REPORT CARD 2023

USE OF AUDITORY BRAINSTEM POTENTIALS TO MEASURE AUDITORY THRESHOLDS: TYPE OF STIMULUS AND USE OF SEDATION

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Journal of Hearing Science®

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USE OF AUDITORY BRAINSTEM POTENTIALS TO MEASURE AUDITORY THRESHOLDS:
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This month's bulletin aims to clarify the differences and uses of click-type sound stimuli in relation to tone burst and chirp type stimuli. Concomitantly, dispel doubts that testing using the Auditory Brainstem Potential (ABR) can only be performed under anesthesia. In this text, we point to some relevant findings that give us fresh perspectives about how this important electrophysiological test can be used.

According to the Joint Committee on Infant Hearing (JCIH, 2019), the audiological diagnosis of infants is the responsibility of the audiologist, since they have the knowledge and skills to carry out the required hearing assessments.

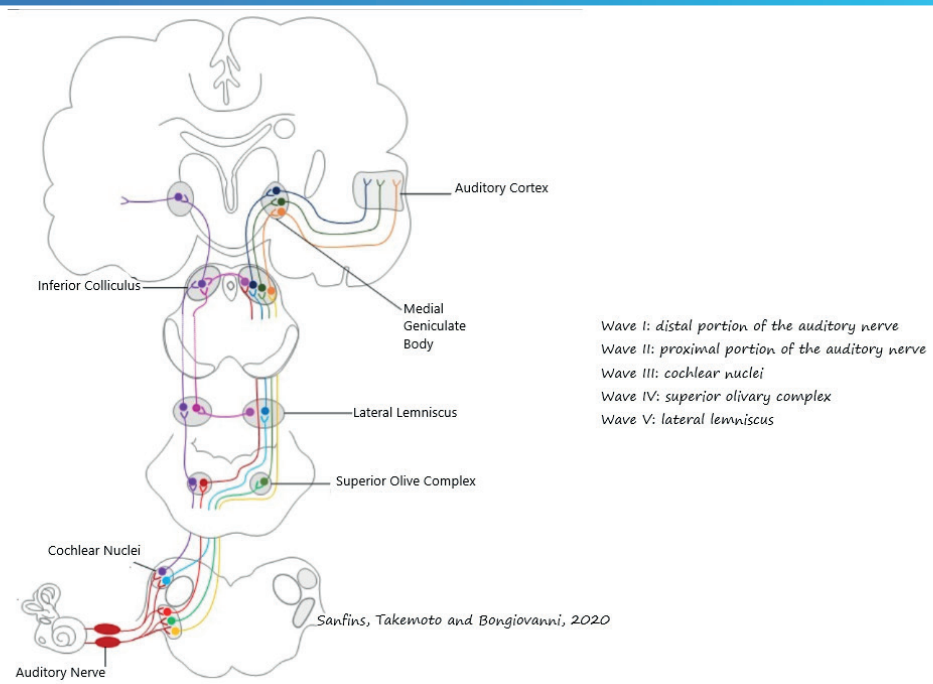
On the other hand, if they don't have the requisite experience or equipment, the young child needs to be referred to a specialised center. To test young children, the professional needs to use best practice and support their work with good scientific evidence, and use validated and internationally recognized protocols.

Among the procedures recommended for assessing infants and young children, use of ABRs (or BAEPs) stands out. According to the JCIH (2019), ABR is the gold standard for estimating hearing thresholds in infants and young children (below 6 months of age) who cannot give clear responses through behavioral methods.

ABR is an electrophysiological assessment of hearing that can be performed using different types of auditory stimuli, including clicks, tone bursts, or chirps. The type of acoustic stimulus will determine the how the evaluation is done. So if the evaluator chooses to use a click, the evaluation will track the auditory pathway, and examine whether the structures involved from the auditory nerve to the lateral lemniscus are intact (see figure 1).

The option of using a chirp or a tone burst will investigate auditory sensitivity, that is how much the individual being assessed hears at different frequencies. More specifically, it reveals the electrophysiological threshold to sound stimuli of various frequencies.

