Cost estimation of universal neonatal hearing screening in Tirana district

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Abstract

Aim: The aim of this study was to estimate the costs of Neonatal Hearing Screening Program in Tirana District hospitals, where Otto Acoustic Emissions (OAE) tests and Auditory Brainstem Response (ABR) testing are used, and to compare these costs with the total budget of the respective hospitals where these procedures are implemented.
Methods: The cost of congenital hearing loss screening per child was estimated based on the retrospective economic analysis from the birth cohort of children enrolled in Tirana District, part of Universal Neonatal Hearing Screening (UNHS) program during year 2011, which was supported by the Italian Cooperation. The data were collected at three participating institutions, two maternity hospitals and the University Hospital Centre in Tirana.
Results: During the year 2011, the prevalence of permanent hearing impairment was 2.3 cases per 1000 births. The cost per detected case with TEOAE was about 810 ALL and the overall expenditure for OAE screening of all the newborns was only 1.07% of the annual total budget of the maternity hospital. The cost of the diagnostic test (ABR) was 6,023 ALL or 0.01% of the budget of Infantile Surgery Department. The cost per detected case was 495,232 ALL.
Conclusion: The cost per detected case of permanent hearing loss as part of the Universal Neonatal Hearing Screening (UNHS) in Tirana district hospital is lower than the global estimates, mainly because of the low cost of the medical staff.

Keywords: cost, hearing loss, screening, universal neonatal hearing screening.

Introduction

Congenital hearing loss is the most frequent disorder detected immediately after birth, and its prevalence is highest among the children of school age due to the late diagnosis of the hearing loss and the acquired hearing loss. The definition of hearing loss refers to hearing loss over 40 dB in the ear with the higher level of hearing in adults, and hearing loss more than 30 dB in the ear with the higher hearing level in children. According to the World Health Organization (WHO), the overall prevalence of congenital hearing disorders is 1-3 per 1,000 live births and the prevalence among high risk groups is estimated to be ten times higher (1).

The low early detection rate and the lack of proper management of hearing loss in children have an impact on the individual educational, cognitive and social development. The objective of early detection of hearing loss is to achieve maximal perception of speech and basic language skills (1,2).

One of the main impacts of hearing loss is the inability to communicate with others, with major negative consequences on children's school performance and a significant impact on their daily life, causing feelings of loneliness, isolation, and frustration (3).

Large neonatal hearing screening programs have been initiated over the last years in several countries of the European Union, in the United States and in many other countries (4).

According to the Joint Committee for Infant Hearing, early identification can now be defined as a diagnosis as early as three months of age, with intervention by the age of six months (5).

The negative impacts related to the lack of sound stimulation during the first two years of life are almost impossible to improve later with rehabilitation efforts. When the diagnosis of hearing loss is made immediately after birth and these children receive intervention (prostheses) early, by the age of 6 months, there is a reduction on the cost of education more than for those with partial hearing loss (6,7).

Economic impact of the hearing loss

In a study conducted in 2000, the costs of rehabilitation, special education and unemployment or part time employment as a result of hearing and speech disorders, were estimated to be about 3% of the gross product in the US (8).

The CDC (Center for Disease Control) and the RTI International (Research Triangle Park International, North Carolina) estimated that the lifetime costs (in dollars) were $383,000 for each person with hearing loss, with a projection of $1.9 billion in total for all people with hearing loss. Total direct costs were estimated to be about 601 million $ (9).

Recently, CDC conducted a multicenter study in which the costs of newborn hearing screening were estimated in six different centres in six states. The cost per baby ranged from about $18 to $26, with TEOAE sites being less expensive (10).

A similar study was done at Logan Regional Hospital as reported by Weirather and her colleagues. The cost per baby was substantially cheaper ($7.42 per baby) (10).

