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Author(s)	Title	Summary	Journal	Year	Vol:Pages
		HEARING SENSITIVITY PREDICTION			
Ruggero MA, Rich NC, Recio A, Narayan SS, Robles L	Basilar-membrane responses to tones at the base of the chinchilla cochlea.	Basilar-membrane responses to single tones were measured, using laser velocimetry, at a site of the chinchilla cochlea located 3.5 mm from its basal end. Responses to low-level (< 10-20 dB SPL) characteristic-frequency (CF) tones (9-10 kHz) grow linearly with stimulus intensity and exhibit gains of 66-76 dB relative to stapes motion. At higher levels, CF responses grow monotonically at compressive rates, with input-output slopes as low as 0.2 dB/dB in the intensity range 40-80 dB. Compressive growth, which is significantly correlated with response sensitivity, is evident even at stimulus levels higher than 100 dB. Responses become rapidly linear as stimulus frequency departs from CF. As a result, at stimulus levels > 80 dB the largest responses are elicited by tones with frequency about 0.4-0.5 octave below CF. For stimulus frequencies well above CF, responses stop decreasing with increasing frequency: A plateau is reached. The compressive growth of responses to tones with frequency near CF is accompanied by intensity-dependent phase shifts. Death abolishes all nonlinearities, reduces sensitivity at CF by as much as 60-81 dB, and causes a relative phase lead at CF.	Acoustical Society of America	1997	101(4):2151-63
Gorga MP, Stover L, Neely ST, Montoya D	The use of cumulative distributions to determine critical values and levels of confidence for clinical distortion product Otoacoustic emission measurements	Distortion product otoacoustic emission (DPOAE) input/output functions were measured at nine f2 frequencies ranging from 500 to 8000 Hz in 210 normal-hearing and hearing-impaired subjects. In a companion paper [Stover et al., J. Acoust. Soc. Am. 100, 956-967 (1996)], L1-L2 was held constant at 10 dB, and L2 was varied from 65 to 10 dB SPL in 5-dB steps. Based upon analyses using clinical decision theory, it was demonstrated that DPOAE amplitudes for 65/55 dB SPL primaries (L1/L2) and DPOAE thresholds resulted in the greatest separation between normal and impaired ears. In this paper, the data for these two conditions were recast as cumulative distributions, which not only describe the extent of overlap between normal and impaired distributions, but also provide the measured value (i.e., the specific DPOAE amplitude or threshold) for any combination of hit and false alarm rates. From these distributions, confidence limits were constructed for both DPOAE amplitude and threshold to determine the degree of certainty with which any measured response could be assigned to either the normal or impaired population. For these analyses, DPOAE measurements were divided into three categories (a) response properties that would be unlikely to come from normal ears, (b) response properties that would be unlikely to come from impaired ears, and (c) response properties for which hearing status was uncertain. Based upon DPOAE amplitude measurements, the region of uncertainty, defined between the 95 percentile for impaired ears and the 5 percentile for normal ears, was relatively narrow for f2 frequencies ranging from 707 to 4000 Hz. For DPOAE thresholds, this region was relatively narrow for F2 frequencies ranging from 1414 to 4000 Hz.	Acoustical Society of America	1996	100(2):968-77

Author(s)	Title	Summary	Journal	Year	Vol:Pages
Gorga MP, Nelson K, Davis T, Dorn PA, Neely ST	Distortion product Otoacoustic emission test performance when both 2f1-f2 and 2f2-f1 are used to predict auditory status.	The objective of this study was to determine whether distortion product otoacoustic emission (DPOAE) test performance, defined as its ability to distinguish normal-hearing ears from those with hearing loss, can be improved by examining response and noise amplitudes at 2 f1-f2 and 2f2-f1 simultaneously. In addition, there was interest in knowing whether measurements at both DPs and for several primary frequency pairs can be used in a multivariate analysis to further optimize test performance. DPOAE and noise amplitudes were measured at 2f1-f2 and 2 f2-f1 for 12 primary levels (L2 from 10 to 65 dB SPL in 5-dB steps) and 9 pairs of primary frequencies (0.5 to 8 kHz in 1/2-octave steps). All