Quarterly Abstract Update

April – June 2007

Part B: L-Z

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68 **"Lateralization discrimination of interaural time delays in four-pulse sequences in electric and acoustic hearing".** Laback, B.; Majdak, P.; Baumgartner, W. D.; (2007); J Acoust Soc Am. 121(4):2182-2191

This study examined the sensitivity of four cochlear implant (CI) listeners to interaural time difference (ITD) in different portions of four-pulse sequences in lateralization discrimination. ITD was present either in all the pulses (referred to as condition Wave), the two middle pulses (Ongoing), the first pulse (Onset), the last pulse (Offset), or both the first and last pulse (Gating). All ITD conditions were tested at different pulse rates (100, 200, 400, and 800 pulses/s pps). Also, five normal hearing (NH) subjects were tested, listening to an acoustic simulation of CI stimulation. All CI and NH listeners were sensitive in condition gating at all pulse rates for which they showed sensitivity in condition Wave. The sensitivity in condition Onset increased with the pulse rate for three CI listeners as well as for all NH listeners. The performance in condition Ongoing varied over the subjects. One CI listener showed sensitivity up to 800 pps, two up to 400 pps, and one at 100 pps only. The group of NH listeners showed sensitivity up to 200 pps. The result that CI listeners detect ITD from the middle pulses of short trains indicates the relevance of fine timing of stimulation pulses in lateralization and therefore in CI stimulation strategies.

69. **"Image-guided technique in neurotology".** Labadie, R. F.; Majdani, O.; Fitzpatrick, J. M.; (2007); Otolaryngologic.Clinics.of North America. 40(3):611-624

To date, clinical application of image-guided surgery (IGS) to otology/neurotology has been limited, but a large potential market and numerous applications support use. Such applications include control of surgical instruments (eg, turning off a drill when close to an anatomic boundary), robotic surgery (eg, robotic mastoidectomy), and minimally invasive surgery (eg, percutaneous cochlear implantation).

70. **"Comparing neural response telemetry amplitude growth functions with loudness growth functions: preliminary results".** Lai, W. K. & Dillier, N.; (2007); Ear Hear. 28(2 Suppl):42S-45S

Comparisons of the subjective loudness growth function and the objective evoked compound action potential (ECAP) amplitude growth function indicate that both functions are exponential in nature. This implies that a more accurate estimate of the ECAP threshold would be obtained using exponential regression of the amplitude growth function instead of the currently used linear regression. The perceptual threshold and the ECAP threshold seem to approach each other when the stimulation rate is lowered to reduce temporal summation effects. The effect of the stimulation rate on the perceptual threshold will have to be taken into account when trying to use the ECAP threshold for predicting the perceptual threshold.

71. **"The application and computer simulation of multi-channel cochlear implant based on all phase DFT filter".** Lan, T.; Zhengxin, H.; Zhimin, P.; (2007); Sch.of Inf.Sci.& Eng., Shandong Univ., Jinan, ChinaIV-701

Band-pass filter bank is an essential part in cochlear implant (CI). Its characteristics are important for synthesized sound quality because the outputs of filter bank contain a lot of fine structure cues which need to be encoded and transmitted to implanted electrode and then to stimulate auditory nerves. All phase DFT (APDFT) filter is a novel and high efficient digital filter, which possesses concurrent merits, such as zero-phase (or all-phase), abrupt cut-off characteristic. This paper presents the principle and the design method of APDFT filter bank and applies this filter into CI signal processing. Under the same acoustic simulation conditions, based on the continuous interleaved sampling (CIS) strategy, we analyze and evaluate the simulation results. Comparing with classical Butterworth filter bank adopted in CI processors, some objective waveform and spectra show that the output signal from APDFT filter bank is much closer to the original sound. For the normal-hearing (NH) listener, the synthetic speech and music by the APDFT filter bank have higher quality, and perceptual tests on six NH listeners primarily verify the improvement of intelligibility in noise. Thus, the APDFT filter could potentially improve the hearing quality for CI user.

72. **"Does music perception have an impact on quality of life following cochlear implantation?".** Lassaletta, L.; Castro, A.; Bastarrica, M.; Perez-Mora, R.; Madero, R.; De, S. J.; Gavilan, J.; (2007); Acta Oto-Laryngologica. 127(7):682-686

Conclusion: Despite the decrease in listening habits, about half of the patients still enjoy music post implantation. Better quality of sound through the implant improves music enjoyment and contributes to achievement of better postoperative quality of life (QOL). Objectives: To evaluate music perception and enjoyment in cochlear implant (CI) users, and to assess their influence on QOL. Materials and methods: Sixty-five post-lingually deaf CI recipients were enrolled in this study. A musical questionnaire evaluated musical background, listening habits, and quality of musical sound through the CI. The validated Glasgow Benefit Inventory (GBI) was used to quantify changes in QOL. Results: Fifty-two patients answered the questionnaires. Listening habits (music enjoyment and hours spent listening to music per week) significantly decreased following implantation when compared with the same parameters before deafness. Nevertheless, 52% of the patients enjoyed music post implantation. The quality of musical sound was rated >50 (0-100 scale) for the adjective pairs 'like-dislike', 'sounds like music-doesn't sound like music' and 'natural-mechanical' by most users. Med-el device users obtained better scores in the adjective pair 'sounds like music-doesn't sound like music' than Cochlear device users. Recipients rating higher scores for quality of sound enjoyed music post implantation and had higher total GBI scores than those rating lower scores.

73. **"APSCI panel discussion I: Imaging and surgical issues".** Laszig, R.; Chang, S. O.; Kubo, T.; Ramos, M. A.; Frijns, J. H.; Briggs, R.; Haynes, D. S.; (2007); Ear Hear. 28(2 Suppl):119S-123S

This is a short overview on imaging techniques in pre-, peri- and postoperative evaluation of cochlear-implant patients. Surgery techniques are described as well as possible complications and how to avoid them.

74. **"Neurotrophic effects of GM1 ganglioside and electrical stimulation on cochlear spiral ganglion neurons in cats deafened as neonates".** Leake, P. A.; Hradek, G. T.; Vollmer, M.; Rebscher, S. J.; (2007); J Comp Neurol. 501(6):837-853

Previous studies have shown that electrical stimulation of the cochlea by a cochlear implant promotes increased survival of spiral ganglion (SG) neurons in animals deafened early in life (Leake et al. [1999] J Comp Neurol 412:543-562). However, electrical stimulation only partially prevents SG degeneration after deafening and other neurotrophic agents that may be used along with an implant are of great interest. GM1 ganglioside is a glycosphingolipid that has been reported to be beneficial in treating stroke, spinal cord injuries, and Alzheimer's disease. GM1 activates trkB signaling and potentiates neurotrophins, and exogenous administration of GM1 has been shown to reduce SG degeneration after hearing loss. In the present study, animals were deafened as neonates and received daily injections of GM1, beginning either at birth or after animals were deafened and continuing until the time of cochlear implantation. GM1-treated and deafened control groups were examined at 7-8 weeks of age; additional GM1 and no-GM1 deafened control groups received a cochlear implant at 7-8 weeks of age and at least 6 months of unilateral electrical stimulation. Electrical stimulation elicited a significant trophic effect in both the GM1 group and the no-GM1 group as compared to the contralateral, nonstimulated ears. The results also demonstrated a modest initial improvement in SG density with GM1 treatment, which was maintained by and additive with the trophic effect of subsequent electrical stimulation. However, in the deafened ears contralateral to the implant SG soma size was severely reduced several months after withdrawal of GM1 in the absence of electrical activation.

75. **"Cortical activity at rest predicts cochlear implantation outcome".** Lee, H. J.; Giraud, A. L.; Kang, E.; Oh, S. H.; Kang, H.; Kim, C. S.; Lee, D. S.; (2007); Cerebral Cortex. 17(4):909-917

The functional status of central neural pathways, in particular their susceptibility to plasticity and functional reorganization, may influence speech performance of deaf cochlear implant users. In this paper, we sought to determine how brain metabolic activity measured before implantation relates to cochlear implantation outcome, that is, speech perception. In 22 prelingually deaf children between 1 and 11 years, we correlated preoperative glucose metabolism as measured by F-18

fluorodeoxyglucose positron emission tomography with individual speech perception performance assessed 3 years after implantation, while factoring out the confounding effect of age at implantation. Whereas age at implantation was positively correlated with increased activity in the right superior temporal gyrus, speech scores were selectively associated with enhanced metabolic activity in the left prefrontal cortex and decreased metabolic activity in right Heschl's gyrus and in the posterior superior temporal sulcus. These results reinforce the notion that implantation should be performed as early as possible to prevent cross-modal takeover of auditory regions and suggest that rehabilitation strategies may be more efficient if they capitalize on general cognitive functions instead of only targeting specialized circuits dedicated to auditory and audiovisual pattern recognition.

76. **"The tone production performance of children receiving cochlear implants at different ages".** Lee, K. Y.; Tong, M. C.; van Hasselt, C. A.; (2007); Ear Hear. 28(2 Suppl):34S-37S

Sixty prelingually deaf children were tested on Cantonese tone production ability at seven time intervals. Results of linear regression showed children in general improved in tone production performance over time. The magnitude of improvement, nevertheless, was different for children implanted at different ages. For children to acquire tone acquisition satisfactory, a critical age of four to receive implant is suggested. Optimally, children should receive their implant before two where they will be able to achieve around 80% accuracy in tone production within 1 yr of implant use. Children received their implant from two to just below 4 yr old achieved high tone production accuracy but needed a longer duration of implant experience. Children who received their implants at the age of 4 yr or older made little, if any, progress in producing tones correctly even after four to 5 yr of implant use.

77. **"Sudden hearing loss, deafness, cochlear implant and central auditory implants".** Lenarz, T.; (2007); Medizinische.Welt. 58(4):149-155

Sudden dysfunction of the inner ear, either uni- or less frequent bilaterally can cause sudden hearing loss. An acute circulation disorder of the cochlea is discussed as the most probable pathophysiology. The wide range of etiologies, however, requires a standardized diagnostic protocol including different audiometric tests, imaging, serological tests and psychosomatic exploration. Immediate treatment with corticosteroids, vasodilating drugs and increase of blood volume is recommended. In cases of total sudden deafness, a tympanoscopy should be done to diagnose and repair a perilymph fistula of the round window membrane. In cases of bilateral cochlear deafness hearing can be restored by cochlear implants. They replace the function of the inner ear by electrical stimulation of the preserved auditory nerve. Congenitally deaf children can achieve near to normal speech and language acquisition, while postlingually deafened patient s regain hearing to the level of free speech understanding.

Patients with bilateral neural deafness with damaged or missing auditory nerves cannot benefit from cochlear implants. Electrical stimulation central to the auditory nerve at the level of the cochlear nucleus (Auditory Brainstem Implant, ABI) or the inferior colliculus (Auditory Midbrain Implant, AMI) can be used for auditory rehabilitation. Indications, surgical procedure, postoperative fitting and results are described.

78. **"Indications for and outcomes of mastoid obliteration in cochlear implantation".** Leung, R. & Briggs, R. J.; (2007); Otol Neurotol. 28(3):330-334

OBJECTIVE: To review the indications, efficacy, and long-term outcomes of mastoid obliteration in cochlear implant surgery. STUDY DESIGN: Retrospective case review. SETTING: Tertiary referral center. PATIENTS: Seventeen patients who underwent a mastoid obliteration procedure to facilitate the insertion of a cochlear implant between 1978 and 2005. INTERVENTION: Mastoid obliteration procedure before cochlear implantation. MAIN OUTCOME MEASURES: Revision rate of the mastoid obliteration and cochlear implantation, postoperative audiometric scores (consonant-nucleus-consonant words/phonemes, Central Institute for the Deaf sentences, City University New York sentences in quiet and in noise), and incidence of complications. RESULTS: There were 17 patients with a median age of 60 years (range, 3-79 yr). Eight patients required mastoid obliteration for active chronic suppurative otitis media before cochlear implantation. Another 8 patients had existing mastoid cavities requiring obliteration (modified radical [n = 5] and fenestration cavities [n = 3]). A single patient with a sclerotic mastoid and an anterior sigmoid sinus underwent obliteration because of inadequate surgical access. The technique of obliteration was radical mastoidectomy with eustachian tube occlusion, blind sac closure of the external auditory canal, and cavity obliteration with either temporalis muscle flap (n = 15) or abdominal fat (n = 2). Cochlear implantation and mastoid obliteration were performed as a two-stage procedure in 10 patients and as a single-stage procedure in 7. Two patients required revision of the mastoid obliteration. At follow-up, all patients had stable obliterated cavities. Fifteen patients obtained significant improvement in speech discrimination scores, whereas 2 patients obtained some benefit from the cochlear implant through the perception of environmental sounds. CONCLUSION: For patients with chronic suppurative otitis media or existing mastoid cavities, the obliteration with temporalis muscle or abdominal fat is an effective technique to facilitate safe cochlear implantation.

79. **"Continuous improvement in Mandarin lexical tone perception as the number of channels increased: A simulation study of cochlear implant".** Lin, Y. S.; Lee, F. P.; Huang, I. S.; Peng, S. C.; (2007); Acta Otolaryngol. 127(5):505-514

Conclusion: With reference to English phoneme recognition, where performance usually does not improve after six or eight channels in cochlear implants (CIs), increasing total channel numbers continuously improved perception of Mandarin

tones. Objective: To test our hypothesis that current CI strategies might be modified to improve Mandarin lexical tonal perception. Materials and methods: Lexical tonal perception tests using 48 monosyllables in Mandarin Chinese were conducted in 32 native Mandarin speakers with normal hearing. The performance of tonal perception was compared among the controlled factors, which were total channel number, number of channels allocated to the F0 spectrum, and whether there were spectral shifts in the electrode configuration. The experimental condition that preserves fine structure was used as a comparison. Results: The signal processing strategy using 16 channels - which is technically possible with current CI devices - produced better tonal perception than those using 12 or 8 channels. Increasing the number of fundamental channels did not improve tonal perception, and spectral shifts did not change tonal perception. An experimental condition (FiC12) that preserves the fine structure produced significantly better overall scores for tone perception than other experimental conditions with envelope strategies.

80. **"Biofilm formation in an in vitro model of cochlear implants with removable magnets".** Loeffler, K. A.; Johnson, T. A.; Burne, R. A.; Antonelli, P. J.; (2007); Otolaryngol Head Neck Surg. 136(4):583-588

BACKGROUND: Cochlear implant (CI) recesses, such as the removable magnet pocket, appear to harbor more biofilm than smooth surfaces. The aim of this study was to examine the impact of removable magnets on biofilm formation in an in vitro model. METHODS: Silastic models were constructed to represent CIs with and without a magnet pocket and with and without a titanium blank in the pocket. CIs were exposed to a culture of a biofilm forming strain of Staphylococcus aureus. Adherence of planktonic bacteria and biofilm formation were assessed with quantitative bacterial counts and scanning electron microscopy. RESULTS: Adherent bacterial counts were significantly higher in CI models with an empty magnet pocket (P = 0.0097). Biofilm formation was significantly lower in CI models without a magnet pocket (P = 0.0121). CONCLUSIONS: CI magnet pockets harbor bacteria that can increase biofilm development in an in vitro model.