A study conducted in Germany found out that at the age of six months (the screening was not carried out) the risk screening, when is compared to universal screening, appears to be insufficient considering the importance of early diagnosis and capture. The cost per case of detected congenital disorders was estimated to be €13,395 for U-screening, €6,715 for R-screening, and €4,125 for no screening (detected when they were symptomatic) (11).

Is screening safe, reliable and possible?

The European Consensus Development Conference on Neonatal Hearing Screening estimated the costs per screened child and detected case in the first six months of life and the costs of treatment in the first 12 months of life as €7-36 and €3-13 respectively (4).

Meanwhile, a final study of costs of screening was reported by John Stevens and his colleagues for several different hearing screening programs in the UK. Results ranged from an average of about $8

per baby born for the high-risk programs to $22 per baby for the universal newborn hearing screening programs to $32 per baby for the home-visitor programs (12).

In Albania, the procedure of the universal newborn hearing screening is not applied yet in the maternity hospitals or elsewhere. During the time period 2009-2011, a pilot project on neonatal hearing screening was supported by the Italian Cooperation. The screening procedures involved all newborns at Tirana's maternity hospitals "Queen Geraldine" and "Koço Gliozheni". After being tested with TEOAE, all babies who resulted FAIL/REFER were followed up by pediatric ENTs at the pediatric surgery service, at the University Hospital Center "Mother Teresa". Thus, the purpose of this study was to estimate the costs of the start-up phase of the Newborn Hearing Screening Program, which utilized Ottoacoustic Emissions (OAE) testing followed by the Auditory Brainstem Response (ABR) diagnostic testing in Tirana District and to compare these costs with the total budget of the respective hospitals where these procedures were implemented during the year 2011.

Methods

The cost of neonatal hearing screening was estimated based on the retrospective economic analysis of data (direct medical cost) from each step of the Universal Neonatal Hearing Screening (UNHS) protocol in Albania during the year 2011, which was supported financially and logistically by the Italian Cooperation.

The protocol of screening and diagnosis of the congenital hearing loss

A two step protocol was applied based on the position statement of the Joint Committee on Infant Hearing 2007 (1,5).