data were collected in a sound-treated room from 70 subjects with normal hearing and 80 subjects with hearing loss. Subjects had normal middle-ear function at the time of the DPOAE test, based on standard tympanometric measurements. Measurement-based stopping rules were used such that the test terminated when the noise floor around the 2 f1-f2 DP was < or = -30 dB SPL or after 32 s of artifact-free averaging, whichever occurred first. Data were analyzed using clinical decision theory in which relative operating characteristics (ROC) curves were constructed and areas under the ROC curves were estimated. In addition, test performance was assessed by selecting the criterion value that resulted in a sensitivity of 90% and determining the specificity at that criterion value. Data were analyzed using traditional univariate comparisons, in which predictions about auditory status were based only on data obtained when f2 = audiometric frequency. In addition, multivariate analysis techniques were used to determine whether test performance can be optimized by using many variables to predict auditory status. As expected, DPOAEs were larger for 2f1-f2 compared to 2 f2-f1 in subjects with normal hearing. However, noise amplitudes were smaller for 2f2-f1, but this effect was restricted to the lowest f2 frequencies. A comparison of signal-to-noise ratios (SNR) within normal-hearing ears showed that the 2f1-f2 DP was more frequently characterized by larger SNRs compared to 2f2-f1. However, there were several subjects in whom 2f2-f1 produced a larger SNR. ROC curve areas and specificities for a fixed sensitivity increased only slightly when data from both DPs were used to predict auditory status. Multivariate analyses, in which the inputs included both DPs for several primary frequency pairs surrounding each audiometric frequency, produced the highest areas and specificities. Thus, DPOAE test performance was improved slightly by examining data at two DP frequencies simultaneously. This improvement was achieved at no additional cost in terms of test time. When measurements at both DPs were combined with data obtained for several primary frequency pairs and then analyzed in a multivariate context, the best test performance was achieved. Excellent test performance (ROC) curve areas >0.95% and specificities >92% at all frequencies, including 500 Hz, were achieved for these conditions. Although the results described should be validated on an independent set of data, they suggest that the accuracy with which DPOAE measurements identify auditory status can be improved with multivariate analyses and measurements at multiple DPs.	Acoustical Society of America	2000	107(4):2128-35

Author(s)	Title	Summary	Journal	Year	Vol:Pages
Gorga MP, Neely ST, Dorn PA, Hoover BM	Further efforts to predict pure-tone thresholds from distortion product Otoacoustic emission input/output functions.	Recently, Boege and Janssen [J. Acoust. Soc. Am. 111, 1810-1818 (2002)] fit linear equations to distortion product otoacoustic emission (DPOAE) input/output (UO) functions after the DPOAE level (in dB SPL) was converted into pressure (in microPa). Significant correlations were observed between these DPOAE thresholds and audiometric thresholds. The present study extends their work by (1) evaluating the effect of frequency, (2) determining the behavioral thresholds in those conditions that did not meet inclusion criteria, and (3) including a wider range of stimulus levels. DPOAE I/O functions were measured in as many as 278 ears of subjects with normal and impaired hearing. Nine f2 frequencies (500 to 8000 Hz in 1/2-octave steps) were used, L2 ranged from 10 to 85 dB SPL (5-dB steps), and L1 was set according to the equation L1 = 0.4L2 + 39 dB [Kummer et al., J. Acoust. Soc. Am. 103, 3431-3444 (1998)] for L2 levels up to 65 dB SPL, beyond which L1 = L2. For the same conditions as those used by Boege and Janssen, we observed a frequency effect such that correlations were higher for mid-frequency threshold comparisons. In addition, a larger proportion of conditions not meeting inclusion criteria at mid and high frequencies had hearing losses exceeding 30 dB HL, compared to lower frequencies. These results suggest that DPOAE I/O functions can be used to predict audiometric thresholds with greater accuracy at mid and high frequencies, but only when certain inclusion criteria are met. When the SNR inclusion criterion is not met, the expected amount of hearing loss increases. Increasing the range of input levels from 20-65 dB SPL to 10-85 dB SPL increased the number of functions meeting inclusion criteria and increased the overall correlation between DPOAE and behavioral thresholds.	Acoustical Society of America	2003	113(6):3275-84