81. **"Comparisons of quality ratings for music by cochlear implant and hearing aid users".** Looi, V.; McDermott, H.; McKay, C.; Hickson, L.; (2007); Ear Hear. 28(2 Suppl):59S-61S

OBJECTIVES: This study aimed to compare the quality ratings by cochlear implant (CI) and hearing aid (HA) users in response to musical sounds. DESIGN: The ratings of 15 experienced adult Nucleus CI users (using the Advanced Combination Encoder (ACE) or Spectral Peak (SPEAK) strategy) were compared with those of 15 experienced adult HA users who met the audiological criteria for implantation. Additionally, nine subjects on the waiting list (WL) for an implant were tested before and after implantation. Three types of musical stimuli were used: single instruments, solo instruments with background accompaniment, and ensembles. For each of these categories, 12 different instruments or ensembles

were presented four times each. Subjects were asked to provide a rating out of 10 according to how pleasant each extract sounded, with 10 being "very pleasant." RESULTS: For the WL subjects, ratings provided after implantation were significantly higher than their preimplant ratings obtained when using HAs ($p = 0.026$). This was consistent with a trend observed from the experienced CI and HA groups, whereby the CI group provided higher ratings than the HA group for all three subtests, although the difference was not statistically significant. For all groups, single-instrument stimuli received significantly higher ratings than those involving multiple instruments (CI and HA subjects: $p < 0.001$; WL subjects: $p = 0.034$). With this research being part of a larger study in which identification testing of these stimuli had previously been conducted, significant correlations were also obtained between the subjects' ability to identify musical stimuli and the corresponding quality ratings (CI: $rho = 0.325$, $p = 0.029$; HA: $rho = 0.491$, $p = 0.001$). CONCLUSIONS: The findings of this study suggest that although neither device enables highly satisfactory music appreciation, the CI users judged music to sound more pleasant than the HA users (who had similar levels of hearing impairment). Also, all subject groups appraised music that involved multiple instruments to sound less pleasant, on average, than music played by single instruments.

82. **"Hybrid cochlear implantation: clinical results and critical review in 13 cases".** Luetje, C. M.; Thedinger, B. S.; Buckler, L. R.; Dawson, K. L.; Lisbona, K. L.; (2007); Otol Neurotol. 28(4):473-478

OBJECTIVE: To substantiate the benefits of hybrid cochlear implantation (CI) in patients with residual low-frequency hearing. STUDY DESIGN:: Prospective study of patients in a manufacturer-sponsored clinical trial. SETTING:: Independent referral center for CI. PATIENTS: Thirteen patients who met candidacy criteria for a hybrid CI. The 10 women and 3 men had a mean age of 51 years. INTERVENTION: Preoperative evaluation, CI with a Nucleus Hybrid cochlear implant, subsequent programming, and diagnostic testing. MAIN OUTCOME MEASURES: Benefits of high-frequency electrical stimulation from the hybrid CI as measured by conventional audiometry, consonant-nucleus-consonant monosyllabic word and Bamford-Kowal-Bench sentence in noise testing at quarterly intervals per protocol. RESULTS: Follow-up ranged from 3 to 24 months. All 13 patients had preserved hearing immediately postoperative. However, one lost residual hearing 7 days postoperatively, and 2 patients had delayed hearing losses at 2 and 24 months, the latter apparently due to barotrauma; however, this was not conclusive. Another had a bilateral symmetrically progressive hearing loss. Six patients showed changes in low-frequency hearing less than 10 dB; 2 showed changes in the range 11 to 20 dB; 2, 21 to 30 dB; and 3, more than 50 dB. Eleven of 13 had improved consonant-nucleus-consonant words ranging up to 83% when tested with hearing aid + CI in the operated ear. Four subjects exhibited improvement in Bamford-Kowal-Bench sentence in noise testing, although only one subject showed a significant decline associated with bilateral progression in hearing impairment. CONCLUSION: Combined electrical and

acoustical hearing can result in significant improvement in speech understanding. Only one patient lost residual hearing as a direct result of surgery. Two others had delayed losses. There are no absolute predictive factors as to success with hybrid CI, just as there are none for conventional CI. Similarly, wide variation in results may occur. Further studies may clarify factors involved in such variation.

83. **"Preoperative integrated imaging in paediatric cochlear implantation".** Lupo, F. A.; Sticchi, G.; Paladini, A.; Perfetto, S. C.; Perrone, A.; De, B. M.; Vitale, S.; (2007); Neuroradiology Journal. 20(2):169-174

Sensorineural hearing loss affects one to two children out of 1000 born apparently healthy and 9% approximately of those born with the risk of different pathologies. The origin of premature deafness is unknown in 25% of children whereas it is genetic in some cases. Prevention and early diagnosis, possibly within six to eight months, aim to avoid deafness becoming a cause of disability. The aim of the present study was to establish the optimal preoperative assessment with a diagnostic imaging protocol involving the integrated use of CT and MRI in the selection of the candidates for cochlear implantation. Twenty children were assessed, divided into three different groups: A) those who had CT only; B) those who had only MR; C) those who had both CT and MRI. The purpose was to estimate diagnostic accuracy in preoperative planning and the role of imaging in the diagnostic protocol for children's deafness. The petro us pyramid was studied with a CT Picker PQ 6000 system to high resolution in the axial and coronal planes, and with an MR Intera Philips 0.5 T device by means of acquisition of sequences B-TFE T2 3D and MIP reconstructions on radial coronal plans. This study was completed successfully for morphological brain MRI examination to complete the diagnosis. The following abnormalities were found in six patients (30%): one case of incomplete partition (Mondini malformation); two cases of vestibular aqueduct enlargement; two cases with anomalous jugular bulb positioning; one case with cochlear ossification. In the remaining 70%: eight patients had no anatomical anomalies; CT and MRI imaging were normal in six patients with minor abnormalities disclosed at surgery (one case of the stapedial artery emerging from the promontory); three anatomical variants of the round window, and two abnormal course of the facial nerve). We emphasize the importance of integrated CT and MRI imaging in the study of children with sensorineural hearing loss. The combination of CT and MRI has been shown to be superior to either modality used alone in view of “risk-free”; cochear implantation. High resolution computed tomography and magnetic resonance images obtained by B-TFE T2-weighted 3D sequences help the surgeon in planning the operation and predict operative difficulty and potential complications in paediatric cochlear implant candidates.

84. **"Otosclerosis: Selection of ear for cochlear implantation".** Matterson, A. G.; O'Leary, S.; Pinder, D.; Freidman, L.; Dowell, R.; Briggs, R.; (2007); Otol Neurotol. 28(4):438-446

OBJECTIVES: 1. To examine whether speech perception after implantation is correlated with the total duration of deafness, the duration of deafness in the implanted ear, or age at implantation. 2. To examine whether the rate of facial nerve stimulation postoperatively is correlated with the type of electrode used. STUDY DESIGN: Retrospective case note review. SETTING: Tertiary referral center. PATIENTS: Fifty-nine adults with profound postlingual sensorineural hearing loss due to otosclerosis. INTERVENTION: Cochlear implantation with the Nucleus device using either a straight (n = 35) or Contour (n = 29) electrode array. MAIN OUTCOME MEASURES: Speech perception scores for patients at 3, 6 and 12 months postimplantation were correlated against duration of deafness in the implanted ear, duration of total deafness, and age at implantation. Data on facial nerve stimulation rates postoperatively were collected. RESULTS: Implantation in the shortest deafened ear conferred an initial advantage for speech perception 3 months after surgery; however, this effect was lost by 6 months. There were no significant correlations between the duration of bilateral deafness and hearing outcomes. Age at implantation was negatively correlated with outcome at 3 months, but not at 6 and 12 months. Fourteen of 35 patients with straight electrodes and 0 of 24 patients with Contour electrodes experienced facial nerve stimulation during mapping sessions ($p < 0.005$, chi). CONCLUSION: Patients with otosclerosis are not disadvantaged in the long term by implantation in the longest deafened ear. Increasing age at implantation did not predict poorer outcomes. A perimodiolar design of electrode should be used in otosclerotic patients when possible to reduce the risk of facial nerve stimulation.

85. **"Performance of multisite silicon microprobes implanted chronically in the ventral cochlear nucleus of the cat".** McCreery, D.; Lossinsky, A.; Pikov, V.; (2007); IEEE Transactions on Biomedical Engineering. 54(6):1042-1052

A central auditory prosthesis based on microstimulation within the ventral cochlear nucleus (VCN) offers a means of restoring hearing to persons whose auditory nerve has been destroyed bilaterally and cannot benefit from cochlear implants. Arrays of silicon probes with 16 stimulating sites were implanted into the VCN of adult cats, for up to 314 days. Compound neuronal responses evoked from the sites in the VCN were recorded periodically in the central nucleus of the contralateral inferior colliculus (ICC). The threshold and growth of most of the responses were stable for at least 250 days after implantation of the arrays. The responses evoked from the deepest and shallowest electrode sites did exhibit some changes over time but none of the thresholds exceeded 10 microA. The thresholds and growth of the compound responses from most of the stimulating sites were very stable over time, and comparable to those of chronic ally implanted single-site iridium microelectrodes. Multiunit neuronal activity evoked from the stimulating sites in the VCN was recorded along the dorsolateral-

ventromedial (DLVM) axis of the ICC. The distribution, span and degree of overlap of the multiunit activity demonstrated the utility of the multisite, multishank array configuration as a means of accessing the neuronal populations in the VCN that encode various acoustic frequencies. These findings are encouraging for the prospects of developing an auditory prosthesis employing multisite silicon microprobes.

86. **"[Experiments on prosody perception with cochlear implants].** Meister, H.; Tepeli, D.; Wagner, P.; Hess, W.; Walger, M.; von Wedel, H.; Lang-Roth, R.; (2007); HNO. 55(4):264-270

BACKGROUND AND OBJECTIVE: Prosody has a myriad of linguistic functions and involves specific aspects of speech, such as stress, intonation and pauses. The underlying acoustic quantities (amplitude envelope, pitch frequency, and temporal structure) can be processed and transmitted by cochlear implants (CI) only to a limited extent. At present, no adequate tests are available in the German-speaking world for evaluation of the perception of prosodic elements. Different experiments have been conducted to address several prosodic cues, and the results are to be used as a basis for appropriate tests. METHODS: Various prosodic materials were used for the experiments. Discrimination was measured for minimal pairs differing in frequency and/or duration, accents in words and phrases, questions versus statements and phrasing. Measurements were performed in ten normal-hearing subjects and five with cochlear implants. RESULTS AND CONCLUSIONS: In all test modules, the subjects with normal hearing proved to have high discrimination rates of 96-100%. The test of word stresses was problematic because the results were influenced by different confounders. The other measurements did prove to be basically suitable for use in the subjects with implants. Early results revealed that the subjects with CI had few problems with prosodic cues based on the temporal structure, the outcome being similar to that of the subjects with normal hearing in these tests. In contrast, the performance of subjects with CI in perceiving prosodic cues based on amplitude variations and, especially, on alterations in pitch frequency was worse, even though some of them achieved very good results in these tests too. These preliminary tests can form the basis for development of a German-language prosody test battery with a limited number of subtests addressing different prosodic cues.

87. **"Interactions of speaking condition and auditory feedback on vowel production in postlingually deaf adults with cochlear implants".** Menard, L.; Polak, M.; Denny, M.; Burton, E.; Lane, H.; Matthies, M. L.; Marrone, N.; Perkell, J. S.; Tiede, M.; Vick, J.; (2007); J Acoust Soc Am. 121(6):3790-3801

This study investigates the effects of speaking condition and auditory feedback on vowel production by postlingually deafened adults. Thirteen cochlear implant users produced repetitions of nine American English vowels prior to implantation, and at one month and one year after implantation. There were three speaking conditions

(clear, normal, and fast), and two feedback conditions after implantation (implant processor turned on and off). Ten normal-hearing controls were also recorded once. Vowel contrasts in the formant space (expressed in mels) were larger in the clear than in the fast condition, both for controls and for implant users at all three time samples. Implant users also produced differences in duration between clear and fast conditions that were in the range of those obtained from the controls. In agreement with prior work, the implant users had contrast values lower than did the controls. The implant users' contrasts were larger with hearing on than off and improved from one month to one year postimplant. Because the controls and implant users responded similarly to a change in speaking condition, it is inferred that auditory feedback, although demonstrably important for maintaining normative values of vowel contrasts, is not needed to maintain the distinctiveness of those contrasts in different speaking conditions.

88. **"[Postmeningitis deafness in young children: Action warranted before obliteration of the cochlea]".** Merkus, P.; van Furth, A. M.; Goverts, S. T.; Suer, M.; Smits, C. F.; Smit, C.; (2007); Ned Tijdschr Geneeskd. 151(22):1209-1213

Meningitis may cause inflammation of the cochlea, which may result in deafness and also in rapid obliteration of the cochlea with fibrous tissue or even ossification, conditions that obstruct the placement of a cochlear implant. In the first of two cases of postmeningitis deafness, in a boy aged 6 months and a girl aged 1 year and 9 months, ignorance about the time of audiological follow-up threatened the options for restoration of hearing. In the other case, a long diagnostic programme and an unsuccessful attempt at cochlear implantation caused a long delay in optimal restoration of hearing. Both cases illustrate the difficulties in connection with postmeningitis deafness in relation to the option of a cochlear implant operation. To increase the chances of a successful implantation, the time span between meningitis and audiological and radiological follow-up must be short. Auditory brain stem responses (ABR) and MRI are the keystones of the work-up.

89. **"Direct comparison between properties of adaptation of the auditory nerve and the ventral cochlear nucleus in response to repetitive clicks".** Meyer, K.; Rouiller, E. M.; Loquet, G.; (2007); Hear Res. 228(1-2):144-155

The present study was designed to complete two previous reports [Loquet, G., Rouiller, E.M., 2002. Neural adaptation to pulsatile acoustical stimulation in the cochlear nucleus of the rat. Hear. Res. 171, 72-81; Loquet, G., Meyer, K., Rouiller, E.M., 2003. Effects of intensity of repetitive acoustic stimuli on neural adaptation in the ventral cochlear nucleus of the rat. Exp. Brain Res. 153, 436-442] on neural adaptation properties in the auditory system of the rat. Again, auditory near-field evoked potentials (ANEPs) were recorded in response to 250-ms trains of clicks from an electrode chronically implanted in the ventral cochlear nucleus (VCN). Up to now, our interest had focused on the adaptive behavior of the first one (N(1)) of the two negative ANEP components. A re-examination of our data for the second negative component (N(2)) was now undertaken. Results show that the adaptation

time course observed for N(2) displayed the same three-stage pattern previously reported for N(1). Similarly, adaptation became more pronounced and occurred faster as stimulus intensity and/or repetition rate were increased. Based on latency data which suggest N(1) and N(2) to be mainly due to the activity of auditory-nerve (AN) fibers and cochlear nucleus neurons, respectively, it was concluded that neural adaptation assessed by gross-potentials was similar in the AN and VCN. This finding is meaningful in the context of our search to restore normal adaptation phenomena via electro-auditory hearing with an auditory brainstem implant on the same lines as our work in cochlear implants.

