population is not therefore representative of the total population of newly born infants. For this reason the incidence of hearing problems referred to in this report, is possibly lower than the incidence in the total neonatal population.

After childbirth, mother and child generally remain in hospital for about five days. In the first phase of our project, a hearing examination was arbitrarily planned during that week. Because there were indications that OAE's could probably only be detected a few days after the birth (7), hearing examinations in the second phase of the project were planned on the last working day of the hospitalisation period. Moreover, the interpretation of the results became more certain, thanks to the new software described in "Material and Method". These modifications, together with the

the timing. Various authors have already stressed the importance of early detection (3).

Utilization of OAE's makes it possible to test neonates in a non-radical, simple and reliable way, so that the treatment of children with hearing disorders can start between the ages of 3 and 6 months. It is clear that the impact of the hearing problem can be reduced by dealing with it at an early stage and a child with hearing disorders has, in that case, a much greater chance of integrating into society. In some states of the USA the right to undergo a hearing screening is established by law. In our present study of 907 neonates, there were no bilaterally handicapped hard of hearing, but since then, some have already been detected and helped by fitting hearing aids and providing treatment before the age of 6 months.

The development of hearing apparatus as well as traditional apparatus such as the Cochlear implant is evolving rapidly. Early stimulation of the hearing nerves so as to obtain an optimal organisation in the auditive cerebral cortex, is of the utmost importance.

Whether hearing screening of all neonates is justified is a good question. Although this is a political and not a medical question, we would like nevertheless to raise one or two points which may generate discussion on the subject. Medical science utilises all the means at its disposal to give the maximum opportunity of social integration to the hard of hearing. This objective has still not yet been achieved. The hard of hearing still face enormous difficulties to integrate socially and to avoid being relegated to the "alternative" social group of the "deaf and hard of hearing", where although they are surrounded by well-intentioned care, they become isolated from society with good hearing. Fortunately, science is making great progress, both in the diagnostic field (e.g. genetic examination of deafness), and in the therapeutic field (e.g. Cochlear implantation). Early detection leads to early therapy and we are becoming more and more aware that the earlier the therapy, the greater the chance of social integration. In Belgium there are still too many children in whom congenital hearing loss is only detected at the age of 2 or 3 years. In the present state of science and social welfare, this can no longer be morally justified.

Acknowledgements

The authors wish to thank the pediatricians and nursing staff of the pediatric and neonatology departments of the Sint-Augustinus hospital for their very willing cooperation and also R. Windmolders, E. Desaeger and H. Stuelens for the extensive fieldwork that they carried out within the structure of their dissertations to the Logopedic and Audiology department of the Katholieke Vlaamse Hogeschool of Antwerp.

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