

OTOACOUSTIC EMISSION HEARING SCREENING OF NEWBORNS IN KORLE-BU TEACHING HOSPITAL, GHANA.

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Abstract

Objectives: The aim of the study was to determine outcomes of new-born hearing screening and identify possible causes of hearing loss in NICU Admissions.

Method: The research is a cross sectional study of new born screening conducted on all consenting consecutive new- born who are healthy and seen at the post-delivery ward, and NICU outpatient department of KBTH. Associations or differences in variables were examined using chi-squared test. P-value ≤ 0.05 was considered statistically significant.

Results: A total of 483 babies were screened during the period. The incidence of hearing loss in the new-born was 7.2%. More than half of the new-born were 4 weeks or less weeks (n=254, 52.6%) and the rest were greater than 4 weeks (n=229, 47.4%). The mean age (\pm SD) of the new-born are 3.94 (\pm 2.09) and 3.80 (\pm 2.16) weeks in the admitted and not admitted group respectively.

It was revealed that 27% of the babies were admitted at Neonatal Intensive Care Unit (NICU) because of prematurity and Macrosomia (from diabetic mothers) respectively. Among the babies that were admitted, 7 failed the OAE and 101 passed. In the not admitted group, 28 failed OAE test and the rest passed (n=347). This study revealed that, there was no statistically significant association of hearing loss between babies admitted to NICU and Non-NICU babies (p= 0.728).

Conclusions: The incidence of hearing loss among the new-born was 7.2% and the main reason for NICU admission are prematurity, big baby, Birth asphyxia, neonatal jaundice, neonatal sepsis, small baby and vacuum delivery. There is no statistically significant association between these different group babies with hearing loss.

Key Words: Neonatal Intensive Care Unit, External Auditory canal, Otoacoustic Emissions, Caesarean Section, Ear, Nose and Throat

Introduction

The degree of loss which is measured in logarithmic ratio decibels, at frequencies between 125 Hz (low-pitch sounds) and 8000 Hz (high-pitch sounds) is termed hearing loss¹. Hearing loss in new-born can be caused by abnormalities or pathologies in the anatomical parts of hearing. These include pathologies in external auditory canal and or middle ear which cause conductive type of hearing loss and, cochlear and or eighth cranial nerve pathologies which results in sensory neural hearing loss. Others have both external auditory canal and or middle ear pathology with cochlear and or eight cranial nerve pathologies resulting in mixed type of hearing loss and finally, pathology in the brain resulting in central type of hearing loss.

Neonatal Intensive Care Unit (NICU) babies are unwell babies who are admitted after birth due to congenital or acquired pathologies within 28days of

birth. Hearing loss in new-born can be caused by prenatal (intrauterine or genetic), perinatal (during delivery) and postnatal (after delivery) factors². One of the most common congenital disorders is Significant hearing loss which occurs in 1 to 2 per 1000 new-borns³. It leads to delayed language development, difficulties with behaviour and impaired psychosocial development, and poor academic achievement. Hence, early identification of hearing loss and appropriate interventional measures such as amplification using hearing aids, Cochlear implants and, speech and language therapy improves language outcomes and level of intelligence. According to Peterson and Ramma⁴, the incidence of hearing loss among new-borns in the United States of America (USA) is 1.86 per 1000 and 1.33 per 1000 in UK (United Kingdom). This variation in incidence is due to difference in screening methods and different definitions of significant childhood permanent hearing loss in USA and the United Kingdom⁵. In Nigeria, 44 babies out of 1274 babies who were involved in a two-stage screening test (Otoacoustic emissions and/or auditory brainstem response) were sent for a diagnostic evaluation. Confirmed cases gave an incidence of 5.5 per 1000 live births⁶. Moreover, a study by Morton⁷ in the United Kingdom and another study by Nikolopoulos⁸ in the United States (US), had unclear criteria for selecting subjects, and none compared babies

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of Neonatal Intensive Care Unit (NICU) admissions with normal new-borns. This study therefore sought to find the incidence of hearing loss in new-borns from NICU and post-delivery ward of Korle –Bu Teaching Hospital so as to detect hearing loss before children between age 6 months and up to 1 year start to pick words.

Subjects and Methods

Study settings

This study was conducted at KBTH in the Greater Accra region. The KBTH serves as a major tertiary health facility for Ghana with over 2000 beds with 45 in the NICU and receives referrals from all over the country and neighboring West African countries. The Unit admits averagely 2180 patients annually.