90. **"Auditory prosthesis with a penetrating nerve array".** Middlebrooks, J. C. & Snyder, R. L.; (2007); J Assoc Res Otolaryngol. 8(2):258-279

Contemporary auditory prostheses ("cochlear implants") employ arrays of stimulating electrodes implanted in the scala tympani of the cochlea. Such arrays have been implanted in some 100,000 profoundly or severely deaf people worldwide and arguably are the most successful of present-day neural prostheses. Nevertheless, most implant users show poor understanding of speech in noisy backgrounds, poor pitch recognition, and poor spatial hearing, even when using bilateral implants. Many of these limitations can be attributed to the remote location of stimulating electrodes relative to excitable cochlear neural elements. That is, a scala tympani electrode array lies within a bony compartment filled with electrically conductive fluid. Moreover, scala tympani arrays typically do not extend to the apical turn of the cochlea in which low frequencies are represented. In the present study, we have tested in an animal model an alternative to the conventional cochlear implant: a multielectrode array implanted directly into the auditory nerve. We monitored the specificity of stimulation of the auditory pathway by recording extracellular unit activity at 32 sites along the tonotopic axis of the inferior colliculus. The results demonstrate the activation of specific auditory nerve populations throughout essentially the entire frequency range that is represented by characteristic frequencies in the inferior colliculus. Compared to conventional scala tympani stimulation, thresholds for neural excitation are as much as 50-fold lower and interference between electrodes stimulated simultaneously is markedly reduced. The results suggest that if an intraneural stimulating array were incorporated into an auditory prosthesis system for humans, it could offer substantial improvement in hearing replacement compared to contemporary cochlear implants.

91. **"Music recognition, music listening, and word recognition by deaf children with cochlear implants".** Mitani, C.; Nakata, T.; Trehub, S. E.; Kanda, Y.; Kumagami, H.; Takasaki, K.; Miyamoto, I.; Takahashi, H.; (2007); Ear Hear. 28(2 Suppl):29S-33S

OBJECTIVES: To examine the ability of congenitally deaf children to recognize music from incidental exposure and the relations among age at implantation, music listening, and word recognition. DESIGN: Seventeen child implant users

who were 4 to 8 yr of age were tested on their recognition and liking of musical excerpts from their favorite television programs. They were also assessed on open-set recognition of three-syllable words. Their parents completed a questionnaire about the children's musical activities. RESULTS: Children identified the musical excerpts at better than chance levels, but only when they heard the original vocal/instrumental versions. Children's initiation of music listening at home was associated with younger ages at implantation and higher word recognition scores. CONCLUSIONS: Child implant users enjoy music more than adult implant users. Moreover, younger age at implantation increases children's engagement with music, which may enhance their progress in other auditory domains.

92. **"Interactions of speaking condition and auditory feedback on vowel production in postlingually deaf adults with cochlear implants".** Moenard, L.; Polak, M.; Denny, M.; Burton, E.; Lane, H.; Matthies, M. L.; Marrone, N.; Perkell, J. S.; Tiede, M.; Vick, J.; (2007); J Acoust Soc Am. 121(6):3790-3801

This study investigates the effects of speaking condition and auditory feedback on vowel production by postlingually deafened adults. Thirteen cochlear implant users produced repetitions of nine American English vowels prior to implantation, and at one month and one year after implantation. There were three speaking conditions (clear, normal, and fast), and two feedback conditions after implantation (implant processor turned on and off). Ten normal-hearing controls were also recorded once. Vowel contrasts in the formant space (expressed in mels) were larger in the clear than in the fast condition, both for controls and for implant users at all three time samples. Implant users also produced differences in duration between clear and fast conditions that were in the range of those obtained from the controls. In agreement with prior work, the implant users had contrast values lower than did the controls. The implant users' contrasts were larger with hearing on than off and improved from one month to one year postimplant. Because the controls and implant users responded similarly to a change in speaking condition, it is inferred that auditory feedback, although demonstrably important for maintaining normative values of vowel contrasts, is not needed to maintain the distinctiveness of those contrasts in different speaking conditions.

93. **"Spatial unmasking and binaural advantage for children with normal hearing, a cochlear implant and a hearing aid, and bilateral implants".** Mok, M.; Galvin, K. L.; Dowell, R. C.; McKay, C. M.; (2007); Audiol Neurootol. 12(5):19-30

The aims of this study were to: (1) determine if spatial unmasking existed and differed for children with normal hearing, a hearing aid and a cochlear implant (CIHA), and bilateral implants (BICI); (2) determine if binaural advantage and headshadow effect differed between children with CIHA and BICI. Results indicated that most of the CIHA and BICI children demonstrated spatial unmasking, though to a lesser degree than children with normal hearing. Results also indicated that the children with BICI demonstrated greater headshadow effect

than those with CIHA. The CIHA and BICI children also differed in binaural advantage, which could be due to the differences in headshadow effect and in detection abilities with the hearing aid versus the second implant.

94. **"Cochlear implantation in Cockayne syndrome: Our experience of two cases with different outcomes".** Morris, D. P.; Alian, W.; Maessen, H.; Creaser, C.; Demmons-O'Brien, S.; Van Wijhe, R.; Bance, M.; (2007); Laryngoscope. 117(5):939-943

Cockayne syndrome is a rare autosomal recessive defect in DNA repair resulting in a classic facies with potential visual and auditory impairment. The hearing loss begins peripherally and may become central as the condition progresses. Coexisting sensory deprivation from visual impairment and the possibility of progressive deterioration in mental function conspire with a lack of published experience to produce many challenges for the cochlear implant team. To the best of our knowledge, we present the first case reports with documented follow-up of cochlear implantation in two patients with different manifestations of Cockayne syndrome.

95. **"Differences between electrode-assigned frequencies and cochlear implant recipient pitch perception".** Nardo, W. D.; Cantore, I.; Cianfrone, F.; Melillo, P.; Fetoni, A. R.; Paludetti, G.; (2007); Acta Otolaryngol. 127(4):370-377

CONCLUSION: This study demonstrated an evident mismatch between frequencies assigned to electrodes and frequencies evoked by stimulation of those same electrodes in implanted patients. We propose that the mapping procedures should include, whenever possible, a comparison with homolateral residual hearing in order to obtain an appropriate frequency range assignation for each electrode. OBJECTIVES: The study aimed to investigate the correspondence between the frequencies assigned to each electrode and those actually perceived by the cochlear implant patient. PATIENTS AND METHODS: We studied five post-lingually deaf adults with detectable residual hearing in the implanted and in the contralateral ear, who had each received a Cochlear implant. An ACE standard setting was used for mapping. The patients were asked to match the electric pitch with the acoustic one following presentation of pure tones to both the implanted and the contralateral ear. RESULTS: In almost all patients the two most apical electrodes evoked higher frequencies than those assigned by the mapping software (E22 = 188-313, E21 = 313-438 Hz). Therefore, electric stimulation seems not to determine pitch sensations for frequencies <500 Hz. For most electrodes there is no correspondence between the acoustic pitch and the assigned frequency ranges. Moreover, these results were almost always different when stimulating the implanted and the contralateral ear.

96. **"Cochlear implantation in the neurofibromatosis type 2 patient: Long-term follow-up".** Neff, B. A.; Wiet, R. M.; Lasak, J. M.; Cohen, N. L.; Pillsbury, H. C.; Ramsden, R. T.; Welling, D. B.; (2007); Laryngoscope. 117(6):1069-1072

OBJECTIVE: To evaluate the long-term hearing outcomes of neurofibromatosis type 2 (NF2) patients with cochlear implants. METHODS: Retrospective analysis of cochlear implant performance in NF2 patients using open- and closed-set speech perception testing. RESULTS: Patients with NF2-associated bilateral vestibular schwannomas frequently become profoundly deaf. The aim of surgical resection should be to preserve serviceable hearing in at least one ear; however, this goal can be difficult to achieve. Frequently, tumor size or poor preoperative hearing status can require a surgical approach that leaves the patient with a profound, bilateral sensorineural hearing loss. If the cochlear nerve is preserved anatomically after vestibular schwannoma surgery, and if promontory stimulation confirms the functionality of the cochlear nerve, then cochlear implantation is an excellent option to restore hearing. We present six cochlear implant patients with NF2 who attained a significant improvement in open- and closed-set speech understanding with a mean follow-up of 7.9 (range: 5-13) years after surgery. In all but one case, the hearing results did not deteriorate over the follow-up period. CONCLUSION: Early surgical intervention for vestibular schwannomas in NF2 patients when the cochlear nerve can be spared is an important consideration to allow for possible cochlear implantation. A 6- to 8-week recovery period for the anatomically intact cochlear nerve may be necessary to obtain a positive promontory stimulation response following tumor resection and should be performed prior to cochlear implantation.

97. **"Effect of training rate on recognition of spectrally shifted speech".** Nogaki, G.; Fu, Q. J.; Galvin, J. J.; (2007); Ear Hear. 28(2):132-140

OBJECTIVE: Previous studies have shown that the protocol used for auditory training may significantly affect the outcome of training. However, it is unclear how often training should be performed to maximize its benefit. The present study investigated how the frequency of training contributed to normal-hearing listeners' adaptation to spectrally shifted speech. METHODS: Eighteen normal-hearing listeners were trained with spectrally shifted and compressed speech via an 8-channel acoustic simulation of cochlear implant speech processing. Five short training sessions (1 hr per session) were completed by each subject; subjects were trained at one of three training rates: five sessions per week, three sessions per week, or one session per week. Subjects were trained to identify medial vowels presented in a cVc format; depending on the level of difficulty, the number of response choices was increased and/or the acoustic differences between vowels were reduced. Vowel and consonant recognition was measured before and after training as well as at regular intervals during the training period. Sentence recognition was measured before and after training only. RESULTS: Results showed that pretraining vowel recognition scores were poor (14.0% correct, on average) for all subjects, due to the severe spectral shift. After five sessions of

targeted vowel contrast training, there was a significant improvement of shifted vowel recognition for most subjects. The mean improvement was comparable (approximately 15 percentage points) across the three training rate conditions, despite significant intersubject variability in pre- and pretraining baseline performance. There was no significant difference in training outcomes among the three training rates. Spectrally shifted consonant and sentence recognition also improved by approximately 20 percentage points after training, even though consonants and sentences were not explicitly trained. Similar to vowel recognition, there was no significant difference in training outcomes among the three training rates for shifted consonant and sentence recognition. CONCLUSIONS: The results demonstrated that the training rate had little effect on normal-hearing listeners' adaptation to spectrally shifted speech, at least for the training periods (ranging from 1 to 5 wk) used in the present study. The outcome of auditory training may depend more strongly on the amount of training (i.e., total number of training sessions) rather than the frequency of training (i.e., daily or once per week). Although more frequent training may accelerate listeners' adaptation to spectrally shifted speech, there may be significant benefits from training as little as one session per week. The results of the present study suggest that appropriate training schedules can be developed to optimize the effectiveness, efficiency, and effort associated with hearing-impaired patients' auditory rehabilitation.

98. **"Binaural interactions of electrically and acoustically evoked responses recorded from the inferior colliculus of guinea pigs".** Noh, H.; Abbas, P. J.; Miller, C. A.; Nourski, K. V.; Robinson, B. K.; Jeng, F. C.; (2007); International Journal of Audiology. 46(6):309-320

Binaural interactions within the interior colliculus (IC) elicited by electric and acoustic stimuli were investigated in this study. Using a guinea pig model, binaural acoustic stimuli were presented with different time delays, as were combinations of binaural electric and acoustic Stimuli. Averaged evoked potentials were measured using electrodes inserted into the central nucleus Of the IC to obtain the binaural interaction component (BIC), computed by subtracting the Sum of the two monaural responses from the binaural response. The BICs to acoustic-acoustic stimulation and electric-acoustic stimulation were found to be similar. The BIC amplitude increased with stimulus intensity, but the shapes of the delay functions were similar across the levels tested. The gross-potential data are thus consistent with the thesis that the central auditory system processes binaural electric and acoustic stimuli in a simi lar manner. These results suggest that the binaural auditory system can process combinations of electric and acoustic stimulation presented across ears and that evoked gross potentials may be used to measure such interaction.

99. **"Rotational tomography of the normal and reconstructed middle ear in temporal bones: An experimental study".** Offergeld, C.; Kromeier, J.; Aschendorff, A.; Maier, W.; Klenzner, T.; Beleites, T.; Zahnert, T.; Schipper, J.; Laszig, R.; (2007); Eur Arch Otorhinolaryngol. 264(4):345-351

Imaging is an essential diagnostic tool in reconstructive middle ear surgery, especially in pre-operative planning. Due to ongoing improvement of imaging quality and development of new imaging techniques like e.g. rotational tomography (RT) post-operative follow-up and immediate evaluation of surgical results may become more important. The aim of this experimental study was to evaluate RT as a new tool for postoperative determination of middle ear anatomy and implant position in temporal bones. RT was performed in ten temporal bone specimen after insertion of different middle ear prostheses concerning material, shape and length (PORP; TORP; Stapes piston). An implantable hearing device (Symphonix Soundbridge) was also implanted and visualized. For comparison some specimen additionally underwent conventional computed tomography (CT), including the newest technology. Characterization of anatomical structures of the temporal bone using RT was of comparable quality to conventional CT-scans in all investigated specimen while requiring approximately 30% of the CT's irradiation exposure. Unlike CT the RT showed almost no problems due to metallic artefacts of the implanted prostheses. Furthermore RT enabled a 3-dimensional view of the temporal bone and angle determination of inserted prostheses towards the tympanic membrane and/or the malleus handle. Detailed imaging of the prostheses allowed determination of shape, material and localization within the specimen's reconstructed middle ear. The new imaging technique of RT allows precise presentation of anatomical structures and middle ear implants in temporal bones. Following these experimental results it will be our future work to evaluate this method in clinical practise.

100. **"Real-time LabVIEW implementation of cochlear implant signal processing on PDA platforms".** Peddigari, V.; Kehtarnavaz, N.; Loizou, P.; (2007); Dept.of Electr.Eng., Texas Univ., Dallas, TX, USA4-ROM

This paper presents the real-time implementation of a cochlear implant signal processing system on PDA platforms. PDAs are chosen as they provide portable and cost-effective computation platforms. To gain software flexibility and interactivity, the LabVIEW graphical programming environment is used. The paper discusses the optimization steps which are taken to achieve a real-time throughput. These steps consist of using dynamic link libraries, utilizing efficient memory allocation, and performing fixed-point arithmetic. These steps are general purpose in the sense that the same steps can be deployed for real-time implementation of other clinical or industrial signal processing applications on PDAs.

101. **"Evaluation of NRT and behavioral measures for MAPping elderly cochlear implant users".** Pedley, K.; Psarros, C.; Gardner-Berry, K.; Parker, A.; Purdy, S. C.; Dawson, P.; Plant, K.; (2007); Int J Audiol. 46(5):254-262

We investigated the acceptability of electrophysiologically derived MAPs and the effect of these MAPs on speech perception in elderly adults using Nucleus 24 cochlear implants. Eight implant recipients aged 75 years or older trialed an electrophysiologically derived MAP and a behavioral MAP. The electrophysiologically derived MAP was based on the threshold and maximum comfort level for electrode 10 and evoked compound action potential thresholds measured on six electrodes using neural response telemetry (NRT). Word perception at 55 dB SPL and sentence perception in noise at 70 dB SPL were assessed after six weeks take-home experience and again after an additional two weeks of experience. During the final two weeks of take-home experience participants indicated their preferred MAP for different listening situations. The NRT derived MAP estimated behavioral T levels well, but underestimated behavioral C levels for apical electrodes in some subjects. Speech perception with NRT derived MAPs was comparable to speech perception with behaviorally measured MAPs. MAPs estimated from NRT data provided good speech perception outcomes for elderly implant recipients and were well tolerated.