Figure 1: Auditory pathway structures involved in generating the ABR



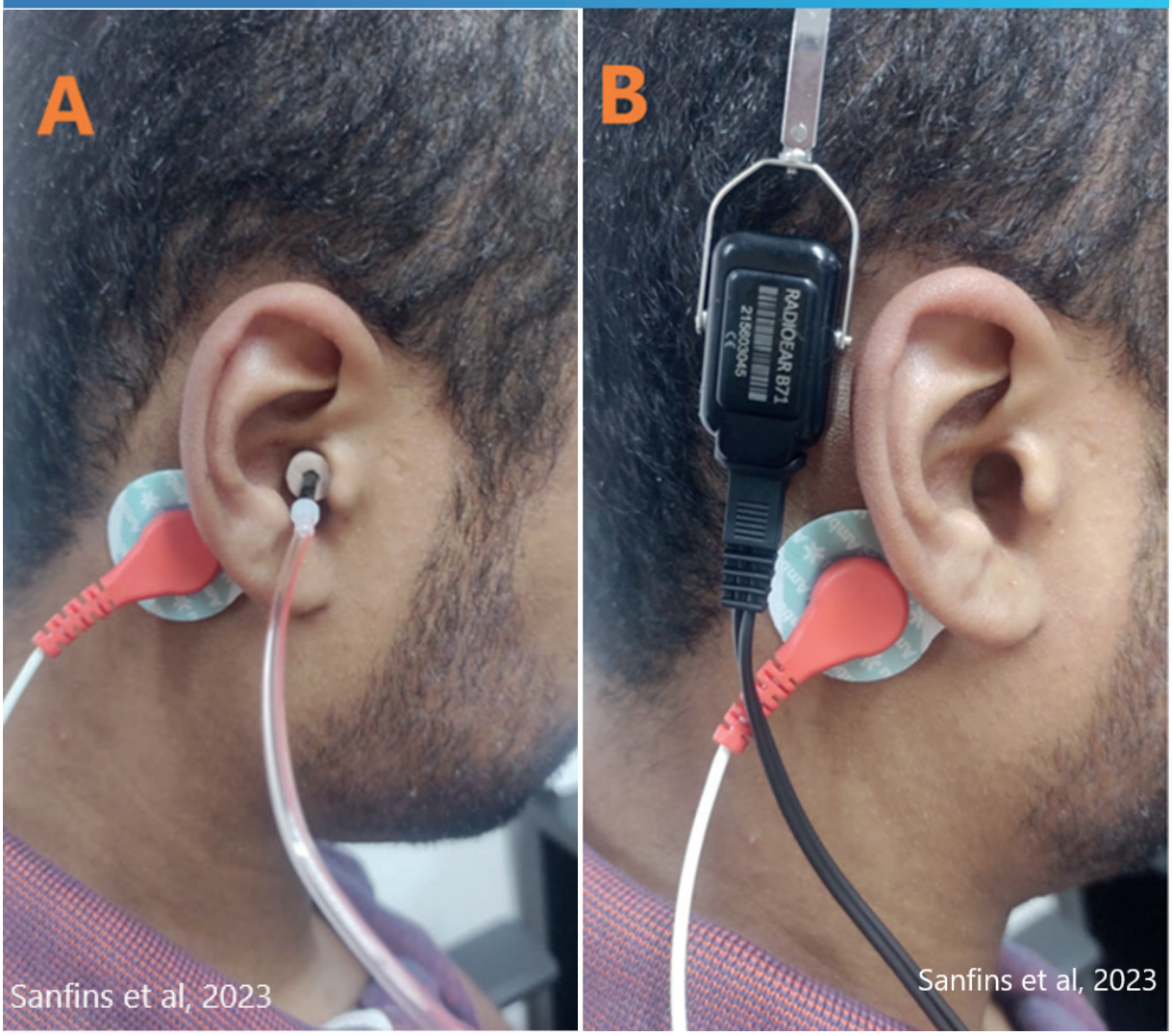
In this context, it is worth noting, that ABR thresholds based on a click stimulus are, as reported by Stapells in 2000, only reliable if the patient has a horizontal audiogram. This is because a click stimulus stimulates a large length of the basilar membrane and therefore it is not possible to say precisely which frequency represents the ABR-click threshold. For this reason, the investigation of minimum response levels (MRLs) at different frequencies must be carried out using different sound stimuli.

There are several studies in the literature that have conclusively shown that the use of an ABR-click for threshold research is inappropriate and not recommended (see: Eggermont 1982; Picton 1978; Picton and Stapells 1985; Stapells 1989; Stapells and Oates 1997). Research has shown that a click will respond best at the frequency which has the lowest threshold. Therefore, the ABR will reflect the best response to sounds in a range anywhere from 500 to 8000 Hz.