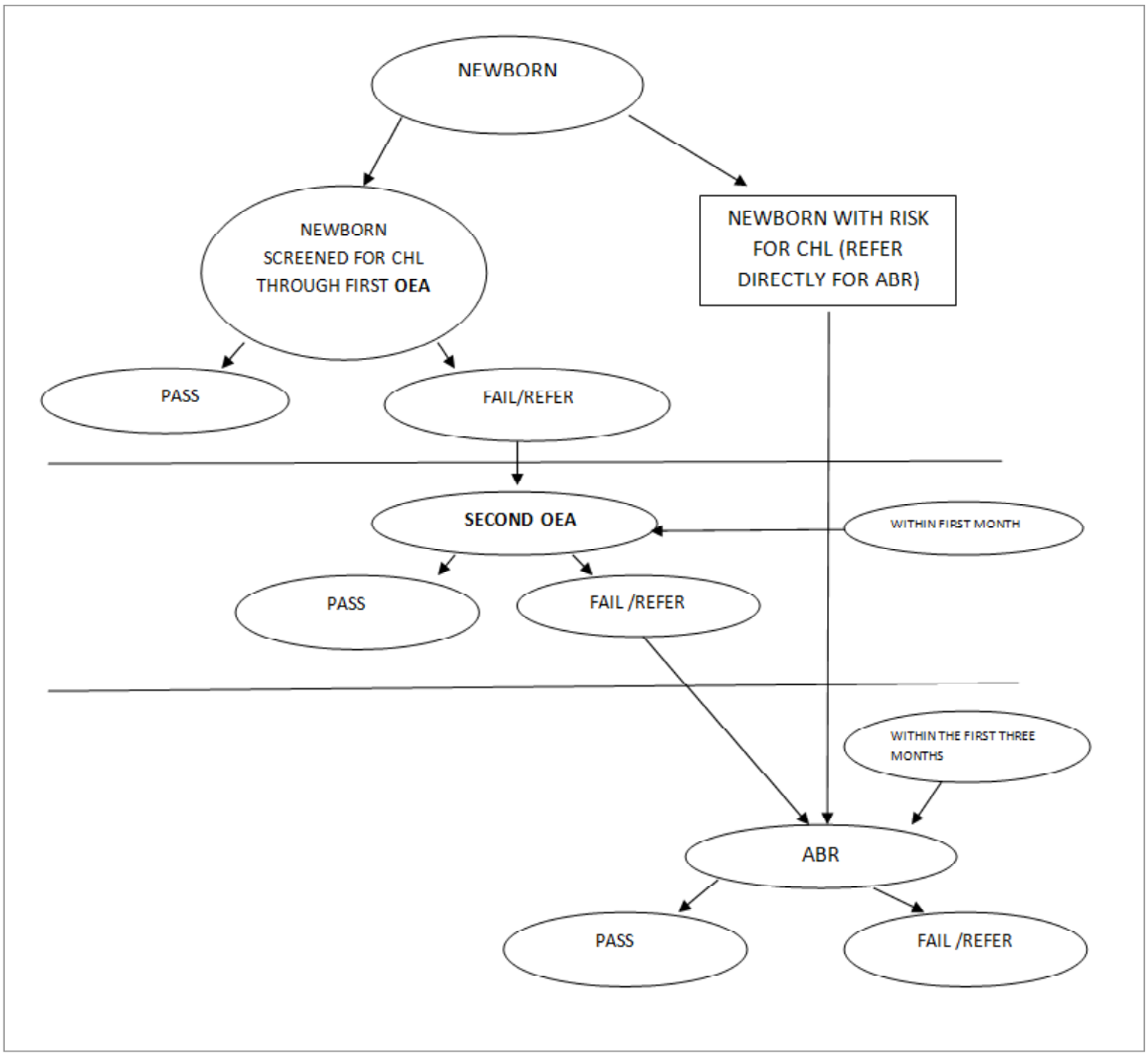
STEP 1

All newborns at the maternity hospitals in the district of Tirana were included. Prior to testing, written educational materials explaining the procedure were given to parents and/or caregivers and consent was obtained. All newborns (with the consent of their parents) were screened before discharge from the maternity centers by use of transient evoked Otoacoustic emissions (TEOAE), which checks the bilateral inner ear response to sound. Testing was performed by using the Maico ERO-SCAN, rechargeable and handheld mobile screening devices. Hearing screening is easy and not painful. In fact, babies are often asleep while being screened. Screening was conducted by well trained nurses in the neonatal unit. The test was considered PASS when the response was present at least in one ear and it was considered FAIL/REFER when it was missing in both ears. These results were communicated by the pediatricians of the neonatal service and the parents of infants who showed "no clear response" on the initial test, were advised to follow up with a recommended second TEOAE within the first month after birth.

STEP 2 (diagnosis confirmation test)

This step included all children who resulted FAIL/REFER in both ears and those with risk factors (infants admitted to the NICU, or who had been hospitalized for more than five days) that were called within three months after birth to undergo the Auditory Brainstem Response (ABR) test which checks the brain's response to sound. Testing was conducted at the pediatric ENT department of the University Hospital Center "Mother Teresa" (UHC). The test was performed using the GSI Audera's device. The child was required to be asleep. After that, a full hearing evaluation was recommended as soon as possible. It was not possible to use the automated auditory brainstem response (aABR) screening in all NICU babies as recommended by the new JCIH 2007 Position Statement. All these children were referred directly to an audiologist to conduct diagnostic evaluations.

Figure 1. Universal screening for congenital hearing loss (CHL) used in the program



Cost estimation

The average direct medical costs were used in this study.

Estimation of direct medical costs includes:

- Cost of physician and nurse compensation based on the mean salary from the respective hospitals;
- Cost of equipment;
- Cost of staff training and informative materials for parents related to the diagnostic tests.