102. **"Time course of speech changes in response to unanticipated short-term changes in hearing state".** Perkell, J. S.; Lane, H.; Denny, M.; Matthies, M. L.; Tiede, M.; Zandipour, M.; Vick, J.; Burton, E.; (2007); J Acoust Soc Am. 121(4):2296-2311

The timing of changes in parameters of speech production was investigated in six cochlear implant users by switching their implant microphones off and on a number of times in a single experimental session. The subjects repeated four short, two-word utterances, /dV1n#SV2d/ (S = /s/ or /S/), in quasi-random order. The changes between hearing and nonhearing states were introduced by a voice-activated switch at V1 onset. "Postural" measures were made of vowel sound pressure level (SPL), duration, F0; contrast measures were made of vowel separation (distance between pair members in the formant plane) and sibilant separation (difference in spectral means). Changes in parameter values were averaged over multiple utterances, lined up with respect to the switch. No matter whether prosthetic hearing was blocked or restored, contrast measures for vowels and sibilants did not change systematically. Some changes in duration, SPL and F0 were observed during the vowel within which hearing state was changed, V1, as well as during V2 and subsequent utterance repetitions. Thus, sound segment contrasts appear to be controlled differently from the postural parameters of speaking rate and average SPL and F0. These findings are interpreted in terms of the function of hypothesized feedback and feedforward mechanisms for speech motor control.

103. **"Neurotrophic factors and neural prostheses: Potential clinical applications based upon findings in the auditory system".** Pettingill, L. N.; Richardson, R. T.; Wise, A. K.; O'Leary, S. J.; Shepherd, R. K.; (2007); IEEE Trans Biomed Eng. 54(6 Pt 1):1138-1148

Spiral ganglion neurons (SGNs) are the target cells of the cochlear implant, a neural prosthesis designed to provide important auditory cues to severely or profoundly deaf patients. The ongoing degeneration of SGNs that occurs following a sensorineural hearing loss is, therefore, considered a limiting factor in cochlear implant efficacy. We review neurobiological techniques aimed at preventing SGN degeneration using exogenous delivery of neurotrophic factors. Application of these proteins prevents SGN degeneration and can enhance neurite outgrowth. Furthermore, chronic electrical stimulation of SGNs increases neurotrophic factor-induced survival and is correlated with functional benefits. The application of neurotrophic factors has the potential to enhance the benefits that patients can derive from cochlear implants; moreover, these techniques may be relevant for use with neural prostheses in other neurological conditions.

104. **"Effects of carrier pulse rate and stimulation site on modulation detection by subjects with cochlear implants".** Pfingst, B. E.; Xu, L.; Thompson, C. S.; (2007); J Acoust Soc Am. 121(4):2236-2246

Most modern cochlear-implant speech processors convey speech-envelope information using amplitude-modulated pulse trains. The use of higher-rate carrier pulse trains allows more envelope detail in the signal. However, neural response properties could limit the efficacy of high-rate carriers. This study examined effects of carrier rate and stimulation site, on psychophysical modulation detection thresholds (MDTs). Both of these variables could affect the neural representation of the carrier and thus affect perception of the modulation. Twelve human subjects with cochlear implants were tested. Phase duration of symmetric biphasic pulses was modulated sinusoidally at 40 Hz. MDTs were determined for monopolar stimulation at two carrier rates [250 and 4000 pulses/s (pps)], three stimulation sites (basal, middle, and apical), and five stimulus levels (10%, 30%, 50%, 70%, and 90% of the dynamic range). MDTs were lower for 250 pps carriers than for 4000 pps carriers in 71% of the 180 cases studied. Effects of carrier rate were greatest at the apical stimulation site and effects of stimulation site on MDTs depended on carrier rate. The data suggest a distinct disadvantage to using carrier pulse rates as high as 4000 pps. Stimulation site should be considered in evaluating modulation detection ability.

105. **"Clinical evaluation of higher stimulation rates in the nucleus research platform 8 system".** Plant, K.; Holden, L.; Skinner, M.; Arcaroli, J.; Whitford, L.; Law, M. A.; Nel, E.; (2007); Ear Hear. 28(3):381-393

OBJECTIVE: The effect on speech perception of using higher stimulation rates than the 14.4 kHz available in the Nucleus 24 cochlear implant system was

investigated. The study used the Nucleus Research Platform 8 (RP8) system, comprising the CI24RE receiver-stimulator with the Contour electrode array, the L34SP body-worn research speech processor, and the Nucleus Programming Environment (NPE) fitting and Neural Response Telemetry (NRT) software. This system enabled clinical investigation of higher stimulation rates before an implementation in the Freedom cochlear implant system commercially released by Cochlear Limited. DESIGN: Use of higher stimulation rates in the ACE coding strategy was assessed in 15 adult subjects. An ABAB experimental design was used to control for order effects. Program A used a total stimulation rate of between 12 kHz and 14.4 kHz. This program was used for at least the first 3 mo after initial device activation. After evaluation with this program, each subject was provided with two different higher stimulation rate programs: one with a total stimulation rate of 24 kHz and the other with a total stimulation rate of 32 kHz. After a 6-week period of familiarization, each subject identified his/her preferred higher rate program (program B), and this was used for the evaluation. Subjects then repeated their use of program A for 3 wk, then program B for 3 wk, before the second evaluation with each. Speech perception was evaluated by using CNC open-set monosyllabic words presented in quiet and CUNY open-set sentences presented in noise. Preference for stimulation rate program was assessed via a subjective questionnaire. Threshold (T)- and Comfortable (C)-levels, as well as subjective reports of tinnitus, were monitored for each subject throughout the study to determine whether there were any changes that might be associated with the use of higher stimulation rates. RESULTS: No significant mean differences in speech perception results were found for the group between the two programs for tests in either quiet or noise. Analysis of individual subject data showed that five subjects had significant benefit from use of program B for tests administered in quiet and for tests administered in noise. However, only two of these subjects showed benefit in both test conditions. One subject showed significant benefit from use of program A when tested in quiet, whereas another showed benefit with this program in noise. Each subject's preferred program varied. Five subjects reported a preference for program A, eight subjects reported a preference for program B and two reported no overall preference. Preference between the different stimulation rates provided within program B also varied, with 10 subjects preferring 24 kHz and five preferring 32 kHz total stimulation rates. A significant increase in T-levels from baseline measures was observed after three weeks of initial experience with program B, however there was no difference between the baseline levels and those obtained after five weeks of use. No significant change in C-levels was found over the monitoring period. No long-term changes in tinnitus that could be associated with the use of the higher stimulation rates were reported by any of the subjects. CONCLUSIONS: The use of higher stimulation rates may provide benefit to some but not all cochlear implant recipients. It is important to optimize the stimulation rate for an individual to ensure maximal benefit. The absence of any changes in T- and C-levels or in tinnitus suggests that higher stimulation rates are safe for clinical use.

106. **"Post-operative complications of cochlear implantation in adults and children: Five years' experience in Maastricht".** Postelmans, J. T.; Cleffken, B.; Stokroos, R. J.; (2007); J Laryngol Otol. 121(4):318-323

Although cochlear implantation is considered a safe method of rehabilitation for profoundly deaf individuals, a number of these patients suffer complications after surgery. To evaluate post-operative complications after cochlear implantation, a retrospective chart review was performed for 112 patients who had undergone implantation in the Maastricht Academic Hospital. Minor complications were defined as those that could be overcome by medical or audiological management. These occurred in 36 patients (32 per cent) and all were managed successfully. Major complications were defined as device extrusion and those requiring further surgery, and these were identified in four patients (3.6 per cent). These complications included wound infection and device failure mediated by middle-ear pathology. In cases of chronic otitis media, we recommend performance of cochlear implantation as a staged procedure. In order to reduce the post-operative incidence of acute otitis media, we recommend adenoidectomy, placement of ventilation tubes and early antibiotic treatment.

107. **"Intervention strategies in children with cochlear implants having attention deficit hyperactivity disorder".** Pundir, M.; Nagarkar, A. N.; Panda, N. K.; (2007); Int J Pediatr Otorhinolaryngol. 71(6):985-988

Attention deficit hyperactivity disorder (ADHD) is the most common neurodevelopmental disorder of childhood which not only affects child's education, development and peer functioning but is also associated with significant morbidity in areas of social and academic success. ADHD may hamper the language acquisition in hearing impaired children. When such children are scheduled for the auditory verbal therapy following cochlear implantation, the outcome is limited due to reduced attention span. We have presented two cases who had undergone cochlear implantation and showed the signs of ADHD. As there was little progress in listening skills and speech and language acquisition following 3 months of therapy, both children were referred to Psychiatry Department and were diagnosed as having ADHD. Following little improvement with behavior modification techniques, they were put on medication. Significant improvement was noticed with reduction in hyperactivity and increased attention span after the administration of the drugs.

108. **"[Cochlear implant in hypoacusis with alteration of connexin 26.]".** Ramos, A.; Rodriguez, C.; Borkoski, S.; Cuyas, J. M.; Falcon, J. C.; Goenaga, L.; Masgoret, E.; (2007); Acta Otorrinolaringol Esp. 58(5):198-201

OBJECTIVE: The objective of this paper is to assess the benefits of cochlear implantation in a population of profound prelingual congenital deaf children with mutation of Connexin 26 (DFNB1 phenotype), compared with a population of profound congenital deaf children without mutation of this gene. PATIENTS AND

METHOD: This retrospective study was carried out in 36 children with cochlear implants under the age of 6. All had profound congenital bilateral sensorineural hearing impairment, without cochlear malformation. Fifteen children were diagnosed as having DFNB1 and homozygous 30-35delG mutation, and 21 had no mutation of Connexin 26 (Cx26). All of them used Nucleus 24K or ST cochlear implants, with complete non-traumatic insertion of the electrodes, and follow-up was 12 months. RESULTS: There is no significant difference in pure tone audiometry and logoaudiometric tests between the 2 groups, children diagnosed as having DFNB1 (homozygous 30-35delG mutation) and children without mutation of Cx26. However, the population with DFNB1 shows a tendency to achieve better results more quickly in vowels and bisyllabic word tests 12 months after implantation. CONCLUSIONS: The cochlear implant is an effective therapy for children with profound prelingual congenital hearing loss with mutation of Cx26.

109. **"Changes in pitch with a cochlear implant over time".** Reiss, L. A.; Turner, C. W.; Erenberg, S. R.; Gantz, B. J.; (2007); J Assoc Res Otolaryngol. 8(2):241-257

In the normal auditory system, the perceived pitch of a tone is closely linked to the cochlear place of vibration. It has generally been assumed that high-rate electrical stimulation by a cochlear implant electrode also evokes a pitch sensation corresponding to the electrode's cochlear place ("place" code) and stimulation rate ("temporal" code). However, other factors may affect electric pitch sensation, such as a substantial loss of nearby nerve fibers or even higher-level perceptual changes due to experience. The goals of this study were to measure electric pitch sensations in hybrid (short-electrode) cochlear implant patients and to examine which factors might contribute to the perceived pitch. To look at effects of experience, electric pitch sensations were compared with acoustic tone references presented to the non-implanted ear at various stages of implant use, ranging from hookup to 5 years. Here, we show that electric pitch perception often shifts in frequency, sometimes by as much as two octaves, during the first few years of implant use. Additional pitch measurements in more recently implanted patients at shorter time intervals up to 1 year of implant use suggest two likely contributions to these observed pitch shifts: intersession variability (up to one octave) and slow, systematic changes over time. We also found that the early pitch sensations for a constant electrode location can vary greatly across subjects and that these variations are strongly correlated with speech reception performance. Specifically, patients with an early low-pitch sensation tend to perform poorly with the implant compared to those with an early high-pitch sensation, which may be linked to less nerve survival in the basal end of the cochlea in the low-pitch patients. In contrast, late pitch sensations show no correlation with speech perception. These results together suggest that early pitch sensations may more closely reflect peripheral innervation patterns, while later pitch sensations may reflect higher-level, experience-dependent changes. These pitch shifts over time not only raise questions for strict place-based theories of pitch perception, but also imply that

experience may have a greater influence on cochlear implant perception than previously thought.

110. **"Cochlear implants and ex vivo BDNF gene therapy protect spiral ganglion neurons".** Rejali, D.; Lee, V. A.; Abrashkin, K. A.; Humayun, N.; Swiderski, D. L.; Raphael, Y.; (2007); Hear Res. 228(1-2):180-187

Spiral ganglion neurons often degenerate in the deaf ear, compromising the function of cochlear implants. Cochlear implant function can be improved by good preservation of the spiral ganglion neurons, which are the target of electrical stimulation by the implant. Brain derived neurotrophic factor (BDNF) has previously been shown to enhance spiral ganglion survival in experimentally deafened ears. Providing enhanced levels of BDNF in human ears may be accomplished by one of several different methods. The goal of these experiments was to test a modified design of the cochlear implant electrode that includes a coating of fibroblast cells transduced by a viral vector with a BDNF gene insert. To accomplish this type of ex vivo gene transfer, we transduced guinea pig fibroblasts with an adenovirus with a BDNF gene cassette insert, and determined that these cells secreted BDNF. We then attached BDNF-secreting cells to the cochlear implant electrode via an agarose gel, and implanted the electrode in the scala tympani. We determined that the BDNF expressing electrodes were able to preserve significantly more spiral ganglion neurons in the basal turns of the cochlea after 48 days of implantation when compared to control electrodes. This protective effect decreased in the higher cochlear turns. The data demonstrate the feasibility of combining cochlear implant therapy with ex vivo gene transfer for enhancing spiral ganglion neuron survival.

111. **"Identifying impaired cochlear implant channels via speech-token confusion matrix analysis".** Remus, J. J. & Collins, L. M.; (2007); Dept.of Electr.& Comput.Eng., Duke Univ., Durham, NC, USAIV-741

Cochlear implant patients exhibit a wide range of performance on speech recognition tasks. One potential explanation for such variability is the existence of psychophysically observed phenomena that might indicate the presence of anomalous percepts associated with certain electrical stimuli, which in turn could limit the transmission of important auditory cues. Exhaustive psychophysical testing to detect all such psychophysical anomalies is time prohibitive; however, the search for anomalous channels could be expedited with prior information identifying channels potentially containing an anomaly. This study proposes a method of analyzing confusion matrices from speech token recognition tasks with the intent of identifying impaired channels. Results using both normal-hearing subjects tested with impaired acoustic models and cochlear implant subjects suggest that the proposed methods are providing information about the probability of impairment on each channel.

112. **"A comparison of adaptive psychometric procedures based on the theory of optimal experiments and bayesian techniques: Implications for cochlear implant testing".** Remus, J. J. & Collins, L. M.; (2007); Percept.Psychophys. 69(3):311-323

Numerous previous studies have focused on the development of quick and efficient adaptive psychometric procedures. In psychophysics, there is often a model of the psychometric function supported by previous studies for the task of interest. The theory of optimal experiments provides a framework for utilizing a model of the process to develop quick and efficient sequential-testing strategies for estimating model parameters, making it appropriate for developing adaptive psychophysical-testing methods. In this study, we investigated the application of sequential parameter search strategies based on the theory of optimal experiments and Bayesian adaptive procedures for measuring psychophysical variables. The results presented in this article suggest that more sophisticated psychometric procedures can expedite the measurement of psychophysical variables. Such techniques for quickly collecting psychophysical data may be particularly useful in cochlear implant research, where a large set of psychophysical variables are useful for characterizing the performance of an implanted device. It is to be hoped that further development of these techniques will make psychophysical measurements available to clinicians for tuning and optimizing the speech processors of individual cochlear implant patients.

