Automated auditory brainstem response vs. otoacoustic emissions in newborn hearing screening – prospective, pilot screening trial

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BACKGROUND

- Severe bilateral sensorineural hearing loss (> 50 dB) affects 1-3 in 1000 live births in the normal newborn population and 2-4 in 100 infants in the intensive care population. Early diagnosis and treatment of congenital and acquired hearing impairment in newborns is a key element for optimal speech development.
- The Polish Universal Neonatal Hearing Screening Program (PUNHSP) by means of transient evoked otoacoustic emissions (TEOAEs) has been carried out in Poland since 2002.
- Gold standard in hearing screening – automated auditory brainstem response (AABR) – clinically proven sensitivity and specificity. It detects hearing deficit not only at the level of ear but also of neural origin.
- Risk factors of hearing impairment – prematurity, treatment in the intensive care unit, mechanical ventilation, ototoxic treatment
- Recent recommendations suggest implementation of AABR to newborn hearing screening, to identify the group of newborns at higher risk of hearing impairment.

METHODS

- The study was performed at the **University Hospital in Poznan, Poland between 01.08.2017 and 31.07.2018.**
- The group of **309 infants with risk factors of hearing deficit and 100 children of the control group** were examined by means of both **TEOAE and AABR** before discharge from the hospital after birth. Healthy neonates were screened in the second or third day of life; infants treated in NICU – when their general condition was stable. All children were tested bilaterally, without any sedation, while sleeping.
- Patient demographic data, risk factors of hearing loss and the results of screening were recorded in the questionnaire. The outcomes of screening were presented as **‘positive’** (i.e. hearing problem detected) or **‘negative’** (i.e. hearing problem not detected) which corresponds to ‘refer’ in at least one ear and ‘pass’ in both ears.
- Infants who failed the screening test and/or had risk factors of hearing deficit were referred for further audiological evaluation within 3 months of life or immediately after hospital discharge. The results of the tests performed in the outpatient clinic were collected to assess the accuracy of the screening by means of TEOAEs and AABR.

Table 1. Number of children with specific risk factors of hearing deficit in the study group.

Risk factor	Number of infants (n=309)	
Treatment in NICU (>7 days)	271	87.7%
Mech. ventilation (>5 days)	252	81.6%
Ototoxic medications	238	77.0%
Prematurity (<33 Hbd)	217	70.2%
Very low birth weight (<1500 g)	126	40.8%
Low Apgar score	54	17.5%
Craniofacial congenital anomaly	5	1.6%
Family history	4	1.3%
TORCH infection	3	1%
Complex congenital anomalies	3	1%
Hyperbilirubinemia	2	0.7%
Bacterial meningitis	1	0.3%

OBJECTIVE

The aim of the study was to analyze the effectiveness of OAE and AABR used as screening tools for hearing impairment among infants.

RESULTS

Actual status of diagnosis	Number of children (n=309)	
Impaired hearing	5	1.6%
Normal hearing	170	55.0%
In the course of diagnosis	75	24.3%
Lost to follow-up	59	19.1%

Table 2. The actual status of diagnosis of hearing impairment in the study group.

Table 3. False positive and false negative results.

Screening method	Positive result – ‘Refer’		Confirmed hearing deficit		False positive results	False negative results
	Bilateral	Unilateral	Bilateral	Unilateral		
OAE (n=409)	6 (1.5%)	2 (0.5%)	4 (66.7%)	1 (50%)	3 (0.7% ^a / 37.5% ^b)	3 (0.7% ^a)
AABR (n=409)	9 (2.2%)	16 (3.9%)	3 (33.3%)	0 (0%)	12 (2.9% ^a / 48% ^b)	4 (1.0% ^a)

a - % of the whole group, b - % of the positive results

Table 4. Risk factors and the results of hearing screening in children with the final diagnosis of hearing deficit.

	OAE	AABR	Risk factors	Final diagnosis
1	Pass/Pass	Pass/Pass	ototoxic treatment; NICU > 7 days; mechanical ventilation > 5 days; < 1500 g; < 32 wg; positive family history	bilateral, mixed type, mild hearing deficit (< 40 dB)
2	Pass/Pass	Pass/Pass	ototoxic treatment; NICU > 7 days; mechanical ventilation > 5 days; < 32 wg	bilateral, mixed type, mild hearing deficit (< 40 dB)
3	Refer/Refer	Pass/Pass	ototoxic treatment; NICU > 7 days; mechanical ventilation > 5 days;	unilateral, conductive, moderate hearing deficit (41-70 dB)
4	Pass/Pass	Pass/Pass	ototoxic treatment; NICU > 7 days; mechanical ventilation > 5 days; < 1500 g; < 32 wg	unilateral, conductive, mild hearing deficit (< 40 dB)
5	Refer/Refer	Refer/Refer	cytomegalovirus infection	bilateral, sensorineural, profound hearing deficit (> 95 dB)

CONCLUSIONS

1. Although AABR is treated as gold standard in newborn hearing screening, the results of screening by means of OAE and AABR in our study seem to be comparable.
2. Larger group of infants should be examined and further analysis should be performed to formulate the final conclusions of our study.
3. Our study confirms that congenital cytomegalovirus infection may lead to profound, sensorineural hearing deficit, even if it is otherwise asymptomatic.