Neely ST, Gorga MP, Dorn PA	Cochlear compression estimates from measurements of distortion-product Otoacoustic emissions.	Evidence of the compressive growth of basilar-membrane displacement can be seen in distortion-product otoacoustic emission (DPOAE) levels measured as a function of stimulus level. When the levels of the two stimulus tones (f1 and f2) are related by the formula L1 = 39 dB + 0.4 x L2 [Kummer et al., J. Acoust. Soc. Am. 103, 3431-3444 (1998)] the shape of the function relating DPOAE level to L2 is similar (up to an L2 of 70 dB SPL) to the classic Fletcher and Munson [J. Acoust. Soc. Am. 9, 1-10 (1933)] loudness function when plotted on a logarithmic scale. Explicit estimates of compression have been derived based on recent DPOAE measurements from the laboratory. If DPOAE growth rate is defined as the slope of the DPOAE I/O function (in dB/dB), then a cogent definition of compression is the reciprocal of the growth rate. In humans with normal hearing, compression varies from about 1 at threshold to about 4 at 70 dB SPL. With hearing loss, compression is still about 1 at threshold, but grows more slowly above threshold. Median DPOAE I/O data from ears with normal hearing, mild loss, and moderate loss are each well fit by log functions. When the I/O function is logarithmic, then the corresponding compression is a linear function of stimulus level. Evidence of cochlear compression also exists in DPOAE suppression tuning curves, which indicate the level of a third stimulus tone (f3) that reduces DPOAE level by 3 dB. All three stimulus tones generate compressive growth within the cochlea; however, only the relative compression (RC) of the primary and suppressor responses is observable in DPOAE suppression data. An RC value of 1 indicates that the cochlear responses to the primary and suppressor components grow at the same rate. In normal ears, RC rises to 4, when f3 is an octave below f2. The similarities between DPOAE and loudness compression estimates suggest the possibility of predicting loudness growth from DPOAEs; however, intersubject variability makes such predictions difficult at this time.	Acoustical Society of America	2003	114(3):1499-507

Author(s)	Title	Summary	Journal	Year	Vol:Pages
Kummer P, Janssen T, Hulin P, Arnold W	Optimal L(1)-L(2) primary tone level separation remains independent of test frequency in humans.	Previous studies described a systematic asymmetry of the level of the 2f(1)-f(2) distortion product otoacoustic emission (DP) in the space of the primary tones levels L(1) and L(2) in normal-hearing humans. Optimal primary tone level separations L(1)-L(2), which result in maximum DP levels, were close to L(1)=L(2) at high levels, but continuously increased with decreasing stimulus level towards L(1)>L(2) (Gaskill and Brown, 1990, J. Acoust. Soc. Am. 88, 821-839). At these optimal L(1)-L(2), however, not only DP levels in normal hearing were maximal, but also trauma-induced DP reductions. A linear equation that approximates optimal L(1)-L(2) level separations thus was suggested to be optimum for use in clinical applications (Whitehead et al., 1995, J. Acoust. Soc. Am. 97, 2359-2377). It was the aim of this study to extend the generality of optimal L(1)-L(2) separations to the typical human test frequency range for f(2) frequencies between 1 and 8 kHz. DPs were measured in 22 normal-hearing human ears at 61 primary tone level combinations, with L(2) between 5 and 65 dB SPL and L(1) between 30 and 70 dB SPL (f(2)/f(1)=1.2). It was found that the systematic dependence of the maximum DP level on the L(1)-L(2) separation is independent on frequency. Optimal L(1)-L(2) level separations may well be approximated by a linear equation L(1)=a L(2)+(1-a) b (after Whitehead et al., 1995) with parameters a=0.4 and b=70 dB SPL at f(2) frequencies between 1 and 8 kHz and L(2) levels between 20 and 65 dB SPL. Below L(2)=20 dB SPL, the optimal L(1) was found to be almost constant. Following previous notions (Gaskill and Brown, 1990), an analysis of basilar membrane response data in experimental animals (after Ruggero and Rich, 1991, Hear. Res. 51, 215-230) is further presented that relates optimal L(1)-L(2) separations to frequency-selective compression of the basilar membrane. Based on the assumption that optimal conditions for the DP generation are equal primary tone responses at the f(2) place, a linear increase of the optimal L(1)-L(2) level separation is graphically demonstrated, similar to our results in human ears.	Hearing Research	2000	146(1):47-56