113. **"From the cover: Evidence that cochlear-implanted deaf patients are better multisensory integrators".** Rouger, J.; Lagleyre, S.; Fraysse, B.; Deneve, S.; Deguine, O.; Barone, P.; (2007); Proceedings of the National Academy of Sciences U.S.A. 104(17):7295-7300

The cochlear implant (CI) is a neuroprosthesis that allows profoundly deaf patients to recover speech intelligibility. This recovery goes through long-term adaptative processes to build coherent percepts from the coarse information delivered by the implant. Here we analyzed the longitudinal postimplantation evolution of word recognition in a large sample of CI users in unisensory (visual or auditory) and bisensory (visuoauditory) conditions. We found that, despite considerable recovery of auditory performance during the first year postimplantation, CI patients maintain a much higher level of word recognition in speechreading conditions compared with normally hearing subjects, even several years after implantation. Consequently, we show that CI users present higher visuoauditory performance when compared with normally hearing subjects with similar auditory stimuli. This better performance is not only due to greater speechreading performance, but, most importantly, also due to a greater capacity to integrate visual input with the distorted speech signal. Our results suggest that these behavioral changes in CI users might be mediated by a reorganization of the cortical network involved in speech recognition that favors a more specific involvement of visual areas. Furthermore, they provide crucial indications to guide the rehabilitation of CI patients by using visually oriented therapeutic strategies.

114. **"[Restoration of hearing-comparing auditory brainstem implant to cochlear implant]".** Seki, Y.; (2007); Brain Nerve. 59(4):323-329

Restorative neurosurgery proceeds in the two ways, through biological means or through nerve-computer interface technology. Stem cells are now expected to repair the injured spinal cord and cochlear implants have already restored hearing in many patients. These examples represent each of these methodologies, respectively. The auditory brainstem implant is an extension of the technology of the cochlear implant. In this review article, the author summarizes the present status of auditory brainstem implant (ABI), comparing it to cochlear implant (CI). CI restores hearing by stimulating the cochlear nerve in the cochlea for patients whose deafness has been caused by inner ear disease; ABI does it by stimulating the cochlear nucleus of the brainstem for those deaf due to bilateral cochlear nerve dysfunction. In the world, up until now, more than 700 patients, almost all of whom are neurofibromatosis type 2, have undergone ABI and had hearing restored. Hearing performance by ABI, however, is not so good as that by CI. To improve the quality of hearing by ABI, new techniques such as advanced coding strategies and depth electrodes are now being introduced.

115. **"Transplantation of conditionally immortal auditory neuroblasts to the auditory nerve".** Sekiya, T.; Holley, M. C.; Kojima, K.; Matsumoto, M.; Helyer, R.; Ito, J.; (2007); Eur J Neurosci. 25(8):2307-2318

Cell transplantation is a realistic potential therapy for replacement of auditory sensory neurons and could benefit patients with cochlear implants or acoustic neuropathies. The procedure involves many experimental variables, including the nature and conditioning of donor cells, surgical technique and degree of degeneration in the host tissue. It is essential to control these variables in order to develop cell transplantation techniques effectively. We have characterized a conditionally immortal, mouse cell line suitable for transplantation to the auditory nerve. Structural and physiological markers defined the cells as early auditory neuroblasts that lacked neuronal, voltage-gated sodium or calcium currents and had an undifferentiated morphology. When transplanted into the auditory nerves of rats in vivo, the cells migrated peripherally and centrally and aggregated to form coherent, ectopic 'ganglia'. After 7 days they expressed beta 3-tubulin and adopted a similar morphology to native spiral ganglion neurons. They also developed bipolar projections aligned with the host nerves. There was no evidence for uncontrolled proliferation in vivo and cells survived for at least 63 days. If cells were transplanted with the appropriate surgical technique then the auditory brainstem responses were preserved. We have shown that immortal cell lines can potentially be used in the mammalian ear, that it is possible to differentiate significant numbers of cells within the auditory nerve tract and that surgery and cell injection can be achieved with no damage to the cochlea and with minimal degradation of the auditory brainstem response.

116. **"Delayed facial palsy in a patient with a bifid facial nerve lending support for viral theory of facial palsy".** Sheahan, P. & Viani, L.; (2007); Otol Neurotol. 28(3):414-416

OBJECTIVE: To describe the level of neurologic impairment in a case of delayed facial palsy occurring after cochlear implantation surgery. PATIENT: A 58-year-old man undergoing cochlear implantation who was found intraoperatively to have congenital bifurcation of the facial nerve just distal to the second genu. INTERVENTION: Cochlear implantation was performed through a facial recess approach. RESULTS: The lateral branch of the nerve impinged on the posterior tympanotomy slot and was uncovered during the procedure, rendering it vulnerable to direct thermal or mechanical injury or to the effects of local tissue injury products. The patient developed facial palsy 9 days later, affecting all facial muscle groups equally. CONCLUSION: Theories regarding the cause of delayed facial palsy after cochlear implantation include direct thermal or mechanical injury to the nerve, local effects of blood breakdown products or other mediators causing vasospasm, and reactivation of latent herpes virus, leading to neural inflammation and neuropathy of the geniculate and labyrinthine segments of the nerve. The fact that the patient developed weakness that affected all facial muscle groups equally suggests that the level of neurologic impairment was proximal to the nerve bifurcation, so distant to the actual site of surgery. This finding lends support for the viral hypothesis of delayed nerve palsy.

117. **"Comparison of cognitive function in deaf children between before and after cochlear implant".** Shin, M. S.; Kim, S. K.; Kim, S. S.; Park, M. H.; Kim, C. S.; Oh, S. H.; (2007); Ear Hear. 28(2 Suppl):22S-28S

OBJECTIVES: This study was conducted to examine improvements of cognitive abilities after cochlear implantation in deaf children. We also examined the psychosocial factors that predict good outcomes of cochlear implantation. DESIGN: A neuropsychological test battery was administered to 17 deaf children (mean age, 7 yr 2 mo) before receiving the cochlear implant, and they were reassessed with the same test at 6-mo follow-up. Their parents completed questionnaires concerning their medical and educational history, parenting style, and parental emotional problems. RESULTS: Deaf children showed marked improvement in speedy and delicate motor coordination and visual organization abilities. Their cognitive functions of comprehension, concentration, and sequential processing, as measured by nonverbal tests, were found to have improved from the levels of borderline to mild mental retardation to that of near-normal range. However, their performances on Information, Comprehension and Similarity, and Mathematics subtests requiring verbal abilities did not show significant changes. Deaf children's working memory improved significantly after cochlear implantation. However, they showed more omission errors in the visual attention test at follow-up than before cochlear implantation. Such inattentiveness for visual stimuli in children post-implantation could be attributed to distractibility of these children toward external noise. Mothers' depression was negatively correlated with scores

of acquired knowledge of deaf children. CONCLUSION: At the 6-mo follow-up after cochlear implant, deaf children showed marked improvement in nonverbal cognitive functions and working memory. Conversely, their verbal abilities did not significantly change. Maternal factors were found to be important for predicting the prognosis of cochlear implantation. The absence of a control group precludes the possibility of drawing any firm conclusions because the effect of the implant cannot be teased apart from the effects of maturation and training. Future studies should address this question with the use of appropriate control groups.

118. **"Modeling and computation of electric potential field distribution generated in cochlear tissues by cochlear implant stimulations".** Sibella, F.; Parazzini, M.; Pesatori, A.; Paglialonga, A.; Norgia, M.; Ravazzani, P.; Tognola, G.; (2007); CNR, Inst.of Biomed.Eng., Milan, Italy

Electric potential field distribution induced in the physiological tissues by electrical stimulation through a cochlear implant electrode array, was calculated by modeling the electrical properties of both the human cochlea and the electrode array, using a finite element method. Simulations were done under different stimulation conditions: by considering different electrode configurations and by activating different electrodes along the stimulating array. These parameters were found to affect the resulting field potentials. Results of this study provide a deeper knowledge of the relationship between the stimulation parameters and the actually delivered electric field, which is crucial to develop more efficient and spatially focused excitations of cochlear neural tissues.

119. **"In vivo estimates of the position of advanced bionics electrode arrays in the human cochlea".** Skinner, M. W.; Holden, T. A.; Whiting, B. R.; Voie, A. H.; Brunsden, B.; Neely, J. G.; Saxon, E. A.; Hullar, T. E.; Finley, C. C.; (2007); Ann Otol Rhinol Laryngol Suppl. 197(2-24)

OBJECTIVES: A new technique for determining the position of each electrode in the cochlea is described and applied to spiral computed tomography data from 15 patients implanted with Advanced Bionics HiFocus I, Ij, or Helix arrays. METHODS: ANALYZE imaging software was used to register 3-dimensional image volumes from patients' preoperative and postoperative scans and from a single body donor whose unimplanted ears were scanned clinically, with micro computed tomography and with orthogonal-plane fluorescence optical sectioning (OPFOS) microscopy. By use of this registration, we compared the atlas of OPFOS images of soft tissue within the body donor's cochlea with the bone and fluid/ tissue boundary available in patient scan data to choose the midmodiolar axis position and judge the electrode position in the scala tympani or scala vestibuli, including the distance to the medial and lateral scalar walls. The angular rotation 0 degrees start point is a line joining the midmodiolar axis and the middle of the cochlear canal entry from the vestibule. RESULTS: The group mean array insertion depth was 477 degrees (range, 286 degrees to 655 degrees). The word scores were negatively correlated (r = -0.59; p = .028) with the number of

electrodes in the scala vestibuli. CONCLUSIONS: Although the individual variability in all measures was large, repeated patterns of suboptimal electrode placement were observed across subjects, underscoring the applicability of this technique.

120. **"Cochlear implantation in a patient with Perisylvian syndrome".** Smith, W. & Axon, P.; (2007); Cochlear Implants Int. 8(2):117-121

Perisylvian syndrome is a rare neurological disorder characterised by the partial paralysis of muscles, epilepsy and mild to severe mental retardation. It is associated with hearing loss and delay in language and speech development. This presents additional challenges in the assessment of whether a child is suitable for cochlea implantation. The method to determine whether the hearing loss is of cochlear or central origin and the progress of a child with Perisylvian syndrome who received a cochlear implant is discussed.

121. **"Using evoked potentials to match interaural electrode pairs with bilateral cochlear implants".** Smith, Z. M. & Delgutte, B.; (2007); J Assoc Res Otolaryngol. 8(1):134-151

Bilateral cochlear implantation seeks to restore the advantages of binaural hearing to the profoundly deaf by providing binaural cues normally important for accurate sound localization and speech reception in noise. Psychophysical observations suggest that a key issue for the implementation of a successful binaural prosthesis is the ability to match the cochlear positions of stimulation channels in each ear. We used a cat model of bilateral cochlear implants with eight-electrode arrays implanted in each cochlea to develop and test a noninvasive method based on evoked potentials for matching interaural electrodes. The arrays allowed the cochlear location of stimulation to be independently varied in each ear. The binaural interaction component (BIC) of the electrically evoked auditory brainstem response (EABR) was used as an assay of binaural processing. BIC amplitude peaked for interaural electrod e pairs at the same relative cochlear position and dropped with increasing cochlear separation in either direction. To test the hypothesis that BIC amplitude peaks when electrodes from the two sides activate maximally overlapping neural populations, we measured multiunit neural activity along the tonotopic gradient of the inferior colliculus (IC) with 16-channel recording probes and determined the spatial pattern of IC activation for each stimulating electrode. We found that the interaural electrode pairings that produced the best aligned IC activation patterns were also those that yielded maximum BIC amplitude. These results suggest that EABR measurements may provide a method for assigning frequency-channel mappings in bilateral implant recipients, such as pediatric patients, for which psychophysical measures of pitch ranking or binaural fusion are unavailable.

122. **"Sensitivity to interaural time differences in the inferior colliculus with bilateral cochlear implants".** Smith, Z. M. & Delgutte, B.; (2007); Journal of Neuroscience. 27(25):6740-6750

Bilateral cochlear implantation attempts to increase performance over a monaural prosthesis by harnessing the binaural processing of the auditory system. Although many bilaterally implanted human subjects discriminate interaural time differences (ITDs), a major cue for sound localization and signal detection in noise, their performance is typically poorer than that of normal-hearing listeners. We developed an animal model of bilateral cochlear implantation to study neural ITD sensitivity for trains of electric current pulses delivered via bilaterally implanted intracochlear electrodes. We found that a majority of single units in the inferior colliculus of acutely deafened, anesthetized cats are sensitive to ITD and that electric ITD tuning is as sharp as found for acoustic stimulation with broadband noise in normal-hearing animals. However, the sharpness and shape of ITD tuning often depended strongly on stimulus intensity; some neurons had dynamic ranges of ITD sensitivity as low as 1 dB. We also found that neural ITD sensitivity was best at pulse rates below 100 Hz and decreased with increasing pulse rate. This rate limitation parallels behavioral ITD discrimination in bilaterally implanted individuals. The sharp neural ITD sensitivity found with electric stimulation at the appropriate intensity is encouraging for the prospect of restoring the functional benefits of binaural hearing in bilaterally implanted human subjects and suggests that neural plasticity resulting from previous deafness and deprivation of binaural experience may play a role in the poor ITD discrimination with current bilateral implants.

123. **"Quantitative evaluation of new bone and fibrous tissue in the cochlea following cochlear implantation in the human".** Somdas, M. A.; Li, P. M.; Whiten, D. M.; Eddington, D. K.; Nadol Jr, J. B.; (2007); Audiol Neurootol. 12(5):1-8

The formation of new bone and fibrous tissue in the human inner ear following cochlear implantation was evaluated by computer-assisted 3-D reconstruction. Seven temporal bones from patients who in life had undergone cochlear implantation were prepared for histological study with the implant in situ. The specimens were sectioned in the axial plane at a thickness of 20 mum. At least every tenth section was digitally reconstructed in three dimensions and volumes of new bone and fibrous tissue were calculated per millimeter length of the cochlea. New bone and fibrous tissue were found in all seven specimens, particularly at the cochleostomy site. In addition, new bone and fibrous tissue had extended to variable lengths along the track of the cochlear implant and in some cases extended beyond the distal end of the implanted electrode. This methodology provides a quantitative tool for evaluation of new bone and fibrous tissue in the inner ear following implantation. This should assist in correlating psychophysical and speech perception tests with intracochlear pathology, evaluating both electrode design and the techniques of preserving residual auditory function.