Study Population and Sample size

The study population was the new-borns from post-delivery ward and babies admitted in NICU babies at KBTH. Using the Fisher's formula for sample size determination with an attrition of 20%, a total of 483 patients was recruited for the study from the 1st February, 2018 to 10th December, 2018.

Study design

The study used a cross sectional study design which was conducted on all consenting consecutive new-borns who are healthy and seen at the post-delivery ward, and NICU of Korle Bu Teaching Hospital.

Procedure

The participants were enrolled from the post-delivery ward and NICU, and their mothers or guardian asked to present at ENT clinic after their first weighing and immunization visit with the babies. The whole procedure was explained to the mother or guardian after the preliminary assessment (screening) with regards to the inclusion and exclusion criteria. Some information was taken from NICU participants folder. Each participant was seated in the arms of the parent or guardian in a comfortable chair in the ENT clinic. With the aid of light from the lamp and head mirror, a full ear, nose and throat examination was done. Otoscopy was done for visual clarity of tympanic membrane (TM). The ears were examined for congenital abnormalities of the pinna and especially, external auditory canal (EAC) narrowing (atresia or stenosis) and the state of the TM.

The lip, oral cavity and oropharynx were examined for congenital or neurological pathology. Head and neck examination were done for any craniofacial deformities and neurological deficits. Physical examination of other systems of the body was also done.

Those who met the inclusion criteria and none of the exclusion criteria, were referred to the hearing assessment centre for hearing assessment.

Data processing and Analysis

Data Handling

The participants were assigned serial numbers at enrolment into the study and subsequently used during analysis. Questionnaire was used to collect all data

which was entered into a computer that is strictly protected and only accessible by the researcher (s).

Statistical Analysis

The data obtained was entered into Microsoft Excel 2016 and exported to Statistical Package for Social Sciences software (IBM SPSS version 25.0) for analysis. Descriptive statistics were performed to obtain frequencies and percentages for categorical variables and means (\pm Standard deviation) for continuous variables such as age of the baby, maternal age. Associations or differences in variables were examined using chi-squared test. P-value ≤ 0.05 was considered statistically significant.

Study Limitations

Some of the study limitations are low number of participants from the post NICU well babies and most mothers were not interested in the hearing screening and those who agreed to take part had some anxiety.

Ethical Consideration

The study was performed in accordance with the declaration of Helsinki and ethical approval was obtained from the joint Korle –Bu Ethical Review Board (Date of issue: March 26, 2018; protocol identification number: KBTH-IRB/00064/2017). The declaration of Helsinki states that medical research must protect the life, health, dignity, integrity, right to self-determination, privacy and confidentiality of personal information of research subjects.

Results

Of the 483 patients involved in the study, the incidence of hearing loss among the participants (new-borns) was 7.2% (n=35) as depicted in table 1. Majority of the participants (54%) were males and 46% were females.

Table 1: Incidence of hearing loss

Hearing loss	Frequency	Percent
Yes	35	7.2
No	448	92.8
Total	483	100.0

The age group of the participants ranged between 1 week and 6 weeks; more than half of them were 4 weeks or less but greater than 1 week (52.6%) and the rest were greater than 4 weeks but less than or equal to 6 weeks (47.4%) as shown in table 2.

Table 2: Demographic Statistics

Variable	Frequency (n=483)	Percent
Sex		
Male	220	46.00%
Female	263	54.00%
Age group		
>1week & \leq 4 weeks	254	52.60%
> 4weeks but \leq 6weeks	229	47.40%

The mean weight of the participant was $3.11 \pm 0.6\text{kg}$ and an average head circumference of $34.41 \pm 2.01\text{cm}$ shown in table 3.

Macrosomia from diabetic mothers (big baby) was the topmost diagnosis for NICU admission as depicted in table 4.