Kummer P, Janssen T, Arnold W	The level and growth behaviour of the 2 f1-f2 distortion product Otoacoustic emission and its relationship to auditory sensitivity in normal hearing and cochlear hearing loss.	The 2 f1-f2 distortion product otoacoustic emission (DP) was measured in 20 normal hearing subjects and 15 patients with moderate cochlear hearing loss and compared to the pure-tone hearing threshold, measured with the same probe system at the f2 frequencies. DPs were elicited over a wide primary tone level range between L2 = 20 and 65 dB SPL. With decreasing L2, the L1-L2 primary tone level difference was continuously increased according to L1 = 0.4L2 + 39 dB, to account for differences of the primary tone responses at the f2 place. Above 1.5 kHz, DPs were measurable with that paradigm on average within 10 dB of the average hearing threshold in both subject groups. The growth of the DP was compressive in normal hearing subjects, with strong saturation at moderate primary tone levels. In cases of cochlear impairment, reductions of the DP level were greatest at lowest, but smallest at highest stimulus levels, such that the growth of the DP became linearized. The correlation of the DP level to the hearing threshold was found to depend on the stimulus level. Maximal correlations were found in impaired ears at moderate primary tone levels around L2 = 45 dB SPL, but at lowest stimulus levels in normal hearing (L2 = 25 dB SPL). At these levels, 17/20 impaired ears and 14/15 normally hearing ears showed statistically significant correlations. It is concluded that for a clinical application and prediction of the hearing threshold, DPs should be measured not only at high, but also at lower primary tone levels.	Acoustical Society of America	1998	103(6):3431-44

Author(s)	Title	Summary	Journal	Year	Vol:Pages
Dorn PA, Konrad-Martin D, Neely ST, Keefe DH, Cyr E, Gorga MP	Distortion product Otoacoustic emission input/output functions in normal-hearing and hearing-impaired human ears.	DPOAE input/output (I/O) functions were measured at 7f2 frequencies (1 to 8 kHz; f2/f1 = 1.22) over a range of levels (-5 to 95 dB SPL) in normal-hearing and hearing-impaired human ears. L1-L2 was level dependent in order to produce the largest 2f1-f2 responses in normal ears. System distortion was determined by collecting DP data in six different acoustic cavities. These data were used to derive a multiple linear regression model to predict system distortion levels. The model was tested on cochlear-implant users and used to estimate system distortion in all other ears. At most but not all f2's, measurements in cochlear implant ears were consistent with model predictions. At all f2 frequencies, the ears with normal auditory thresholds produced I/O functions characterized by compressive nonlinear regions at moderate levels, with more rapid growth at low and high stimulus levels. As auditory threshold increased, DPOAE threshold increased, accompanied by DPOAE amplitude reductions, notably over the range of levels where normal ears showed compression. The slope of the I/O function was steeper in impaired ears. The data from normal-hearing ears resembled direct measurements of basilar membrane displacement in lower animals. Data from ears with hearing loss showed that the compressive region was affected by cochlear damage; however, responses at high levels of stimulation resembled those observed in normal ears.	Acoustical Society of America	2001	110(6):3119-31