We did not estimate the cost of all diagnostic interventions such as clinical examination, excluded the cost (and benefits) of treatment, and the cost of follow-up of the cases detected.

The most significant portion of costs on both stages was the cost of equipment.

MAICO ERO-Scan devices were used for the TOEA screening in both maternity hospitals. A total of four devices were used, two at each maternity hospital with a price of €8,500/pcs or 1,192,500 ALL (exchange rate of 2011 is 140 ALL/Euro) (13). The cost of the ABR equipment used had a price of 20,000 Euro or 2,806,000 ALL.

Related to the disposables (probe tips, ear tips, electrodes, ear couplers, gloves, etc), the costs were calculated as part of the screening cost and were based on the average prices of purchases from the project.

Equipment and disposable costs were combined with personnel costs in order to get a more complete estimate of the program costs.

Human resource utilization data were also collected. These data included personnel type, time devoted to screening tests, data on administrative staff of the program, costs of the personnel training. In addition, IEC (information, education, communication) materials for parents of all newborns were also considered during the cost estimation. The cost of both physician and nurse who conducted these tests was estimated based on their monthly average salary at maternity hospitals during year 2011 (14) and the mean time of conducting the testing which was 15 minutes for TOEA testing and 25 minutes for the ABR testing. Given that the program was implemented for the first time, training staff by international experts was conducted. All the estimated costs mentioned above are summarized in Table 2.

The cost for every case detected is estimated as follows:

$$\frac{\textbf{Total Cost of screening TOEA + Total cost of diagnosing test (ABR)}}{\textbf{Number of cases detected}}$$

Results

During 2011 the birth cohort was 10,698 for the Tirana District. Table 1 indicates the number of children who were screened and diagnosed for congenital hearing loss during each stage of the protocol.

Table 1. Results for screening and the diagnoses process

Description	OEA	ABR
First stage		
Screened newborns with TOEA	9896 (92.5%)	
Screened high risk newborns with ABR (after first OEA)*		442 (62.07%)
Second Stage		
Screened newborns results Fail/Refer in first OEA†	294 (56%)	
Screened newborns with ABR (cases F/R after second TOEA)		79 (26.87%)
Total number of newborns	**10190**	**521**

*Total number of newborns with high-risk 712.

†Total Number of F/R cases from first TOEA =525 newborns

Only 9,896 of 10,698 newborns were included in the first stage of the screening process with OEA (newborns whose mothers gave the consent to participate).

Newborns who were classified to be at risk for congenital hearing loss had been referred to undergo ABR testing directly by the ENT service at UHC "Mother Teresa" within 3 months of birth. The total number of high risk newborns was 712 of whom only 62.07% followed up and underwent ABR testing.

From 9,184 newborns that underwent OEA testing at maternity hospitals, 525 resulted as "Fail /Refer" and were recommended to return to the maternity hospital within the first month of life for repeat OEA testing. However, only 294 of them presented at the hospital to repeat the test.

Of 294, only 79 of them resulted "Fail/Refer" and were recommended to undergo further testing with ABR by the ENT service at the UHC "Mother

Teresa" within 3 months. In total, the ABR testing was performed in 521 children, 79 children who resulted "Fail/Refer" during the screening step (at first and second OEA testing) and 442 children at risk for congenital hearing loss (of 712 recommended). The prevalence of permanent hearing loss was 2.32 per 1,000 newborns.