124. **"Performance of patients using different cochlear implant systems: Effects of input dynamic range".** Spahr, A. J.; Dorman, M. F.; Loiselle, L. H.; (2007); Ear Hear. 28(2):260-275

OBJECTIVE: To determine, for patients who had identical levels of performance on a monosyllabic word test presented in quiet, whether device differences would affect performance when tested with other materials and in other test conditions. DESIGN: For Experiment 1, from a test population of 76 patients, three groups (N = 13 in each group) were created. Patients in the first group used the CII Bionic Ear behind-the-ear (BTE) speech processor, patients in the second group used the Esprit3G BTE speech processor, and patients in the third group used the Tempo+ BTE speech processor. The patients in each group were matched on (i) monosyllabic word scores in quiet, (ii) age at testing, (iii) duration of deafness, and (iv) experience with their device. Performance of the three groups was compared on a battery of tests of speech understanding, voice discrimination, and melody recognition. In Experiments 2 (N = 10) and 3 (N = 10) the effects of increasing input dynamic range in the 3G and CII devices, respectively, was assessed with sentence material presented at conversational levels in quiet, conversational levels in noise, and soft levels in quiet. RESULTS: Experiment 1 revealed that patients fit with the CII processor achieved higher scores than Esprit3G and Tempo+ patients on tests of vowel recognition. CII and Tempo+ patients achieved higher scores than Esprit3G patients on difficult sentence material presented in noise at +10 and +5 dB SNR. CII patients achieved higher scores than Esprit3G patients on difficult sentence material presented at a soft level (54 dB SPL). Experiment 2 revealed that increasing input dynamic range in the Esprit3G device had (i) no effect at conversational levels in quiet, (ii) degraded performance in noise, and (iii) improved performance at soft levels. Experiment 3 revealed that increasing input dynamic range in the CII device improved performance in all conditions. CONCLUSIONS: Differences in implant design can affect patient performance, especially in difficult listening situations. Input dynamic range and the method by which compression is implemented appear to be the major factors that account for our results.

125. **"Frequency map for the human cochlear spiral ganglion: Implications for cochlear implants".** Stakhovskaya, O.; Sridhar, D.; Bonham, B. H.; Leake, P. A.; (2007); J Assoc Res Otolaryngol. 8(2):220-233

The goals of this study were to derive a frequency-position function for the human cochlear spiral ganglion (SG) to correlate represented frequency along the organ of Corti (OC) to location along the SG, to determine the range of individual variability, and to calculate an "average" frequency map (based on the trajectories of the dendrites of the SG cells). For both OC and SG frequency maps, a potentially important limitation is that accurate estimates of cochlear place frequency based upon the Greenwood function require knowledge of the total OC or SG length, which cannot be determined in most temporal bone and imaging studies. Therefore, an additional goal of this study was to evaluate a simple

metric, basal coil diameter that might be utilized to estimate OC and SG length. Cadaver cochleae (n = 9) were fixed <24 h postmortem, stained with osmium tetroxide, microdissected, decalcified briefly, embedded in epoxy resin, and examined in surface preparations. In digital images, the OC and SG were measured, and the radial nerve fiber trajectories were traced to define a series of frequency-matched coordinates along the two structures. Images of the cochlear turns were reconstructed and measurements of basal turn diameter were made and correlated with OC and SG measurements. The data obtained provide a mathematical function for relating represented frequency along the OC to that of the SG. Results showed that whereas the distance along the OC that corresponds to a critical bandwidth is assumed to be constant throughout the cochlea, estimated critical band distance in the SG varies significantly along the spiral. Additional findings suggest that measurements of basal coil diameter in preoperative images may allow prediction of OC/SG length and estimation of the insertion depth required to reach specific angles of rotation and frequencies. Results also indicate that OC and SG percentage length expressed as a function of rotation angle from the round window is fairly constant across subjects. The implications of these findings for the design and surgical insertion of cochlear implants are discussed.

126. **"Patient safety issues in magnetic resonance imaging: State of the art".** Stecco, A.; Saponaro, A.; Carriero, A.; (2007); Radiol Med (Torino). 112(4):491-508

The presence of a static magnetic field (Bo), a radiofrequency field (RF), a dynamic gradient which varies in time and loud noises during an MR examination could increase patient risk. Specifically, a magnetic field could interfere with ferromagnetic material leading to one of the following five dangerous interactions: 1) projectile effect, 2) twisting, 3) burning, 4) artefacts and 5) device malfunction. The projectile effect is when an object is attracted by the magnet with the risk, as reported in literature, of hitting the patient, operators and/or the instrument. Objects which typically can undergo this effect are oxygen and helium cylinders, IV stands, cleaning trolleys, chairs, lamp holders, scissors, forceps, clampers, traction weights, monitoring instruments, and especially metallic splinters within the patient. Twisting (torsion) typically occurs with cerebral vascular clamps and cochlear implants. If parts of implants are involved a malfunction may result. Burns can be caused when electrically conductive material is introduced within the magnet, for example, ECG electrodes, monitoring cables and coils which are in contact with the patient's skin, as well as tattoos and eye-liners that contain iron-oxides. Artefacts can be induced by RF emission of implanted devices which can be mistaken for noise of the receiving coil. Implanted devices can induce signal voids which mask or simulate pathologies. Electrical or mechanical malfunction of implanted devices includes pacemakers which can stimulate inappropriately or at an elevated frequency yielding a distorted ECG with altered T-waves. The risk for patients can be reduced by specific educational programs within individual

radiology departments which include other specializations and external referring physicians with the aim of developing a standardized safety protocol.

127. **"[In vitro neurite outgrowth induced by BDNF and GDNF in combination with dexamethasone on cultured spiral ganglion cells]".** Stover, T.; Scheper, V.; Diensthuber, M.; Lenarz, T.; Wefstaedt, P.; (2007); Laryngorhinootologie. 86(5):352-357

BACKGROUND: The efficacy of cochlear implant performance depends, among many other factors, on the number of excitable spiral ganglion cells (SGCs) and the nerve-electrode interface. In earlier animal studies it has been demonstrated that neurotrophic factors are effective to improve SGC survival after experimentally induced deafness. With regard to their anti-inflammatoric and anti-proliferative effects, glucocorticoids (e. g. dexamethasone) are potentially interesting therapeutic agents to reduce connective tissue formation around the inserted electrode. The biological effects of a combined intervention of neurotrophic factors with steroids on SGCs are unknown. Therefore the objective of the study was to investigate possible trophic or even toxic effects of brain-derived neurotrophic factor (BDNF), glial cell line-derived neurotrophic factor (GDNF) and dexamethasone on neurite outgrowth of cultivated SGCs. METHODS: By using dissociated postnatal spiral ganglion cells (p3-5) for cultivation in the present study, the influence of the mentioned factors in various concentrations and combinations on neurite outgrowth of SGCs was analysed. RESULTS: Our results indicate significant trophic effects for BDNF (50 ng/ml) and a combination of BDNF with dexamethasone (100 ng/ml) on SGC neurite outgrowth. In contrast, single application of GDNF or dexamethasone in different concentrations caused no significant changes on neurite outgrowth when compared to the control condition. CONCLUSIONS: Neurite outgrowth induced by neurotrophic factors could not be observed to be reduced when dexamethasone is given at the same time. Therefore the demonstrated results provide a basis for further animal studies in this field of research.

128. **"Balance sensory organization in children with profound hearing loss and cochlear implants".** Suarez, H.; Angeli, S.; Suarez, A.; Rosales, B.; Carrera, X.; Alonso, R.; (2007); Int J Pediatr Otorhinolaryngol. 71(4):629-637

OBJECTIVES: (1) To determine the feasibility of the use of a modified postural control test under altered sensory conditions in children over 8 years of age, and (2) to assess how deaf children use sensory information for postural control when they have normal or abnormal vestibular responses, and if hearing input from a unilateral cochlear implant, changes their postural behavior. PATIENTS: We selected 36 children, 8 to 11 years of age, with congenital or early-acquired profound sensorineural hearing loss, 13 of them with unilateral cochlear implantation and 22 normal-hearing children. METHODS: The Postural Control (PC) test consists of a force platform with 2 stimulation paradigm conditions: (1) standing on the platform with opened eyes; (2) standing on foam placed on the

force platform with closed eyes. Implanted children were tested with the implant turn on and turn off in this condition, in order to evaluate eventual change in the postural control parameters when they have hearing habilitation. The body center of pressure distribution area (COP) and the body sway velocity (SV) were the parameter to evaluate the postural control. RESULTS: Deaf children were classified into two groups according with the vestibular responses: group A (n=28) Children with normal vestibular rotary responses; group B (n=8) children with hypoactive responses. Children in group A had diagnoses of syndromic and non-syndromic hereditary deafness, and children in group B had inner ear malformations, post-meningitis deafness, and one child had non-syndromic hereditary deafness with hypoactive vestibular response. In condition 1, when vestibular, somatosensory and visual information were enabled, the COP and SV values did not show any statistically significant differences between groups A, B and control. In condition 2, when visual information was removed and the somatosensory input strongly modified by standing on the foam, group B showed significant higher COP and SV values than groups A and control ($p<0.05$). In addition, the scalograms by wavelets of children in group B had higher amplitudes increasing the sway frequencies contents up to 3 Hz, not allowing them to maintain the up right stance in similar stimulation than in condition. Implanted children of the group A and B with the implant turn on, in the condition 2, did not show any significant difference in the SV, comparing when they had the implanted turn off. Group A $p=0.395$ and group B $p=0.465$ (Wilcoxon ranked test). CONCLUSION: These findings allow us to confirm that this postural test can be performed in children over 8 years old. Also our results suggest that deaf children with associated hypoactive vestibular responses included in our study, despite the etiology of the deafness, primarily use visual and somatosensory information to maintain their postural control. Hearing habilitation with a unilateral cochlear implant has no effect on the observed sensory organization strategy.

129. **"Technologic advances in aural rehabilitation: Applications and innovative methods of service delivery".** Sweetow, R. W. & Sabes, J. H.; (2007); Trends in Amplification. 11(2):101-111

The level of interest in aural rehabilitation has increased recently, both in clinical use and in research presentations and publications. Advances in aural rehabilitation have seen previous techniques such as speech tracking and analytic auditory training reappear in computerized forms. These new delivery methods allow for a consistent, cost-effective, and convenient training program. Several computerized aural rehabilitation programs for hearing aid wearers and cochlear implant recipients have recently been developed and were reported on at the 2006 State of the Science Conference of the Rehabilitation Engineering Research Center on Hearing Enhancement at Gallaudet University. This article reviews these programs and outlines the similarities and differences in their design. Another promising area of aural rehabilitation research is the use of pharmaceuticals in the rehabilitation process. The results from a study of the effect

of d-amphetamine in conjunction with intensive aural rehabilitation with cochlear implant patients are also described.

130. **"Age at implantation and development of vocal and auditory preverbal skills in implanted deaf children".** Tait, M. E.; Nikolopoulos, T. P.; Lutman, M. E.; (2007); Int J Pediatr Otorhinolaryngol. 71(4):603-610

BACKGROUND: Preverbal vocal and auditory skills are essential precursors of spoken language development and they have been shown previously to predict later speech perception and production outcomes in young implanted deaf children. OBJECTIVES: To assess the effect of age at implantation on the development of vocal and auditory preverbal skills in implanted children. METHODS: The study assessed 99 children, 33 in each of three groups (those implanted between 1 and 2 years; 2 and 3 years; and 3 and 4 years). Preverbal skills were measured in three areas: turn taking, autonomy and auditory awareness of spoken language, using the Tait video analysis method. RESULTS: The youngest implanted group made an exceptional progress outperforming in all measures the two other groups ($p<0.01$), 6 and 12 months post-implantation, whereas there was no such difference before implantation. In the youngest group there was also significantly greater use of an auditory/oral style of communication: 85% of the group by 12 months post-implantation compared with 30% and 18% of the two older groups. CONCLUSIONS: Vocal and auditory preverbal skills develop much more rapidly in children implanted between 1 and 2 years in comparison with older implanted children and reach a significantly higher level by 6 and 12 months post-implantation. In addition, younger implanted children are significantly more likely by 12 months post-implantation to adopt an auditory/oral mode of communication. These findings favour cochlear implantation as early as between 1 and 2 years, provided that correct diagnosis and adequate hearing-aid trial have been achieved.

131. **"Cochlear implantations in visually impaired patients".** Takasaki, K.; Kanda, Y.; Kumagami, H.; Yashida, H.; Yamamoto-Fukuda, T.; Miyamoto, I.; Takahashi, H.; (2007); Eur Arch Otorhinolaryngol. 264(4):363-367

We retrospectively review the cases to evaluate the outcome of cochlear implantation (CI) in patients with severe-to-profound hearing loss and visual impairment (VI). Six adults with severe or profound hearing loss and significant VI underwent multichannel CI. Follow-up period ranged from 17 months to 7 years. Case history, etiology of visual and hearing loss, and benefit from CI were evaluated. To measure the outcomes, we selected the pure-tone thresholds with CI, the speech discrimination scores (SDS) using the Japanese video SDS system, the speech perception rates using the Japanese CD SDS system by monosyllable and word, and the open-set and closed sentence score using live voice. All the patients live happily after CI. There was no significant difference between the present six patients and the patients with profound hearing loss

without VI in evaluations of hearing and quality of life. CI can play a significant rehabilitative role in patients with severe hearing loss and VI.

132. **"Analysis of genetic mutation in patients with nonsyndromic hearing loss received cochlear implant".** Tian, Y.-S.; Chen, X.-W.; Cao, K.-L.; Chen, D.-Y.; Zuo, J.; Fang, F.-D.; (2007); National Medical Journal of China. 87(16):1093-1096

Objective: To investigate the prevalence of mutations of the gap junction protein (GJB)2 and mitochondria 12SrRNA in patients with nonsyndromic hearing loss who received cochlear implant. Methods: Genomic DNA was extracted from the peripheral blood samples obtained from 100 Chinese patients who had received cochlear implantation, 96 with prelingual hearing loss and 4 with postlingual hearing loss, all very severe. Sixteen of the 100 patients had the history of application of aminoglycosides, among which 12 were with prelingual hearing loss and 4 with postlingual hearing loss. PCR was performed and the products were sequenced by automated DNA sequencer. Results: GJB2 mutations were detected in 34 of the 100 cochlear implant recipients (34%), all with prelingual hearing loss, among which 27 (27%) had 235delC mutation. Among the 16 patients who had used aminoglycosides, two had the mutation A1555G, and one carried the mitochondrial gene tic mutation delT961Cn. Conclusion: Mutation of GJB2 gene is the major cause of deafness in cochlear implant recipients, with a high frequency of 235delC mutation. Mitochondria genetic mutation A1555G is the common form of mutation in postlingual deafness with a history of aminoglycoside injection.

133. **"Force application during cochlear implant insertion: An analysis for improvement of surgeon technique".** Todd, C. A.; Naghdy, F.; Svehla, M. J.; (2007); IEEE Transactions on Biomedical Engineering. 54(7):1247-1255

Highly invasive surgical procedures, such as the implantation of a prosthetic device, require correct force delivery to achieve desirable outcomes and minimize trauma induced during the operation. Improvement in surgeon technique can reduce the chances of excessive force application and lead to optimal placement of the electrode array. The fundamental factors that affect the degree of success for cochlear implant recipients are identified through empirical methods. Insertion studies are performed to assess force administration and electrode trajectories during implantations of the Nucleus® 24 Contour™ and Nucleus® 24 Contour Advance™ electrodes into a synthetic model of the human Scala Tympani, using associated methods. Results confirm that the Advance Off- Stylet insertion of the soft-tipped Contour Advance electrode gives an overall reduction in insertion force. Analysis of force delivery and electrode positioning during cochlear implantation can help identify and control key factors for improvement of insertion method. Based on the findings, suggestions are made to enhance surgeon technique.

