Quarterly Abstract Update

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13 Castaneda-Villa N. & James C. J.; (2006); "ICA of auditory evoked potentials in children with cochlear implants: component selection"; Annu Int Conf IEEE Eng Med Biol Proc 15

14 Cerini R.; Faccioli N.; Cicconi D.; Schenal G.; Cugini C.; Giarbini N.; Colletti V.; & Pozzi Mucelli R.; (2006); "Role of CT and MRI in the preoperative evaluation of auditory brainstem implantation in patients with congenital inner ear pathology"; Radiol Med (Torino). 111(7):978-988..... 16

15 Chang J. E.; Bai J. Y.; & Zeng F. G.; (2006); "Unintelligible low-frequency sound enhances simulated cochlear-implant speech recognition in noise"; IEEE Trans Biomed.Eng. 53(12 Pt 2):2598-2601 16

16 Chang Y. p. & Fu Q. J.; (2006); "Effects of talker variability on vowel recognition in cochlear implants"; Journal of Speech, Language, and Hearing Research. 49(6):1331-1341 17

17 Chatterjee M.; Sarampalis A.; & Oba S. I.; (2006); "Auditory stream segregation with cochlear implants: a preliminary report"; Hear Res. 222(1-2):100-107 17

18 Chen D. Y.; Chen X. W.; Cao K. L.; Jin X.; Zuo J.; Wei C. G.; & Fang F. D.; (2006); "[High prevalence of connexin-26 (GJB2) mutation in cochlear implant recipients]"; Zhonghua Yi Xue Za Zhi. 86(44):3114-3117..... 18

19 Chen F. & Zhang Y. T.; (2006); "Loudness normalization for cochlear implant using pulse-rate modulation to convey Mandarin tonal information: A model-based study"; Annu Int Conf IEEE Eng Med Biol Proc..... 18

20 Chung K.; Zeng F. G.; & Acker K. N.; (2006); "Effects of directional microphone and adaptive multichannel noise reduction algorithm on cochlear implant performance"; J Acoust Soc Am. 120(4):2216-2227 19

21 Claeson M. & Ringdahl A.; (2006); "Prevalence of cochlear implants in postlingually deafened adults in a Swedish region"; Int J Audiol. 45(11):670-674 19

22 Connor C. M.; Craig H. K.; Raudenbush S. W.; Heavner K.; & Zwolan T. A.; (2006); "The age at which young deaf children receive cochlear implants and their vocabulary and speech-production growth: is there an added value for early implantation?"; Ear Hear. 27(6):628-644 20

23 Corbett S.; Johnson T.; & Ketterl J.; (2006); "Polymer-based microelectrode arrays"; Mater Res Soc Symp Proc 20

24 Devous M. D., Sr.; Altuna D.; Furl N.; Cooper W.; Gabbert G.; Ngai W. T.; Chiu S.; Scott J. M., III; Harris T. S.; Payne J. K.; & Tobey E. A.; (2006); "Maturation of speech and language functional neuroanatomy in pediatric normal controls"; Journal of Speech, Language, and Hearing Research. 49(4):856-866 .....…21

25 Dingemanse J. G.; Frijns J. H.; & Briaire J. J.; (2006); "Psychophysical assessment of spatial spread of excitation in electrical hearing with single and dual electrode contact maskers"; Ear Hear. 27(6):645-657 21

26 Donaldson G. S. & Kreft H. A.; (2006); "Effects of vowel context on the recognition of initial and medial consonants by cochlear implant users"; Ear Hear. 27(6):658-677 22

27 Dong M.; Mai S.; Wang Z.; & Zhang C.; (2006); "A cochlear system with implant DSP"; ICASSP IEEE Int Conf Acoust Speech Signal Process Proc 23

28 Doucet M. E.; Bergeron F.; Lassonde M.; Ferron P.; & Lepore F.; (2006); "Cross-modal reorganization and speech perception in cochlear implant users"; Brain. 129(12):3376-3383 24