Boege P, Janssen T	Pure-tone threshold estimation from extrapolated distortion product Otoacoustic emission I/O-functions in normal and cochlear hearing loss ears.	A new method for direct pure-tone threshold estimation from input/output functions of distortion product otoacoustic emissions (DPOAEs) in humans is presented. Previous methods use statistical models relating DPOAE level to hearing threshold including additional parameters e.g., age or slope of DPOAE I/O-function. Here we derive a DPOAE threshold from extrapolated DPOAE I/O-functions directly. Cubic 2 f1-f2 distortion products and pure-tone threshold at f2 were measured at 51 frequencies between f2=500 Hz and 8 kHz at up to ten primary tone levels between L2=65 and 20 dB SPL in 30 normally hearing and 119 sensorineural hearing loss ears. Using an optimized primary tone level setting (L1 = 0.4L2 + 39 dB) that accounts for the nonlinear interaction of the two primaries at the DPOAE generation site at f2, the pressure of the 2 f1-f2 distortion product pDP is a linear function of the primary tone level L2. Linear regression yields correlation coefficients higher than 0.8 in the majority of the DPOAE I/O-functions. The linear behavior is sufficiently fulfilled for all frequencies in normal and impaired hearing. This suggests that the observed linear functional dependency is quite general. Extrapolating towards pDP=0 yields the DPOAE threshold for L2. There is a significant correlation between DPOAE threshold and pure-tone threshold (r=0.65, p<0.001). Thus, the DPOAEs that reflect the functioning of an essential element of peripheral sound processing enable a reliable estimation of cochlear hearing threshold up to hearing losses of 50 dBHL without any statistical data.	Acoustical Society of America	2002	111(4):1810-8

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Author(s)	Title	Summary	Journal	Year	Vol:Pages
Whitehead ML, Stagner BB, Lonsbury-Martin BL, Martin GK	Effects of ear-canal standing waves on measurements of distortion-product Otoacoustic emissions.	At frequencies above 3 kHz, standing waves in the ear canal complicate calibration of stimulus sound-pressure levels (SPLs) for measurements of distortion-product otoacoustic emissions (DPOAEs). In the literature, two stimulus-presentation strategies have been used for DPOAE measurements. In the "in-the-ear adjustment" strategy, the voltage command to the speakers is adjusted to maintain a constant stimulus SPL across frequency at the DPOAE-measurement microphone. In the "iso-voltage" strategy, the voltage presented to the speakers is held constant across frequency, on the basis of the assumption that the frequency response of the speakers is approximately flat at the eardrum in the average human ear canal. Because of standing-wave effects, there are large, systematic but idiosyncratic differences of stimulus SPL between the two strategies. DPOAE-versus-frequency functions ("DPOAE audiograms") obtained using both stimulus-presentation strategies in the same ears are presented. The differences of stimulus SPL between the two strategies, and the associated differences of DPOAE amplitude, are described and quantified. Around frequencies of standing-wave minima at the DPOAE probe, the in-the-ear adjustment strategy resulted in smaller DPOAEs at high L1 = L2, but much larger DPOAEs at low L1 = L2, than did the iso-voltage strategy. For any L1, the DPOAE-amplitude differences between the two strategies varied systematically with L1-L2. At the stimulus levels used to construct previously published population norms for clinical applications (i.e., L1 > or = 65 dB SPL), there are only small differences of mean DPOAE amplitudes, and of the standard deviations of these means, between the two strategies.	Acoustical Society of America	1995	98(6):3200-14
NEONATAL ASSESSMENT					
Janssen T, Gehr DD, Klein A, Muller J	Distortion product Otoacoustic emissions for hearing threshold estimation and differentiation between middle-ear and cochlear disorders in neonates.	Our aim in the present study was to apply extrapolated DPOAE I/O-functions [J. Acoust. Soc. Am. 111, 1810-1818 (2002); 113, 3275-3284 (2003)] in neonates in order to investigate their ability to estimate hearing thresholds and to differentiate between middle-ear and cochlear disorders. DPOAEs were measured in neonates after birth (mean age = 3.2 days) and 4 weeks later (follow-up) at 11 test frequencies between f2 = 1.5 and 8 kHz and compared to that found in normal hearing subjects and cochlear hearing loss patients. On average, in a single ear hearing threshold estimation was possible at about 2/3 of the test frequencies. A sufficient test performance of the approach is therefore suggested. Thresholds were higher at the first measurement compared to that found at the follow-up measurement. Since thresholds varied with frequency, transitory middle ear dysfunction due to amniotic fluid instead of cochlear immaturity is suggested to be the cause for the change in thresholds. DPOAE behavior in the neonate ears differed from that found in the cochlear hearing loss ears. From a simple model it was concluded that the difference between the estimated DPOAE threshold and the DPOAE detection threshold is able to differentiate between sound conductive and cochlear hearing loss.	Acoustical Society of America	2005	117(5):2969-79