Table 3: Mean and standard deviation of Maternal age, weight and head circumference of baby

Variable (N=483)	Mean	SD	Min.	Max.
Maternal Age (years)	31.07	5.58	18	45
Weight of baby (kg)	3.11	0.6	1.1	5.1
Head circumference (cm)	34.41	2.01	25	40

SD= Standard Deviation

Min= Minimum

Max= Maximum

Table 4: Topmost cause of Admission of baby

Topmost Cause of Admission	Frequency
Macrosomia from diabetic mother	36
Prematurity	33
Neonatal Jaundice	12
Birth Asphyxia	12
Neonatal Sepsis	6
Fetal Distress	3
Small baby	3
Vacuum Delivery	3

None of the mothers had congenital or intrauterine infection during their pregnancy. 3.8% of the mothers used other drugs such as Metformin. According to alcohol or substance abuse in pregnancy, 27 of the mothers had abused alcohol and only 4 children of those mothers failed the hearing loss. A little above 50% of the mode of delivery were caesarean section (C/S) and the rest were spontaneous vaginal delivery (SVD). Majority of the participants did not have any family history of hearing loss (n=441, 91%) while 9% (n=42) have a family history of hearing loss. 4 of the total participants who had family history of hearing loss failed the OAE test and the rest passed and there was no statistically significant association between the family history of hearing loss and hearing loss (p=0.551). A total of 45 participants had exposure to Ototoxic drug, 2 of the total participants who had the exposure failed the OAE test and the rest passed which, was no statistically significant (p=0.739) as shown in table 5.

Table 5: Pregnancy related Characteristics of participants

Variable	Frequency (n=483)	Percent
Use of other drugs apart from antenatal medications		
Yes	18	3.8
No	465	96.3
Alcohol or substance abuse in pregnancy		
Yes	27	5.6
No	456	94.4
Mode of delivery		
C/S	246	50.9
SVD	237	49.1
Family history of hearing loss		
Yes	42	9
No	441	91
Ototoxic drug exposure		
Yes	45	9
No	438	91

Of the total participants, 108 participants were admitted at NICU and 375 were not admitted. Among the participants that were admitted, 7 failed the OAE test and 101 passed. In the not admitted group, 28 of the participants had hearing loss and the rest did not have hearing loss (n=347). It was also revealed that there was no statistically significant association of failed test between the admitted or not admitted babies (p=0.728). The null hypothesis is thus rejected i.e. there is a high incidence of hearing loss among NICU babies compared with babies that were not admitted to NICU as shown in table 6.

Table 6: Hearing loss and type of Admission

Type of Admission	Hearing loss		Total	P-value
	Yes	No		
*Hearing loss				
Admitted	7	101	108	0.728
Not Admitted	28	347	375	
Total	35	448	483	

Discussion

Newborn hearing screening provides for early detection of hearing disorders thus enabling intervention before 6 months of age⁹. It is considered a process, and not an event which provides parents and children a follow up, from pre-screening instructions all the way to the treatment and follow up of the child diagnosed with the hearing loss and child's family⁹.

The incidence rate of hearing loss after OAE testing in this study is 7.2% as compared to a study done by Olusanya and coworkers⁶ in Nigeria found an incidence of 5.3 (7/1330) per 1000 using a two-stage screening, 5.0-5.6 in India by Peterson & Ramma⁴, Pourarian and coworkers¹⁰ in Iran showed 13% and 25.3% by Onoda and co-workers¹¹ in Brazil. Antwi B.B¹² had 35% of participants and Akinola and co-workers¹³ had 29.0% failing the initial OAE hearing screening test. Antwi B.B¹² and Akinola and co-workers¹³ used only OAE as the screening tool. Antwi B.B worked on only MBU neonate¹² but Akinola and co-workers worked on neonates with and without risk factors¹³. This variation in incidence could be due to sample size variation, type of test (OAE, Automated ABR, time of test (< or > 1week old), addition and exclusion of syndromic babies, unwell babies and other factors in NICU. This study supports that, new born hearing loss can be detected early, followed up and managed appropriately as found by Patel and coworkers¹ and Nikolopoulos⁸.

Wroblewska-Seniuk and coworkers stated that, the incidence of SNHL in healthy neonates is 1 to 3 per 1000 and 2-4 per 100 in high risk infants and found hearing loss in 11% in less than or equal to 25 weeks, 5% at 26-27 weeks, 3.46% at 18 weeks and 2-3 at 29-32 weeks preterm¹⁴. TOAE screening was used and participants included new-borns with craniofacial abnormalities who will fail OAE because of eustachian tube dysfunction. It is therefore not surprising that, participants in their research who had the highest fail(referred) in OAE screening were preterm with craniofacial dysfunction¹⁴. In this research, 28(7.47%) out of 375 normal participants (non NICU admitted) had hearing loss and 7(6.48%) out of 108 post NICU admitted newborn babies with hearing loss with $p=0.728$.