Table 2. Estimation of the direct medical costs for screening with TOEA at maternity hospitals

Category cost	Unit	Quantity	Cost/ Unit (ALL)	No. of babies screened	Total (ALL)
Medical Cost					
Salary of medical doctor (mean 76,555 lek/month) (14)	min/baby	5	7.60	10,190	387,220
Nurse Salary (mean 4,.462 lek/month) (14)	min/baby	10	4.21	10,190	428,999
Data management /administration staff (14)	Month	4	44,462		177,848
Equipment					
Equipment of TOEA and ABR	Pcs	4	1,192,805		4,771,220
Computer, printer, etc	set/year	2	130,000		260,000
Screening consumables					
Probes per screen	pcs	10,200	88		897,600
Ear tips	pcs	20,400	40		816,000
Ear couplers	pcs	0			-
Electrodes	pcs	0			-
Rechargeable battery	pcs	4	12,800		51,200
Gloves	pcs	11,000	5		55,000
Disinfectant	pcs	10	700		7,000
Training and Education					
Education, information materials	pcs	102,000	20		204,000
Training of Staff (by international experts)	day	1	196,462		196,462
TOTAL Cost (ALL)					8,252,549
Number of children					10,190
Cost per child screened (ALL)					810
Cost per child screened (Euro)					€ 5.77

Table 3. Estimation of the direct medical costs for screening and diagnosing with ABR at the "Mother Teresa" University Hospital Center in Tirana (pediatric ENT service)

Category cost	Unit	Quantity	Cost/ Unit (ALL)	No. of babies screened	Total (ALL)
Medical Cost					
Salary of medical doctor (mean 76555 lek/month) (14)	min/baby	20	7.60	521	79,192
Nurse Salary (mean 44.462 lek/month) (14)	min/baby	5	4.21	521	10,967
Data management /administration staff (14)	month	1	44,462		44,462
Equipment					
Equipment of TOEA and ABR	pcs	1	2,806,600		2,806,600
Computer, printer, etc	set/year	1	130,000		130,000
Screening consumables					
Probes per screen	pcs	0			
Ear tips	pcs	0			
Ear couplers	pcs	200	140		28,000
Electrodes	pcs	600	60		36,000
Rechargeable battery					
Gloves	pcs	*400*	5		2,000
Disinfectant	pcs	*2*	700		1,400
Training and Education					
Education, information materials					-
Training of Staff (by international experts)					
TOTAL cost (ALL)					3,138,621
Number of children					521
Cost per child screened (ALL)					6,024
Cost per child screened (Euro)					€42.93

Table 2 and Table 3 shows the estimation of the direct medical costs of all the components needed for the implementation of the screening (OAE) and diagnostic testing (ABR).

The time needed for the screening testing (OAE) was estimated to be 10 minutes for the nurse and 5 minutes for the physician, while the time needed for the diagnostic testing (ABR) was estimated to be 5 minutes and 20 minutes for the respective providers. According to the data in Table 2, the cost of performing the OEA testing was 810 ALL, or €5.77 per newborn and the cost of performing the ABR testing was 6,024 ALL, or €42.93 per child. In total, the cost of the OEA testing among all newborns was 8,252,549 ALL and the cost of ABR testing was 3,138,621 ALL.

Taking into consideration costs of both OEA and ABR testing, it was estimated that the cost per one child detected with hearing loss during year 2011 was 495,268 ALL, or €3,529.

The data from the Ministry of Health indicated that the total budget of Maternity Hospital "Queen Geraldine" was 434,694,000 ALL and "Koço Gliozheni" was 335,724,000 ALL. The cost of performing OEA testing for all newborns as a percentage of the total budget of the obstetrical hospitals was about 1.07%. The budget of UHC "Mother Teresa" Infantile Surgery Service, which includes the ENT service, was 112,665,207 ALL and the cost of performing ABR diagnostic testing was about 0.1% of the total budget of this service. Assuming that the participation rate in the screening

process was 92.5% and the cost per each child screened was €5.77, the total cost of screening was estimated to be €5,337 per 1,000 live births in Albania.

Discussion

To the best of our knowledge, this is the first study aiming to estimate the cost of the universal screening for congenital hearing loss (including a two-stage OAE screening, and the ABR for rescreen).