Author(s)	Title	Summary	Journal	Year	Vol:Pages
HEARING AID SELECTION / ADJUSTMENT					
Müller J, Janssen T	Similarity in loudness and distortion product Otoacoustic emission input/output functions: implications for an objective hearing aid adjustment.	The aim of the present study was to compare distortion product otoacoustic emissions (DPOAEs) to loudness with regard to the potentiality of DPOAEs to determine characteristic quantities of the cochlear-impaired ear and to derive objective hearing aid parameters. Recently, Neely et al. [J. Acoust. Soc. Am. 114, 1499-1507 (2003)] compared DPOAE input/output functions to the Fletcher and Munson [J. Acoust. Soc. Am. 5, 82-108 (1933)] loudness function finding a close resemblance in the slope characteristics of both measures. The present study extended their work by performing both loudness and DPOAE measurements in the same subject sample, and by developing a method for the estimation of gain needed to compensate for loss of cochlear sensitivity and compression. DPOAEs and loudness exhibited similar behavior when plotted on a logarithmic scale and slope increased with increasing hearing loss, confirming the findings of Neely et al. To compensate for undesired nonpathological impacts on the magnitude of DPOAE level, normalization of DPOAE data was implemented. A close resemblance between gain functions based on loudness and normalized DPOAE data was achieved. These findings suggest that DPOAEs are able to quantify the loss of cochlear sensitivity and compression and thus might provide parameters for a noncooperative hearing aid adjustment.	Acoustical Society of America	2004	115(6):3081-91
OTOTOXICITY					
Berg AL, Spitzer JB, Garvin JH Jr.	Ototoxic impact of cisplatin in paediatric oncology patients.	OBJECTIVE: To describe hearing changes in a group of 28 children (age range, 8-180 mo) undergoing protocol-based cisplatin therapy. METHODS: Conventional, play audiometry, visual reinforcement audiometry (VRA), immittance audiometry, transient click evoked otoacoustic emissions (OAEs), and auditory brainstem response (ABR) evoked potentials were used to assess peripheral sensitivity and for threshold determination. RESULTS: Bilateral symmetrical high-frequency sensorineural hearing loss was noted in 9 of the 28 children (26%). Hearing loss was evident as early as 1 month after chemotherapy and as late as 50 months and was not dependent on individual or cumulative dosage of cisplatin. CONCLUSIONS: 1) Presence of sensorineural hearing loss was independent of individual and/or cumulative dosage of cisplatin; 2) audiologic assessment should be incorporated into a child's periodic medical evaluations after chemotherapy treatment, as onset of sensorineural hearing loss cannot be predicted; 3) personal hearing aids may be indicated for those children with hearing loss affecting the low- to mid-frequencies; a personal assistive listening device (frequency modulated system) may be more appropriate for losses above 3000 Hz; and 4) evaluation and intervention by a speech-language pathologist may be indicated to address possible articulation or language development problems consequent to hearing loss.	Laryngoscope	1999	109(11):1806-14

Author(s)	Title	Summary	Journal	Year	Vol:Pages