134. **"Age and outcome of cochlear implantation for patients with bilateral congenital deafness in a Cantonese-speaking population".** Tong, M. C.; Leung, E. K.; Au, A.; Lee, W.; Yue, V.; Lee, K. Y.; Chan, V. S.; Wong, T. K.; Cheung, D. M.; van Hasselt, C. A.; (2007); Ear Hear. 28(2 Suppl):56S-58S

OBJECTIVE: To evaluate the effect of age at implantation by assessment of speech perception in cochlear implant users with bilateral congenital deafness. DESIGN: A retrospective cohort analysis of 60 cochlear implant users (age at implantation, 1.01 to 22.0 yr) who have at least 2 yr of experience. Their outcome performance was defined by the change in i) speech perception category (SPC) score based on postoperative assessment results and ii) the type of education attended after implantation. The association of age at implantation with SPC scores was analyzed at different ages at implantation (2, 3, 4, 5, and 6 yr old). The SPC scores for a particular age at implantation were compared at 6, 12, and 24 mo after implantation. The impact of age at implantation on choice of education was evaluated by analyzing the transition from a school for the deaf to mainstream education for the 45 children who were operated on before the age of 10, because older children are less likely to make such a change. RESULTS: Children implanted at the ages of 2, 3, 4, 5, and 6 yr all obtained significant improvements in SPC scores 24 mo after implantation. The greatest improvement was noted at 24 mo after implantation among those operated on before age 3. For all age groups, improvement at 24 mo after implantation is greater than at 12 mo, whereas the latter is greater than the improvement noted at 6 mo after implantation. Comparison of children implanted before the age of 3 and between ages 3 and 10 showed a significant difference in the choice of education after implantation. Children who were implanted before the age of 3 were more likely to attend mainstream education after implantation. CONCLUSION: Results from the present study are consistent with the current belief that implantation at a younger age provides greater benefit. The proportion of children attending mainstream education was significantly higher for those implanted before age 3, which may be a potential benefit to early implantation for relieving the burden of governments in providing special education.

135. **"Training-related changes in the brain: Evidence from human auditory-evoked potentials".** Tremblay, K. L.; (2007); Seminars.in Hearing. 28(2):120-132

Auditory-evoked potentials are being used to examine training-related changes in the human central auditory system, and there is converging evidence that focused listening training, using various training methods and different types of stimuli alters evoked neural activity. Such training-related changes are often described in terms of physiological plasticity, a process whereby the neural representation of the acoustic cue is modified with training. In this review, the concept of plasticity is discussed from a broader perspective. Specifically addressed is how electrophysiological methods are being used to study physiological modifications that occur with training, and how this information might contribute to the rehabilitation of people who wear hearing aids and cochlear implants.

136. **"Computed tomography and/or magnetic resonance imaging before pediatric cochlear implantation? Developing an investigative strategy".** Trimble, K.; Blaser, S.; James, A. L.; Papsin, B. C.; (2007); Otol Neurotol. 28(3):317-324

OBJECTIVE: To investigate and compare the usefulness of preoperative magnetic resonance (MR) imaging and high-resolution temporal bone computed tomography (HRCT) in pediatric cochlear implant candidates. STUDY DESIGN: Prospective. SETTING: Tertiary referral center. PATIENTS: A cohort of 92 pediatric patients with profound hearing. Inclusion criteria were MR, computed tomography, and cochlear implantation. INTERVENTION. DIAGNOSTIC: All patients had preoperative imaging of the petrous temporal bone (HRCT, T2-weighted fast spin echo, axial 3D Fast Imaging Employing Steady-state Acquisition [FIESTA] MR) and brain (Fast Fluid-attenuated Inversion-recovery [FLAIR] MR). MAIN OUTCOME MEASURE(S): Overall prevalence of inner ear dysplasias in this population and comparison of detection rates between HRCT, T2 Fast Spin Echo (FSE), and FIESTA MR sequences. RESULTS: Radiological abnormalities were observed in 32 and 59% of MR and HRCT temporal bone, respectively. Synchronous intracranial findings were noted in 40% on brain MR. Common vestibulocochlear nerve was observed in 3% ears and directed side of implantation. Consistent discrepancies noted on HRCT were inability to diagnose early obliterative labyrinthitis and presence of the cochlear nerve in the internal auditory canal. With respect to MR, enlarged vestibular aqueducts and narrow cochlear nerve canals were consistently under identified. CONCLUSION: Dual-modality imaging with HRCT and MR of petrous bone and MR brain in the precochlear implant pediatric population detects abnormalities related to deafness, which would not otherwise be found using either modality alone. There is overlap between the imaging modalities in the type of abnormalities detected, and we present a case for selective use of HRCT within a diagnostic algorithm, using the patient risk factors we have identified.

137. **"Speech perception and localization with adults with bilateral sequential cochlear implants".** Tyler, R. S.; Dunn, C. C.; Witt, S. A.; Noble, W. G.; (2007); Ear Hear. 28(2 Suppl):86S-90S

This investigation reports measures of binaural hearing of all of our seven adults who have received sequential bilateral cochlear implants (range of time between implantation of 6 yr/8 mo and 17 yr). All subjects used both devices in everyday life. The internal array, number of channels, rate, and signal processing strategies were usually quite different between devices. Speech recognition was tested by using words in quiet and sentences in noise with the sentence stimuli presented from the front and the noise presented from the front, the right, or the left at a 90 degrees angle. Bilateral localization was tested by using an everyday sounds test with stimuli presented from one of eight loudspeakers. Results showed that all subjects received a significant bilateral improvement on at least one speech perception test compared to either implant alone. Four of seven subjects with

bilateral devices demonstrated some (root-mean-square error below 30 degrees) localization abilities. The two subjects tested unilaterally before receiving a second implant showed a bilateral improvement on localization after implantation of the second side. We conclude that sequential implants can be beneficial even after many years of monaural use and even with very different cochlear implants.

138. **"Sensitivity to binaural timing in bilateral cochlear implant users".** van Hoesel, R. J.; (2007); J Acoust Soc Am. 121(4):2192-2206

Various measures of binaural timing sensitivity were made in three bilateral cochlear implant users, who had demonstrated moderate-to-good interaural time delay (ITD) sensitivity at 100 pulses-per-second (pps). Overall, ITD thresholds increased at higher pulse rates, lower levels, and shorter durations, although intersubject differences were evident. Monaural rate-discrimination thresholds, using the same stimulation parameters, showed more substantial elevation than ITDs with increased rate. ITD sensitivity with 6000 pps stimuli, amplitude-modulated at 100 Hz, was similar to that with unmodulated pulse trains at 100 pps, but at 200 and 300 Hz performance was poorer than with unmodulated signals. Measures of sensitivity to binaural beats with unmodulated pulse-trains showed that all three subjects could use time-varying ITD cues at 100 pps, but not 300 pps, even though static ITD sensitivity was relatively unaffected over that range. The difference between static and dynamic ITD thresholds is discussed in terms of relative contributions from initial and later arriving cues, which was further examined in an experiment using two-pulse stimuli as a function of interpulse separation. In agreement with the binaural-beat data, findings from that experiment showed poor discrimination of ITDs on the second pulse when the interval between pulses was reduced to a few milliseconds.

139. **"Biofilms in ear, nose, and throat infections: How important are they?".** Vlastarakos, P. V.; Nikolopoulos, T. P.; Maragoudakis, P.; Tzagaroulakis, A.; Ferekidis, E.; (2007); Laryngoscope. 117(4):668-673

BACKGROUND: Biofilms present a new challenging concept in sustaining chronic, common antibiotic-resistant ear, nose, and throat (ENT) infections. They are communities of sessile bacteria embedded in a matrix of extracellular polymeric substances of their own synthesis that adhere to a foreign body or a mucosal surface with impaired host defense. The aim of this paper is to review the literature on ENT diseases that can be attributed to biofilm formation and to discuss options for future treatment. MATERIALS AND METHODS: Literature review from Medline and database sources. Electronic links and related books were also included. STUDY SELECTION: Controlled clinical trials, animal models, ex vivo models, laboratory studies, retrospective studies, and systematic reviews. DATA SYNTHESIS: Biofilm formation is a dynamic five-step process guided by interbacterial communicating systems. Bacteria in biofilms express different genes and have markedly different phenotypes from their planktonic counterparts. Detachment of cells, production of endotoxin, increased resistance to the host

immune system, and provision of a niche for the generation of resistant organisms are biofilm processes that could initiate the infection process. Effective prevention and management strategies include interruption of quorum sensing, inhibition of related genes, disruption of the protective extrapolymer matrix, macrolides (clarithromycin and erythromycin), and mechanical debridement of the biofilm-bearing tissues. With regard to medical indwelling devices, surface treatment of fluoroplastic grommets and redesign of cochlear implants could minimize initial microbial colonization. CONCLUSION: As the role of biofilms in human infection becomes better defined, ENT surgeons should be prepared to deal with their unique and tenacious nature.

140. **"More challenging speech-perception tasks demonstrate binaural benefit in bilateral cochlear implant users".** Wackym, P. A.; Runge-Samuelson, C. L.; Firszt, J. B.; Alkaf, F. M.; Burg, L. S.; (2007); Ear Hear. 28(2 Suppl):80S-85S

OBJECTIVE: Preliminary studies show that bilateral cochlear implantation improves speech-recognition ability in many subjects; however, the magnitude of this improvement has been variable. The objective of our research was to explore means to better differentiate the binaural benefit that many patients who receive bilateral cochlear implants (CIs) describe. HYPOTHESIS: Binaural improvements in speech-perception performance will be consistently evident across patients when they are tested in more challenging listening situations. DESIGN: This was a prospective clinical study. Speech-perception performance was compared between the unilateral and bilateral cochlear implant conditions. Because the purpose was to investigate testing parameters that would demonstrate binaural benefit, word- and sentence-recognition tests were administered under several stimulation conditions: with and without noise and at three presentation levels. In addition, all subjects completed the Abbreviated Profile of Hearing Aid Benefit as a measure of subjective benefit. Subjects were adult cochlear implant recipients. Three device manufacturers were represented (Advanced Bionics Corporation, Cochlear Americas, and the Med-El Corporation); three patients received simultaneous implantation, and the other four patients received sequential CIs. The setting was a comprehensive cochlear implant program/tertiary referral center. The main outcomes measures were speech-recognition scores in percent correct, mean score difference for unilateral versus bilateral conditions, and subjective benefit scores. RESULTS: The most significant improvements in binaural cochlear implant use were found when subjects were tested with sentence material presented at 60 dB SPL with a +8 dB signal-to-noise ratio. Six of seven subjects showed significant binaural improvement, with a mean improvement score of 12.43% (SD = 5.32). All subjects preferred the binaural listening condition. Measured improvements in quality of life were seen. CONCLUSIONS: Preliminary study findings suggest that significant cochlear implant binaural benefit in speech perception may be observed when testing in more difficult listening situations (i.e., lower presentation levels and in noise). According to the outcome of our study, testing the binaural benefit of CIs requires consideration of suitable test materials and stimulation parameters.

141. **"Value of electricity evoked auditory brainstem response in evaluating the postoperative auditory function after cochlear implant".** Wang, L. & Dong, M.-M.; (2007); Journal of Clinical Rehabilitative.Tissue Engineering Research. 11(13):2494-2497

Aim: To evaluate the postoperative auditory function of cochlear implant patients with electrically evoked auditory brainstem response (EABR) test, and detect the characters and normal values of these EABR waves, so as to evaluate the auditory function of the patients. Methods: The test was conducted in the Audiometric Room, First Hospital affiliated to Zhengzhou University from July 2002 to June 2004. EABR was recorded in electrode 3, 10 and 20 in 53 cases received Nucleus 24 cochlear implant with test parameters: frequency ≤ 100 Hz, pulse wide: 25, 50 and 75 μs/phase. Results: All 53 cases were involved in the result analysis. 1 Artifact of EABR in alternating polarity stimulus mode was smaller than that in simple polarity stimulus mode, and the bilateral recording mode was smaller than in the same lateral recording mode. Latencies of EABR prolonged with stimulus frequency increasing. 2 With the increase in stimulating frequency, the latency of each wave prolonged gradually. Latency of wave V was shortened (1.5-3 kHz) or maintained (3-25 kHz) constant with the low cut-off frequency changing; Latency of wave V maintained constant with cut-off frequency changing from 100 to 0.002 Hz. 3 EABR thresholds were decreased with stimulus width widening, and it was lower in electrode 20 than in electrodes 3 and 10 ($F< 0.01$), but there was no difference between electrode 3 and 10 ($P> 0.05$). 4 EABR latency of waves III and V in electrode 3 was longer than in electrode 10 and 20 ($P> 0.01$), and in electrode 10 longer than in electrode 20 ($P> 0.01$). 5 Wave rate of EABR test was 96.22%. Conclusion: 1 Proper EABR test made is established. 2 EABR latency and threshold are different when stimulating different electrodes of cochlear. 3 EABR is an effective method to evaluate the auditory function of cochlear implant patients objectively.

142. **"Objectively adjusting cochlear implant processor postoperatively using electrically evoked auditory brainstem response, electrically evoked auditory compound action potential, and electrically elicited stapedius reflex".** Wang, L. & Dong, M.-M.; (2007); Journal of Clinical Rehabilitative.Tissue Engineering Research. 11(9):1713-1715

Aim: To study the feasibility of objectively adjusting cochlear processor postoperatively using electrically evoked auditory brainstem response (EABR), electrically evoked auditory compound action potential (ECAP), and electrically elicited stapedius reflex (ESR). Methods: The experiment was accomplished in the Hearing Test Room of the First Affiliated Hospital of Zhengzhou University from July 2002 to June 2004. 1 Subjective hearing threshold value (T-level), subjective maximum comfortable threshold value (C-level), EABR, ECAP, and ESR were recorded in 53 cases who received Nucleus 24 cochlear implant. 2 Correlation analysis was carried out between T-level, C-level and EABR, ECAP, ESR, between T-level, C-level predicted from EABR threshold or ECAP threshold and

actual value. Results: All 53 subjects were involved in the result analysis. 1 The EABR threshold and ECAP threshold were correlated with T-level and C-level (r =0.585, 0.555, 0.592, 0.630, P < 0.001). 2 EABR threshold, ECAP threshold, and ESR threshold all had significant variability in different patients. EABR thresholds and ECAP thresholds in all cases were higher than T-level. ESR threshold in all cases were lower than uncomfortable level. 3 The T-level and C-level predicted from EABR threshold or ECAP threshold were significantly correlated with actual T-level and actual C-level (r =0.918, 0.924, 0.934, 0.883, P < 0.001). Conclusion: T-level and C-level can be adjusted objectively using EABR, ECAP, and ESR tests.

143. **"Application of artificial cochlear implantation and anatomic characteristics related to operation".** Wang, W.-Y.; (2007); Journal of Clinical Rehabilitative.Tissue Engineering Research. 11(21):4228-4231

Objective: To introduce clinical advancement of artificial cochlear implantation and anatomic characteristics of relevant region. Data sources: The Medline database was undertaken to identify the articles of artificial cochlear implantation from January 1986 to December 2006 with the key words of “cochlear implantation, indication, complication, dissection, electrically evoked compound action potential”; in English. At the same time, relevant articles were searched for in Wanfang database between January 2000 and December 2006 with the same key words in Chinese. Relevant books were also searched by hand. Study selection: Totally over 300 relevant articles were retrieved. Full-texts were searched, and relevant articles of dissection, indication, complication and postoperative effect of artificial cochlear implantation were selected. Clinical researches where human as subjects were involved, no matter control or non-control. Articles of obvious repetition and reviews were excluded. Totally 40 literatures were included for review. Data extraction: Of the 40 literatures, 16 articles were about anatomy, 17 articles were on artificial cochlear implantation and 8 articles were about postoperative adjustment and effect of artificial cochlear implantation. Data synthesis: 1 It was ideal by facial recess approach in artificial cochlear implantation, which was near to round window niche and was helpful for electrode insertion, but the approach was near to spiroid canal, so it was stressed to protect facial nerve in operation. 2 With scientific improvement and accumulation of clinical experiences, the inclusion criteria of artificial cochlear implantation was wide. The cause of deaf and age of implantation were not significant to the hearing of postlingual deaf patients after operation. However, the earlier the artificial cochlear implantation, the better the curative effect was in prelingual deaf patients. The curative effect in patients with better residual hearing was better than that in patients with bad residual hearing after transplantation. 3 Abnormal structure of inner ear affected the artificial cochlear implantation, but imaging examination before operation could help the physicians to do correct judgment. 4 Postoperative effect mainly depended on the accurate adjustment of dynamic range of electrical stimulation. Conclusion: At present, artificial cochlear implantation has become the conventional therapeutic methods for severe or more serious sensorineural

deafness. Preoperative evaluation and postoperative corrective adjustment are the key measure to protect operative effect.