In most Western countries, the prevalence of moderate to very severe bilateral congenital hearing loss in newborns is about one per thousand (1,15). In our study, the prevalence of permanent hearing loss was 2.3 per 1,000 live births (16), which is higher than the incidence encountered elsewhere (1). The Universal Hearing Screening was performed at tertiary maternity hospitals which admit high risk pregnant women from other Albanian regions (at risk for preterm birth or other severe pregnancy conditions). These pathologies are considered to be risk factors for congenital hearing loss thus they result in a higher prevalence of hearing loss.

Regardless, based on the prevalence of hearing loss in countries with similar health system conditions, we expected the prevalence in Albania to be higher than that observed. In a previously conducted study it was concluded that several reasons might be responsible for this finding (16).

First, about 7.5% of newborns didn't participate in the first phase of screening and only 56% of children that resulted "Fail/Refer" in TEOAE did return for ABR testing.

This was in part due to parents' choice not to participate due to limited understanding of the importance of screening stemming from suboptimal health educational / lower socioeconomic status. In other cases parents decided to leave the hospital prematurely (against medical advice) within 24 hours of admission; and there were cases when parents didn't return for re-examination. This was the case not only for the first or second level testing, but also for follow-up and rehabilitation procedures (16).

Secondly, we believe that the exceptionally good performance of our national immunization program and the follow-up done in the mother and child health centers might have improved the overall health status of pregnant mothers and their children.

Moreover, we found that children with HL returned later in time (that is after the pilot study period of time), only when parents noticed their difficulty in communication. Unfortunately this was a waste of valuable time in terms of preventing the irreversible consequences of the late stimulation of the auditory system (not done within a sensitive time period).

According to estimates, the cost per newborn screened for the presence of permanent hearing loss with the OEA method in the maternity hospital was 810 ALL or €5.77 while the cost of the ARB diagnostic testing conducted at Tirana's University Hospital Center "Mother Teresa" was 6,024 ALL or €42.93. These costs are similar to the costs of €7-36 mentioned in the European consensus conference 1998 (4) and the study conducted in the UK (12).

The estimated total cost for all the screening procedure (OEA test) during 2011 was 8,252,549 ALL which was only 1.07% at a total budget of Obstetrical Hospital, a cost that should be considered low and affordable for the budget of a health institution. The estimated cost for all children in which the ABR was performed, during 2011 was 3,138,621 ALL that is only 0.01% of total budget of UHC "Mother Teresa", ENT service.

The detection cost for one case with hearing loss is 495,268 ALL or €3,529 which is low significantly compared with the reported cost from the German study where the cost of detection for one child with congenital hearing loss was 13,395 Euro (11).

The low cost is explained by the low compensation value of medical personnel and administrative staff who were involved in the process.

Conclusion

The cost of screening for hearing loss is about 810 ALL for OEA testing, approximately €5.77 and the cost of ABR diagnostic testing is about 6,024 ALL, or €42.93. This cost is comparable to the cost

reported in other countries.

Based on the prevalence of hearing loss found (2.3 per 1000 newborns) and the cost per child detected, the total budget estimated assuming that the prevalence will be the same in the country, the number of children detected with hearing loss would be 81, whereas the total cost would be approximately 40,116,729 ALL, or €285,874.

At the current prevalence, the cost of universal hearing screening is affordable for the budget of the obstetrical university hospital. Therefore, it is recommended that Universal Hearing Screening should be included in the routine neonatal examination after birth.

It is very likely that these figures are underestimated, which does not account for indirect medical costs due to difficulties with disaggregated data from hospitals, as well as social costs.

This study presents the evidence on the cost for universal screening in Albania and could serve as a milestone for further studies related to cost-benefits of UNHS. The cost-benefits studies can accurately produce the data needed to inform decision makers and stakeholders on how to best spend the limited health resources and assist in making the decision of what should be included in a package of health services in order to respond better to population's health needs.

Conflicts of interest: None declared.

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