Fausti SA, Larson VD, Noffsinger D, Wilson RH, Phillips DS, Fowler CG	High-frequency audiometric monitoring strategies for early detection of ototoxicity	Therapeutic drugs such as the aminoglycoside antibiotics (AMG) and the chemotherapy agent cisplatin (CDDP) are known to cause irreversible hearing loss, typically affecting highest frequency hearing first with progression of loss to the lower frequency regions. Conventional (0.25-8 kHz) and high-frequency (9-20 kHz) serial hearing threshold monitoring was done in 123 hospitalized patients (222 ears) administered AMG or CDDP. Of ears showing a decrease in sensitivity corresponding with treatment, 62.5% demonstrated initial hearing loss solely in the high-frequency range, 13.5% first showed loss only in the conventional-frequency range, and 24.0% showed loss in both frequency ranges concurrently. Thus, if only high frequencies had been monitored, early change in auditory sensitivity would have been detected in 86.5% of these patients. Further analysis revealed a range of five frequencies, specific to each individual's hearing threshold configuration, in which initial ototoxicity appeared most likely to be detected. Testing only these five frequencies would have identified 89.2% of ears that showed change. The results of this study confirm the need to serially monitor auditory thresholds, especially in the high-frequency range, of patients receiving ototoxic drugs. A shortened five-frequency monitoring protocol is presented and suggested for use with patients unable to tolerate lengthy audiometric testing procedures.	Ear & Hearing	1994	15(3):232-239
Kopelman J, Budnick AS, Sessions RB, Kramer MB, Wong GY	Ototoxicity of high-dose cisplatin by bolus administration in patients with advanced cancers and normal hearing.	Our institution undertook a phase I trial to define the toxicity of high-dose (150 to 225 mg) bolus administration (every 3 to 4 weeks) of cisplatin in patients with advanced cancers. All patients reported had baseline normal hearing. Hearing levels were measured prior to each course of chemotherapy. Audiological monitoring included conventional assessment of pure tone sensitivity at 500 to 8,000 Hz and assessment of ultra high frequencies (9,000 to 20,000 Hz). After one to two doses, 100% of patients failed to respond at 9,000 Hz and above. In the 2,000 to 8,000 Hz range, repeated administration of the drug effected successively lower frequencies with progressive loss, until a maximum threshold shift or plateau was reached at each frequency between 3,000 and 8,000 Hz. The plateau for cisplatin ototoxicity appears to fall within the moderate hearing loss range (40 to 60 dB HL) in the high frequencies. All patients complained of tinnitus and difficulty understanding speech in the presence of background noise. The pattern of pure tone audiometric alteration is consistent in all patients, all dosages, and each method of administration. The ultra high frequency alteration is prompt and dramatic.	Laryngoscope	1988	98(8):858-64
Lonsbury-Martin BL, Martin GK	Evoked Otoacoustic emissions as objective screeners for Ototoxicity.	Ototoxicity produces hearing losses that are irreversible. The only certain method of preventing debilitating ototoxicity is to detect it as early as possible in the treatment regimen so that medications can be substituted, doses changed, and/or the mode of administration altered. With increasing survival rates of patients requiring ototoxic medication (e.g., aminoglycosides, cisplatin), early detection of ototoxicity is important for providing effective management options. A protocol including the use of otoacoustic emissions to detect and monitor the impact of ototoxicity will be presented.	Seminars in Hearing	2001	22:377-392

Author(s)	Title	Summary	Journal	Year	Vol:Pages
Stavroulaki P, Apostolopoulos N, Segas J, Tsakanikos M, Adamopoulos G	Evoked Otoacoustic emissions -an approach for monitoring cisplatin induced ototoxicity in children.	OBJECTIVES: Cisplatin chemotherapy is associated with an increased risk of ototoxic changes. The incidence of hearing loss after the 1st cisplatin-infusion session is only scarcely mentioned in the international literature. With increasing survival rates, prevention and/or early detection of ototoxicity are important for providing management options. The predictive value of pure-tone audiometry in early detection of ototoxicity has been questioned, particularly in the higher frequencies. Otoacoustic emissions appear to be more sensitive to cochlear insult than the conventional pure-tone audiometry. The aims of our study was (a) to define the extent of hearing damage in children after the 1st cisplatin-infusion session (50 mg/m(2)); and (b) to compare the efficacy of otoacoustic emissions (transient evoked otoacoustic emissions, distortion-product otoacoustic emissions) with that of pure-tone audiometry as methods of audiological