144. **"Percutaneous cochlear access using bone-mounted, customized drill guides: Demonstration of concept in vitro".** Warren, F. M.; Balachandran, R.; Fitzpatrick, J. M.; Labadie, R. F.; (2007); Otol Neurotol. 28(3):325-329

HYPOTHESIS: Percutaneous cochlear access can be performed using bone-mounted drill guides that are custom made on the basis of preintervention computed tomographic scans. BACKGROUND: We have previously demonstrated the ability to use image guidance based on fiducial markers to obtain percutaneous cochlear access in vitro. A simpler approach that has far less room for application error is to constrict the path of the drill to pass in a predetermined trajectory using a drill guide. METHODS: Cadaveric temporal bone specimens (n = 8) were affixed with three bone-implanted fiducial markers. The temporal bone computed tomographic scans were obtained and used in planning a straight trajectory from the mastoid surface to the cochlea without violating the boundaries of the facial recess, namely, the chorda tympani, the incus buttress, and the facial nerve. These surgical plans were used to manufacture a customized drill guide by means of rapid prototyping (MicroTargeting Platform; FHC Inc.; Bowdoinham, ME, U.S.A.) that mounts onto anchor pins previously used to mount fiducial markers. The specimens then underwent traditional mastoidectomy with facial recess. The drill guide was mounted, and a 1-mm drill bit was passed through the guide across the mastoid and the facial recess. The course of the drill bit and its relationship to the boundaries of the facial recess were photographed and measured. RESULTS: Eight cadaveric specimens were subjected to the study protocol. In seven of eight specimens, the drill bit trajectory was accurate; it passed from the lateral cortex to the lateral wall of the cochlea without compromise of any critical structures. In one specimen, the access to the middle ear was achieved, but the incus was hit by the drill. The average shortest distance +/- standard deviation from the edge of the drill bit to the boundaries of the facial recess was 0.78 +/- 0.56 mm (chorda tympani), 2.00 +/- 1.06 mm (incus buttress), and 1.27 +/- 0.54 mm (facial nerve). CONCLUSION: Our study demonstrates the ability to obtain percutaneous cochlear access in vitro using customized drill guides manufactured on the basis of preintervention radiographic studies.

145. **"Parents' views on changing communication after cochlear implantation".** Watson, L. M.; Hardie, T.; Archbold, S. M.; Wheeler, A.; (2007); The Journal of Deaf Studies and Deaf Education Jun 2007; 10.1093

We sent questionnaires to families of all 288 children who had received cochlear implants at one center in the United Kingdom at least 5 years previously. Thus, it was a large, unselected group. We received 142 replies and 119 indicated that the child and family had changed their communication approach following cochlear implantation. In 113 cases the change was toward spoken language and in 6 cases the change was toward signed communication. Parents were asked to

respond to statements about communication with their deaf child, and their responses indicated that parents wanted the most effective means of communication and one that their child would find most useful in the future. Findings that emerged from parents' comments indicated that the change toward greater use of spoken language was child-led and driven by increased audition. Parents also valued the contribution of signed communication.

146. **"Performance and preference for ACE stimulation rates obtained with nucleus RP 8 and freedom system".** Weber, B. P.; Lai, W. K.; Dillier, N.; von Wallenberg, E. L.; Killian, M. J.; Pesch, J.; Battmer, R. D.; Lenarz, T.; (2007); Ear Hear. 28(2 Suppl):46S-48S

Cochlear recently released the Nucleus Freedom System which has been based on the Nucleus Research Platform 8. Both systems make use of the same implant, the CI24RE, which includes expanded total stimulation rates up to 32 kHz. In this study the performance of the ACE strategy at 500, 1200 and 3500 pps/channel was investigated using an ABC-CBA design. At the end of each period speech tests were performed. In the CBA phase the patients completed a comparative questionnaire to determine the subjective rate preference. Preliminary results in 13 recipients indicate no differences in for the ACE strategy at rates ranging from 500 pps to 3500 pps/channel.

147. **"Threshold shift: effects of cochlear implantation on the risk of pneumococcal meningitis".** Wei, B. P.; Shepherd, R. K.; Robins-Browne, R. M.; Clark, G. M.; O'Leary, S. J.; (2007); Otolaryngol Head Neck Surg. 136(4):589-596

OBJECTIVES: The study goals were to examine whether cochlear implantation increases the risk of meningitis in the absence of other risk factors and to understand the pathogenesis of pneumococcal meningitis post cochlear implantation. STUDY DESIGN AND SETTING: Four weeks following surgery, 54 rats (18 of which received a cochleostomy alone, 18 of which received a cochleostomy and acute cochlear implantation using standard surgical techniques, and 18 of which received a cochlear implant) were infected with Streptococcus pneumoniae via three different routes of bacterial inoculation (middle ear, inner ear, and intraperitoneal) to represent all potential routes of bacterial infection from the upper respiratory tract to the meninges. RESULTS: The presence of a cochlear implant reduced the threshold of bacteria required to cause pneumococcal meningitis from all routes of infection in healthy animals. CONCLUSION: The presence of a cochlear implant increases the risk of pneumococcal meningitis regardless of the route of bacterial infection. SIGNIFICANCE: Early detection and treatment of pneumococcal infection such as otitis media may be required, as cochlear implantation may lead to a reduction of infectious threshold for meningitis.

148. **"Psychophysical performance and Mandarin tone recognition in noise by cochlear implant users".** Wei, C.; Cao, K.; Jin, X.; Chen, X.; Zeng, F. G.; (2007); Ear Hear. 28(2 Suppl):62S-65S

OBJECTIVE: The present study was aimed to examine the relationship between psychophysical performance in temporal and spectral resolution and Mandarin tone recognition in noise by cochlear-implant (CI) listeners. DESIGN: Seventeen Nucleus-24 implant users, 10 postlingually deafened and 7 prelingually deafened, participated in the experiments. A 3-interval, forced-choice procedure was used to measure gap detection and pure-tone frequency discrimination at 250 to 4,000 Hz in octave steps. A 4-alternative forced-choice procedure was used to measure Mandarin tone recognition in quiet and in noise. Signal-to-noise ratios (SNRs) varied from +10 to -10 dB. All stimuli were delivered to the clinical processor via a speaker in a sound free field. The obtained data were compared to data collected from normal-hearing control subjects, as well as cochlear-implant users who performed similar tasks using single-electrode stimulation via a research interface. RESULTS: Postlingually-deafened CI subjects generally performed better than prelingually-deafened subjects. The average gap detection threshold was 30 ms with a range from 4 to 128 ms. The average frequency difference limen was 100 Hz with a range from 12 to 192 Hz, regardless of the standard frequency. The average tone recognition was 80% correct in quiet, which dropped to 55% at +10 dB SNR and essentially chance performance at -5 dB SNR. In comparison, the normal-hearing control subjects maintained essentially perfect performance over this SNR range. Only frequency discrimination at 1,000 Hz was significantly correlated with tone recognition in quiet but all psychophysical measures were correlated to tone recognition in noise. CONCLUSIONS: The present result suggests that the CI users can rely on either temporal or spectral cues to perform tone recognition in quiet, but need both cues for tone recognition in noise. Future CI processors need to extract and encode these acoustic cues to achieve better performance in tone perception and production.

149. **"Children with a cochlear implant: Characteristics and determinants of speech recognition, speech-recognition growth rate, and speech production".** Wie, O. B.; Falkenberg, E. S.; Tvete, O.; Tomblin, B.; (2007); Int J Audiol. 46(5):232-243

The objectives of the study were to describe the characteristics of the first 79 prelingually deaf cochlear implant users in Norway and to investigate to what degree the variation in speech recognition, speech- recognition growth rate, and speech production could be explained by the characteristics of the child, the cochlear implant, the family, and the educational setting. Data gathered longitudinally were analysed using descriptive statistics, multiple regression, and growth-curve analysis. The results show that more than 50% of the variation could be explained by these characteristics. Daily user-time, non-verbal intelligence, mode of communication, length of CI experience, and educational placement had the highest effect on the outcome. The results also indicate that children educated

in a bilingual approach to education have better speech perception and faster speech perception growth rate with increased focus on spoken language.

150. **"The surprising performance of present-day cochlear implants".** Wilson, B. S. & Dorman, M. F.; (2007); IEEE Trans Biomed Eng. 54(6 Pt 1):969-972

The speech reception performance of a recipient of the Clarion CII implant was evaluated with a comprehensive set of tests. The same tests were administered for a group of six subjects with normal hearing. Scores for the implant subject were not different from the scores for the normal-hearing subjects, for seven of the nine tests, including the most difficult test used in standard clinical practice. These results are both surprising and encouraging, in that the implant provides only a very crude mimicking of only some aspects of the normal physiology.

151. **"Effects of computer-assisted speech training on Mandarin-speaking hearing-impaired children".** Wu, J. L.; Yang, H. M.; Lin, Y. H.; Fu, Q. J.; (2007); Audiol Neurootol. 12(5):31-36

The present study investigated whether moderate amounts of computer-assisted speech training can improve the speech recognition performance of hearing-impaired children. Ten Mandarin-speaking children (3 hearing aid users and 7 cochlear implant users) participated in the study. Training was conducted at home using a personal computer for half an hour per day, 5 days per week, for a period of 10 weeks. Results showed significant improvements in subjects' vowel, consonant, and tone recognition performance after training. The improved performance was largely retained for 2 months after training was completed. These results suggest that moderate amounts of auditory training, using a computer-based auditory rehabilitation tool with minimal supervision, can be effective in improving the speech performance of hearing-impaired children.

152. **"Application of a corticosteroid (Triamcinolon) protects inner ear function after surgical intervention".** Ye, Q.; Tillein, J.; Hartmann, R.; Gstoettner, W.; Kiefer, J.; (2007); Ear Hear. 28(3):361-369

HYPOTHESIS: Opening of the inner ear during stapes surgery or cochlear implantation may result in trauma to inner ear structures and possible hearing loss. The dual aim of the present study was to evaluate the effectiveness of locally applied Triamcinolon* to protect the inner ear against surgically induced trauma and to exclude possible ototoxic effects. METHODS: In an animal model (guinea pig), a corticosteroid (Triamcinolon) was topically applied to the inner ear, either by extracochlear application and diffusion through the round window membrane or by direct intracochlear application via a cochleostomy. Physiological effects of the steroid were investigated by monitoring the hearing of steroid treated animals in comparison to control animals treated with Ringer solution instead of Triamcinolon. Thresholds as well as input/output functions (I/O function) of compound action potentials (CAPs) in response to auditory stimuli were

determined before the cochleostomy and at specific intervals up to 4 weeks after application of Triamcinolon. RESULTS: Extracochlear application of Triamcinolon induced only minor shifts of mean CAP thresholds but significantly increased mean maximal amplitudes of I/O function 14 d after application. No detrimental effects on cochlear function were noted; thus, indicating absence of ototoxicity for extracochlear application in the concentrations used. After the surgical trauma of cochleostomy, CAP thresholds increased by 12.5 dB directly after surgery and by 15.8 dB at day 3. Amplitudes of CAPs diminished. Intracochlear application of Triamcinolon resulted in significantly enhanced recovery of CAP thresholds and amplitudes of I/O function from initial loss over a period of 4 weeks. CONCLUSIONS: From these results, we conclude that extracochlear topical application of Triamcinolon has no ototoxic effect in the concentrations that were used and that intracochlear application supports an increased recovery of cochlear functions after surgical trauma. Furthermore, the results indicate a protective effect of corticosteroids, partially preventing progressive loss of hearing after cochleostomy over a period of 4 weeks. Intracochlear application of Triamcinolon may be useful to prevent hearing loss after surgical intervention on the inner ear; however, clinical safety and efficacy remain to be proven in clinical studies.

153. **"Parenting a child with a cochlear implant: A critical incident study".** Zaidman-Zait, A.; (2007); The Journal of Deaf Studies and Deaf Education. 12(2):221-241

This study aimed to describe and categorize the attributes that parents of young children with cochlear implants (CIs) consider as facilitating their parental coping experience. I interviewed 15 hearing mothers and 13 hearing fathers (including 12 married couples) whose children had CIs, using the critical incident technique that asked parents to describe significant incidents (observable behaviors, thoughts, feelings) that facilitated their parenting experience. A total of 430 critical incidents were documented and sorted into 20 categories. Further analyses supported the suggested categorical system's validity and reliability. Results indicated various sources of influence on parents' coping experience, associated with social contextual aspects (e.g., professionals' support, sharing experience with others, family's/friends' consistent involvement, intervention services), with the parent himself or herself (e.g., taking action, personal resources, incorporating deafness into daily life), and with the child (e.g., child characteristics, identifying progress and success). The current research substantiates the soundness of implementing early intervention models such as the developmental system model (Guralnick, 2001) and the support approach to early intervention (McWilliam & Scott, 2001), which coincide with ecological theory and recognize that families need various combinations of resources, social support, information, and services to help them address the stressors associated with parenting in general and parenting a child with special needs in particular.

154. **"Paroxysmal positional vertigo after cochlear implantation".** Zanetti, D.; Campovecchi, C. B.; Balzanelli, C.; Pasini, S.; (2007); Acta Otolaryngol. 127(5):452-458

Conclusions. We observed 4 cases of paroxysmal positional vertigo (PPV) among 62 cochlear implant (CI) recipients. They occurred in the implanted ear without chronological relation with the surgical procedure or the implant's activation. All of them relapsed within 3 months after an initially successful repositioning maneuver, and finally recovered after the second one. None of the patients showed labyrinthine weakness in the implanted ear. The outbreak of PPV did not affect the patients' speech perception performances. Objectives. To report and discuss the occurrence of PPV after cochlear implantation Patients and methods. Among 32 adult patients who received a Nucleus(R) CI, 4 suffered from PPV on the basis of Dix-Hallpike's maneuvers. After a Semont's repositioning maneuver, recurrences were similarly addressed. An electro-nystagmography (ENG) recording of caloric irrigation tests was obtained once the symptoms subsided Results. The observed incidence of 12.5% exceeds the figures reported in the literature. No anatomic abnormalities were identified in these patients, nor were any intraoperative or postoperative complications reported. PPV developed 1-12 months after CI surgery in the posterior canal and relapsed within 3 months. ENG showed a normal reflectivity in two patients, while the other two had a significant prevalence of the implanted side. The outcomes of the speech perception tests after CI in all the four patients matched those of their corresponding categories.