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# MODERN DIAGNOSTIC TECHNIQUES IMPLEMENTED AT THE AUDIOVESTIBULAR LABORATORY OF THE UNIVERSITY MEDICAL AND DENTAL CENTER, FACULTY OF DENTAL MEDICINE, MEDICAL UNIVERSITY OF VARNA

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## ABSTRACT

**INTRODUCTION:** The audiovestibular laboratory of the University Medical and Dental Center in the Faculty of Dental Medicine was established in 2020. Its purpose is diagnosis, treatment, and prevention of hearing, balance and sleep disorders of patients of all ages. It was set up thanks to the joint efforts of the academic management of the Medical University of Varna and the Faculty of Dental Medicine. The audiovestibular laboratory is equipped with the most modern and up-to-date electrophysiological diagnostic and rehabilitation devices. Since 2015, MU-Varna has conducted a number of interdisciplinary forums with international participation on the topics of audiological and vestibular disorders, obstructive sleep apnea (OSA), newborn hearing screening. The audiovestibular laboratory works in close relationship with laboratories in the field situated in Europe, USA, the Russian Federation, Asia, and Australia.

**MATERIALS AND METHODS:** The most important features of the different diagnostic systems will be briefly summarized in the following text, so as to express the specific diagnostic options they provide clinicians with.

**DISCUSSION:** Different diagnostic features of the systems used are described, pointing out the features of the most frequently used ones.

**CONCLUSION:** Patients should be given different, adequate and clear diagnostic solutions. Universities play an important role in becoming centers for providing full medical care—diagnostics, treatment, and rehabilitation in the specific field of medicine.

**Keywords:** *audiology, vestibular disorders, obstructive sleep apnea, neonatal screening, modern*

## INTRODUCTION

The audiovestibular laboratory of the University Medical and Dental Center in the Faculty of Dental Medicine was established in 2020. Its purpose is diagnosis, treatment, and prevention of hearing, balance and sleep disorders of patients of all ages. It was set up thanks to the joint efforts of the academic management of the Medical University of Varna and the Faculty of Dental Medicine. The audiovestibular laboratory is equipped with modern and up-to-date electrophysiological diagnostic and rehabilitation devices. They allow clinicians to perform complete

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diagnostics of the hearing ability from the external auditory canal to the brain with high precision. Patients with more than 50 types of otologic, neurologic, ophthalmologic, hereditary and rare diseases can be consulted in the laboratory. Lowered hearing ability, idiopathic and non-idiopathic tinnitus, dizziness, vertigo, Meniere's disease, headaches, gait instability, endocrinologic and psychiatric disorders, traumatic injuries, etc. are increasingly common social diseases (1–6). All the stated disorders can be adequately tested in the Laboratory. It must be stressed out that newborn hearing screening can be performed with high reliability as well. The modern audiovestibular equipment is furnished with a chair and own software network as well as an additional module for information stocking with scientific purposes. Aviation and maritime affairs workers, athletes, divers and high-altitude workers can be tested. Since 2015, MU–Varna has conducted a number of interdisciplinary forums with international participation on the topics of audiological and vestibular disorders, obstructive sleep apnea (OSA), newborn hearing screening. The International Black Sea Otology and Neurootology Association has been established. The audiovestibular laboratory works in close relationship with laboratories in the field situated in Europe, USA, the Russian Federation, Asia, and Australia.

## **MATERIALS AND METHODS**

The most important features of the different diagnostic systems will be briefly summarized in the following text, so as to express the specific diagnostic options they provide clinicians with.

### **DISCUSSION**

#### ***OtoAccess® Database***

**OtoAccess® Database** is a computer application for easy management of patient information, evaluation of the examinations performed, maintenance of profiles of each patient with all the diagnostics done so far. The database is a unique interface integrating audiological and vestibular modules from different manufacturers. It can be configured as a server and network client, only as a network client or as a stand-alone application. The **OtoAccess® Database** provides a comprehensive data management tool and offers a continuous and fast way to add patient's information, launch a test module, and after its completion—

securely store the results of all the tests performed, in sessions in the database. The system works with the creation of accounts—with a username and password, in order to securely store the patient's information. A feature to regularly compile database backups for recovery in the event of a crash is also supported. Of all the modules included in the database, there is a function to print each study performed (7).

#### ***SERA with an ABRIS module***

The SERA module is a multifunctional device performing and recording an automatic auditory response of the brainstem. This module is used for audiological testing and documentation of hearing and neurological disorders, using auditory potentials from the inner ear, auditory nerve and brainstem. The target population for the study with the SERA module is newborns in need hearing screening. SERA works with various transducers and cable configurations. It has a lithium-ion battery, which is charged by placing the device in the stand for wireless charging. Charging can also be done via a USB cable when connected to a computer. It is possible to connect the HearSim software to a computer in the general **OtoAccess® Database** (7).

#### ***Titan—a Tympanometer with an Impedance Meter***

Titan with an IMP440 impedance system is an electroacoustic testing device that produces controlled levels of test tones and signals intended for use in the diagnostic assessment of hearing conduction and to assist in the diagnosis of possible otological diseases. Tympanometry and acoustic reflexes tests are possible. Different coefficients are measured—reflection, absorption, transmission, group delay of reflection, complex acoustic impedance and admittance, equivalent volume of the ear canal. Functional assessment of the middle and outer ear is possible. The IMP440 system allows the examination of patients of all ages. The device can work independently, as a portable one or connected to a computer (via USB connection) as a part module of the **OtoAccess® Database**. It is powered by a lithium-ion battery (7).

