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Prediction of hearing thresholds using the Cochlea-Scan

Comment to:

A pilot study on assessing hearing threshold using the Cochlea-Scan
Stavros Hatzopoulos, Krzyszof Kochanek, Lech Sliwa, Henryk Skarzynski
Med Sci Monit, 2008; 14(4): MT7–11

Dear Editor,

We read with interest the paper written by Hatzopoulos et al. on predicting hearing thresholds using the Cochlea-Scan [1]. The Cochlea-Scan is a device recently developed by Fischer-Zoth, Germany, a division of Natus Europe GmbH. This device has been designed to predict pure-tone or hearing thresholds from extrapolated distortion product otoacoustic emission (DPOAE) input/output (I/O) functions. For more details, the reader is referred to the literature [2,3].

Basically, the results of the Hatzopoulos et al. study confirm the major finding of previous studies that thresholds estimated from DPOAE input/output functions are well correlated with pure-tone thresholds for groups of subjects [2–4]. However, DPOAE input/output functions are poor predictors of individual pure-tone thresholds, at least for a significant proportion of the individual subjects [2–4]. This latter finding is a relevant limitation of the use of DPOAE input/output functions for clinical purposes. For clinical purposes, the prediction of individual thresholds is more relevant than the prediction of mean thresholds.

Unfortunately, Hatzopoulos et al. did not adequately separate mean data from individual data [1]. For example, the authors stated, that their "mean hearing level differences between behavioral and Cochlea-Scan estimates, are less than 10 dB HL in all frequencies. These estimates are significantly smaller than the values reported in a previous pilot study recently published by Schmuziger et al. [4]." This statement is incorrect. In the study of Schmuziger et al., the median difference between pure-tone hearing and DPOAE thresholds was approximately 2 dB. The mean difference was 4.6 dB (range: 0.5 to 9.5 dB at single frequencies) and comparable or even smaller than the differences in the Hatzopoulos et al. study. In the discussion section, Hatzopoulos et al. state, "A possible explanation is that in the Schmuziger et al study, the referenced behavioral levels were measured at 10 dB steps, which could contribute significantly to the difference between behavioral and Cochlea-Scan threshold values." This statement is also incorrect. Pure-tone thresholds were determined in 5-dB steps, which is clearly visible in Figure 1 of the Schmuziger et al. study. Hatzopoulos et al. compared their mean threshold differences with Schmuziger et al. threshold differences of up to 40 dB in individual cases, which is incorrect.

Possible reasons for the poor prediction of hearing thresholds, at least for a significant minority of individual cases, may be that, (a) the otoacoustic emission (OAE) fine structure does not necessarily maintain a one-to-one relationship with the auditory threshold [5], (b) the basal region of the cochlea may contribute significantly to low-frequency OAE components [6], (c) the generation of OAEs may be only a by-product of the forces involved in cochlear mechanics, (d) OAEs are generated prior to the excitation of the inner hair cells and of the auditory nerve where the threshold is set [7], and (e) the influence of middle ear disorders on OAEs and pure-tone thresholds in humans is not well documented [8].

The influence of middle ear pathologies on OAEs is another limitation of the clinical use of DPOAEs for threshold estimation. In a significant portion of cases, middle ear pathologies have been found to reduce the emission amplitudes to a level that is below the minimum noise threshold, thus rendering them immeasurable [8]. Using the Cochlea-Scan device, informal measurements on 10 ears with documented conductive hearing loss and both air and bone conduction thresholds <50 dB HL from 1.5 to 4 kHz, demonstrated that DPOAE thresholds could not be determined in 33/36 measurements (8/10 ears). Gehr et al. previously demonstrated different DPOAE growth behaviors in guinea pigs after filling middle ears with saline to simulate middle ear pathology and after excessive noise exposure to induce inner ear disorder [9]. The authors concluded that DPOAE I/O-functions allow a differentiation between middle and inner ear dysfunction. In humans however, the influence of middle ear disease on OAEs is complex [8] and may be different from the results of animal studies. Therefore, it seems unlikely that measurements of DPOAE I/O functions will replace immitance procedures for the detection of middle ear disorders in newborns. A further limitation of The Cochlea-Scan particularly in universal newborn hearing screening programs is the increase in measurement time in comparison to "conventional" DPOAE measurements [4,10].

In summary, the clinical benefits of this method to estimate hearing threshold are probably limited.

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Sincerelly,
Nicolas Schmuziger[1], Rudolf Probst[2]
[1] Department of Otorhinolaryngology, Cantonal Hospital, Liestal, Switzerland
[2] Department of Otorhinolaryngology, University Hospital Zurich, Switzerland
Nicolas Schmuziger, Department of Otorhinolaryngology, Cantonal hospital Rheinstrasse 26
CH-4410 Liestal, Switzerland
e-mail: nschmuziger@vtxmail.ch

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