In this study, more than half of the new-borns were 4 weeks old or less but more than one week old ($n=254,52.6\%$) and the rest were greater than 4 weeks old but less than or equal to 6weeks old ($n=229, 47.4\%$). The mean age of the new-borns is 3.02 and 2.12 weeks respectively. This is different from Olusanya and coworkers in Nigeria who used infants aged 46 days to 360days at diagnosis⁶ and by Onoda and co-workers from Brazil in which the age groups were not highlighted¹¹. One week to 6weeks old were used in this work to ensure there is no vernix in the external auditory canal to prevent false fail.

The data revealed that 54% of the participants were females and their male counterparts formed the remaining 46% which is similar to the published series by Onoda and co-workers¹¹.

This study revealed that majority 27% of the babies were admitted because of prematurity and big baby, 13.5% were due to Birth Asphyxia, Neonatal jaundice and neonatal sepsis and 2.7% were due to small baby and vacuum delivery. There was no statistically significant association between reason for admission and hearing loss ($p>0.05$). This finding is similar to studies by Pourarian and co-workers who found no

association between hearing loss and new born admitted at NICU for ventilator use, transient tachypnea of newborn, sepsis, neonatal jaundice and congenital heart disease¹⁰.

In this study, there was no statistically significant association between family history of hearing loss, exposure to Ototoxic drugs and mechanical ventilation of new-born for more than 5 days. This is contrary to the study done by Onoda and co-workers which stated that hearing disorders are significantly associated with the variables such as family history of hearing loss, use of ototoxic drugs, use of mechanical ventilation, stay in middle to high risk neonatal ICU for over 48 hours and birth weight below 1,500g¹¹. Onoda and coworkers screened all new-borns admitted to NICU including ill babies, and syndromic babies regardless of the age groups (babies less than a week old)¹¹. This study used well babies from NICU and post-delivery word who are non-syndromic and without any form of congenital anomaly. No genetic studies of hearing loss were done in both studies. This study was a one stage screening test using (OAE testing) and Onoda and co-workers used a 2-stage screening test using Transient Stimulus Evoked Otoacoustic Emissions (TEOE) and the Cochleo-eyelid Reflex (CER) by means of an Agogô musical instrument (large campanula) at 100 dB SPL of intensity in a retrospective study¹¹.

Amini and co-workers found that there is no statistically significant correlation between asphyxiated babies and hearing loss¹⁵. This finding is similar to that of this study except that, OAE testing screening was done in only asphyxiated babies in 80 participants out of 149 having a mean 1st minute APGAR score of 4.01, and mean in first 5 minutes score of 7.24. However, they found a significant relationship between the mean birth weight and abnormal OAE (P value = 0.0406).

Akinola and co-workers¹³ found that, prematurity, multiple births, jaundice and small birth weight are significantly associated with referrals (fail) outcome with prematurity being the highest. The difference is that, new-borns born in the hospital within 6 months with a mean age of 2.3 days ($SD \pm 1.5$) were used for that study instead of 1 to 6 weeks old and healthy post NICU babies used for this study.

Wroblewska-Seniuk and coworkers stated that, Hearing impairment is a severe consequence of prematurity¹⁴. This is not surprising because their research was limited to premature neonates including participants with craniofacial abnormalities (excluded in this work) who will usually have eustachian tube dysfunction and fail OAE as a result. AL-Kandari and Alshuaid in Kuwait found 2% hearing loss in well babies' and 46.7 in high risk groups in 200 well babies and 15 high risk babies¹⁶.

Among the participants that were admitted in NICU, 7 participants failed the OAE and 101 passed. In the non NICU admitted group, 28 of the participants failed OAE test and the rest passed ($n=347$). It was also noted that there was no statistically significant

association between hearing loss and a baby admitted into NICU or not ($p=0.728$) thus ,agreeing with the null hypothesis i.e. there is no high incidence of hearing loss among NICU babies compared with babies that were not admitted to NICU which is in contrast to the study done by Wilson et al which says that babies who were born prematurely and were admitted to NICU had a higher chance of developing hearing loss than normal babies¹⁷.

Conclusion

The incidence of hearing loss in new-borns loss was 7.2%. There were no main reasons for NICU admission associated with hearing loss in KBTH. The post NICU babies in this research do not have high incidence of hearing loss as were expected.

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