#### ***AD629—a Diagnostic Hybrid Air-Bone Audiometer***

The AD629 audiometer is a device that allows the diagnosis of a hearing loss. Output signals—strength and frequency—depend on the clinician

and may vary. Speech audiometry is also included. The patient's collaboration is needed, but despite the possibility that it may not be adequate enough, tests are available to confirm or rule out hearing loss. The patients are of all ages, genders and health conditions. This module can also be connected with a USB cable to a laptop and respectively to the OtoAccess® Database. It can also be controlled from a laptop—this makes it a hybrid, like the tympanometer (7).

#### ***Air Fx—a Caloric Irrigator***

The Air Fx caloric irrigator injects cold or warm liquid—distilled water, to perform caloric tests to diagnose the vestibular apparatus. The water flow is directed to the tympanic membrane through the patient's ear canal, creating a difference in temperature in the ears, which leads to the manifestation of a nystagmus in the patient's eyes. After doing one lukewarm and one warm irrigation for each ear, the responses to the irrigation are compared to determine which vestibular sensor—left or right—is affected. The module can work with any of the VisualEyes 515/525/VNG modules. This examination is performed on children and adults with normal external auditory canal, anatomy of the middle ear, without the presence of any active infections, open wounds, earwax, perforation of the eardrum, in a clinical environment (7,8).

#### ***VisualEyes 515/525***

The VisualEyes module is a complex software platform, which provides an opportunity to study the nystagmus manifested by the patient's videonystagmography (VNG). Vestibular disorders are diagnosed and documented by using glasses with mounted video cameras, showing, recording, and storing the movements of the eyeballs during or after turning the patient on a swivel chair. The information is then studied. Patients who can be examined are recommended to be 5 years and older. These glasses can be connected to a laptop via a USB cable and via software to the OtoAccess® Database (7,9–11).

#### ***EyeSeeCam—vHIT***

The module allows the examination of patients with dizziness. Head Impulse Tests (HIT) are performed to measure the vestibulo-ocular reflex (VOR). Impulses to the head should be movements with a small positional amplitude—between 10 and 20 degrees, but with high acceleration and speed.

In the clinical practice without quantitative analysis, the test detects only the presence of a corrective saccade as an indirect sign of a vestibular disorder. In patients with unilateral disorder, the quantitative HIT is very reliable, as is the caloric test. This module offers lightweight goggles and an integrated inertial measurement system for objective HIT. Dizziness of peripheral or central origin can be quickly distinguished. The test is modern, fast and economical, it can be performed at the patient's bedside, in the emergency department or in an outpatient setting, upon connection to a laptop via a USB cable. Information on the function of the vestibular balance system is provided, as well as objective information on the response of the eye velocity to the head velocity stimulus, showing the gain of VOR in the plane of rotation of the head. Suitable for examination are patients 5 years and older, physically healthy, seeing the red dots projected on the wall opposite. These glasses can be connected to a laptop via a USB cable and via software to the OtoAccess® Database (7,10–15).

#### ***Virtual SVV—Glasses for Virtual Reality***

This module uses virtual reality glasses and is designed to measure the subjective visual vertical and the patient's ability to align it. Patients must be 8 years of age or older. Patients' ability to adjust a line parallel to the vertical in the absence of other visible signals is assessed. The necessary sensory information is provided primarily by the inner ear. If it does not function normally, there will be a deviation in the patient's response. These glasses can be connected to a laptop via a USB cable and via software to the OtoAccess® Database. They are using rechargeable batteries (7,16).

#### ***Eclipse Module—a Multifunctional System for Diagnostic Screening, a Combination of Several Subsystems***

##### ***cVEMP and oVEMP***

Eclipse together with VEMP (Vestibular Evoked Myogenic Potential) is designed to test vestibular evoked myogenic potential to support the assessment of the vestibular function. The target group for the study includes patients over 8 years of age (7,10).

##### ***TEOAE—Transitory Evoked Otoacoustic Emissions***

Otoacoustic emissions are sounds generated by the movement of the outer hair cells in a healthy

functioning cochlea in response to external stimuli. Eclipse TEOAE is intended for audiological assessments and documentation of ear tract disorders using transitory evoked otoacoustic emissions. The target group for the study includes patients of all ages (7,10,17).

#### **DPOAE—Distortion Product Otoacoustic Emissions**

Eclipse DPOAE is designed for audiological assessments and documentation of disturbances in the ear tract using otoacoustic emissions, a product of distortion. The target group for the study comprises patients of all ages (7,9,10–17).

#### **ABRIS**

Eclipse ABRIS is designed for audiological assessments and documentation of disorders of the ear tract and nervous system using auditory evoked potentials from the inner ear, auditory nerve and brainstem. The target group for the study are pediatric or difficult to test populations. ABRIS has high specificity and sensitivity (99.7% and 99.9%, respectively) to exclude normally from abnormally hearing babies (7).

#### **ASSR—Auditory Steady-State Response**

Unlike auditory brainstem response (ABR), which points at amplitude and latency of the response in the time domain, when testing with ASSR, amplitudes and phases in the frequency domain are important. ASSR allows for binaural testing—4 frequencies in each ear at the same time. The technology is completely objective, based on statistical probability. ASSR provides an estimate of the pure tone audiogram, used for rehabilitation. Patients from all ages can be tested (7,18).

### **CONCLUSION**

Patients should be given different, adequate and clear diagnostic solutions. Universities play an important role in becoming centers for providing a full medical care—diagnostics, treatment, and rehabilitation in the specific field of medicine.

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