FOR THIS REASON, "AN ABR-CLICK SHOULD NOT BE USED ROUTINELY FOR THE DETERMINATION OF AUDITORY THRESHOLDS" (STAPELLS, 2004). IN THIS SAME WORK, STAPELLS HAS SHOWN THAT A FREQUENCY-SPECIFIC ABR TEST (FE-ABR) CAN RELIABLY PREDICT AUDITORY THRESHOLDS AT DIFFERENT FREQUENCIES. NEVERTHELESS, MANY PROFESSIONALS STILL PERSIST IN USING A CLICK-TYPE STIMULUS WHEN INVESTIGATING HEARING THRESHOLDS, AND THIS IS REALLY A BIG MISTAKE.

Frequency-specific ABR demands a longer time for data collection, since the MRLs are investigated in each ear at frequencies of 500, 1000, 2000, and 4000Hz, either by air or, if necessary, by bone.

Figure 2: Representation of the evaluation by air (A) and by bone (B).



The main aim of performing an EF-ABR on a child is to obtain electrophysiological thresholds at different frequencies and correlate them with psychoacoustic thresholds. In cases of a hearing impairment, it is possible to identify the type, degree, and configuration of the hearing loss. All assessments need to be carried out by an experienced professional who can confidently read the responses presented on the equipment, as any uncertainty could prolong the diagnosis and delay medical or speech therapy intervention, as well as auditory rehabilitation.

To obtain reliable and reproducible answers, it is absolutely necessary to guarantee the collection conditions in terms of both the environment and the patient. A crucial factor in electrophysiological assessment of infants, babies, and young children is relaxation at the time of collection.

Deep natural sleep allows responses to be collected reliably and without muscular or ocular interference resulting from the patient's movement. The specialist evaluator must have complete control over the technical conditions, including possible interference from internal or environmental noise. Interference from the mains (60 Hz), surrounding equipment, and some types of lighting systems are common sources. Once these problems are identified, the evaluator can review the set up and make any necessary adjustments to ensure good quality responses.

A common statement is that anesthetics need to be used to perform an ABR on an infant. However, evaluators should know that with appropriate guidance to the parents and planning around the baby's sleep routine, it is possible to carry out the procedure without sedation and adequate conditions.

IN SPECIAL CASES THE USE OF ANESTHETICS MAY BE NECESSARY,

mainly in cases where the sleep routine has been disrupted and the auditory battery may be compromised. When dealing with very young children the use of sedation for ABR should only be considered after respecting what is best for the patient and considering the parents' wishes.
In particular, there are some children who, due to various health conditions, cannot undergo anesthesia. We believe that sedation is not generally needed to perform an ABR. On the contrary, sedation should only be considered in exceptional situations and when it is really needed.

THE USE OF ANY TYPE OF ANESTHETIC INTERVENTION CAN POSE A RISK TO THE PATIENT.

Therefore, it must only be carried out in a hospital environment and administered by an anesthesiologist. The patient must be prepared and monitored by appropriate equipment and be supervised throughout the process by the anesthetist and specialized medical staff. After an ABR is done under sedation, the patient will be transferred to a post-anesthetic monitoring unit.

The medical and nursing staff will monitor the patient and check for responsiveness, control any nausea or vomiting, and make sure the patient is calm and well. In view of perspectives set out above, the choice of using sedatives in the ABR assessment must be considered carefully. The literature presents several studies on anesthetic neurotoxicity in the pediatric population, through retrospective, prospective and case studies. These studies reported that exposure to anesthetics in children under 4 years of age may lead to an increased incidence of behavioral, learning, memory and neurobehavioral problems.

Evaluators should be aware that ABR responses are affected by anesthetics. Skarzynska and Sanfins (2022) have pointed out that certain medications can cause significant changes in electrophysiological responses and, consequently, modify the test results.

Evaluating children's hearing plays an important role in early identification of hearing impairment. Rehabilitation allows the child to have access to sounds and therefore a better likelihood of developing speech and language. A pediatric audiological evaluation is always carried out with cross-checking, the principle being that the diagnosis must present a convergence of responses between different methods (behavioral, electrophysiological, and electroacoustic). Diagnosis should be complete by around 2 months of age, thus allowing rehabilitation to be started as soon as possible, preferably by 3 months.

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