monitoring. METHODS: Baseline audiometric (0.25-8 kHz) and otoacoustic emission testing (transient evoked otoacoustic emissions, distortion-product otoacoustic emissions) was conducted in 19 children, 12 of whom met the criteria for inclusion in the final study. Comparisons were performed between baseline measurements and those recorded after the 1st cisplatin course. Transient evoked otoacoustic emissions were analyzed in terms of emission level and reproducibility as a function of frequency (0.8-4 kHz). Distortion-product otoacoustic emissions were obtained as DP-grams and I/Q functions at 4,6 and 8 kHz. The DP-gram amplitude, the dynamic range and the detection thresholds from the I/Q functions were determined for each child. RESULTS: Threshold changes from baseline were founded to be statistically significant from 4-8 kHz in 50% of the children (P<0.01). Transient evoked otoacoustic emissions revealed a significant decrease in the emission level and in the reproducibility at the highest frequency tested (4 kHz, P<0.01), reflecting the results seen in pure-tone audiometry. Distortion-product otoacoustic emissions demonstrated a significant threshold shift, a reduced dynamic range and a decreased amplitude in the frequencies >3 kHz (P<0.05). Furthermore, DP-gram amplitude also reduced significantly at 3 kHz (P<0.05) without any similar change in pure-tone audiometry. CONCLUSIONS: A significant high-frequency hearing loss is identified in children even after one low-dose cisplatin-infusion session. As ototoxicity screening tools DP-grams were extremely sensitive and superior to pure-tone audiometry and/or transient evoked otoacoustic emissions. Their use is recommended for regular monitoring of cochlear function, aiming in prevention of permanent damage. Some suggestions for reducing the potential for cisplatin ototoxicity (chemoprotective agents, gene therapy, inhibition of apoptosis) are also discussed.	Paediatric Otorhino-laryngology	2001	59(1):47-57

Author(s)	Title	Summary	Journal	Year	Vol:Pages
		TINNITUS			
Janssen T, Kummer P, Wolfgang A	Growth behavior of the 2 f1 – f2 distortion product Otoacoustic emission in tinnitus	High-resolution hearing threshold and 2 *f*1 – *f*2 distortion product otoacoustic emission (DP) were measured with the same in-the-ear sound probe and same calibration at 51 frequencies between 500 and 8000 Hz in 39 sensorineural hearing loss ears associated with tinnitus. Using a primary tone setting *L*1 = 0.4*L*2 + 39 that accounts for the nonlinear interaction of the two primary tones at the DP generation site at *f*2, DPs were elicited in a wide range from *L*2 = 65 to 20 dB SPL. We failed to find a uniform DP behavior in the 39 tinnitus ears tested. Seventeen of them behaved like impaired ears without tinnitus. In these ears a linearized DP growth was observed where the DP level decreased and the slope of the DP I/O functions steepened with increasing hearing loss and as a result both the DP level and the DP slope strongly correlated with hearing threshold. The other population, 22 tinnitus ears, exhibited a poor or even inverse relationship between DP level and hearing threshold, i.e., displayed an increase of DP level with increasing hearing loss. Despite the severe hearing loss but due to the high level, DPs could be recorded well in the frequency range that corresponded to the appearance of the tinnitus. The DP slope, however, increased with increasing hearing loss and, therefore, did still correlate with hearing threshold revealing pathological alteration. The data suggest that the DP level alone is hardly capable of assessing hearing impairment in tinnitus ears and may even be misleading. Thus just the DP slope seems to be the only reliable indicator of cochlear malfunction around the tinnitus frequency. The observed nonuniform DP behavior suggests different cochlear impairments in tinnitus ears. In those ears where the DP level decreases and the slope of the I/O functions increases with hearing loss, cochlear sensitivity and tuning are supposed to be diminished. In those ears where the DP level increases with increasing hearing loss, a reinforced mechanical distortion is hypothetized to be generated by cochlear hyperactivity that can be the source of both the abnormally high DP level and the tinnitus. *©1998 Acoustical Society of America.*	Acoustical Society of America	1998	103(6):3418-30