29 Fatterpekar G. M.; Doshi A. H.; Dugar M.; Delman B. N.; Naidich T. P.; & Som P. M.; (2006); "Role of 3D CT in the evaluation of the temporal bone"; RadioGraphics. 26(suppl_1):S117-S132 24

30 Filipo R.; Patrizi M.; La Gamma R.; D'Elia C.; La Rosa G.; & Barbara M.; (2006); "Vestibular impairment and cochlear implantation"; Acta Otolaryngol. 126(12):1266-1274 25

31 Fitzgerald M. B.; Morbiwala T. A.; & Svirsky M. A.; (2006); "Customized selection of frequency maps in an acoustic simulation of a cochlear implant"; Annu Int Conf IEEE Eng Med Biol Proc 26

32 Fortnum H. M.; Stacey P. C.; & Summerfield A. Q.; (2006); "An exploration of demographic bias in a questionnaire survey of hearing-impaired children: implications for comparisons of children with and without cochlear implants"; Int J Pediatr Otorhinolaryngol. 70(12):2043-2054 26

33 Friesen L. M. & Tremblay K. L.; (2006); "Acoustic change complexes recorded in adult cochlear implant listeners"; Ear Hear. 27(6):678-685 27

34 Fu Q. J. & Galvin J. J., III; (2006); "Recognition of simulated telephone speech by cochlear implant users"; American Journal of Audiology. 15(2):127-132 27

35 Fu Q. J.; Liu C.; & Narayanan S. S.; (2006); "Smooth GMM based multi-talker spectral conversion for spectrally degraded speech"; ICASSP IEEE Int Conf Acoust Speech Signal Process Proc 27

36 Gardner P.; Oitmaa E.; Messner A.; Hoefsloot L.; Metspalu A.; & Schrijver I.; (2006); "Simultaneous multigene mutation detection in patients with sensorineural hearing loss through a novel diagnostic microarray: A new approach for newborn screening follow-up"; Pediatrics. 118(3):985-994 28

37 Guan T. & Ye D.; (2006); "[Comparison of the clinic results of speech processing strategies and latest advances on cochlear implant]"; Sheng Wu Yi Xue Gong Cheng Xue Za Zhi. 23(5):1138-1141 28

38 Haenggeli C. A.; Kos M. I.; Pellizone M.; & Guyot J. P.; (2006); "[Cochlear implant or regular hearing aid?]"; Rev Med Suisse. 2(81):2230-2, 2234 29

39 Hildebrand M. S.; de Silva M. G.; Gardner R. J.; Rose E.; de Graaf C. A.; Bahlo M.; & Dahl H. H.; (2006); "Cochlear implants for DFNA17 deafness"; Laryngoscope. 116(12):2211-2215 29

40 Hochmair I.; Nopp P.; Jolly C.; Schmidt M.; Schosser H.; Garnham C.; & Anderson I.; (2006); "MED-EL cochlear implants: state of the art and a glimpse into the future"; Trends in Amplification. 10(4):201-219 29

41 Iverson P.; Smith C. A.; & Evans B. G.; (2006); "Vowel recognition via cochlear implants and noise vocoders: effects of formant movement and duration"; J Acoust Soc Am. 120(6):3998-4006 30

42 Karimi-Yazdi A.; Sazgar A. A.; Nadimi-Tehran A.; Faramarzi A.; Nassaj F. E.; & Yahyavi S.; (2006); "Application and usage of tactile aid in Iran"; Arch Iran Med. 9(4):344-347 30

43 Kennedy C. R.; McCann D. C.; Campbell M. J.; Law C. M.; Mullee M.; Petrou S.; Watkin P.; Worsfold S.; Yuen H. M.; & Stevenson J.; (2006); "Language ability after early detection of permanent childhood hearing impairment"; New England Journal of Medicine. 354(20):2131-2141 31

44 Kent B. & Smith S.; (2006); "They only see it when the sun shines in my ears: exploring perceptions of adolescent hearing aid users"; The Journal of Deaf Studies and Deaf Education. 11(4):461-476..... 31

45 King J. E.; Polak M.; Hodges A. V.; Payne S.; & Telischi F. F.; (2006); "Use of neural response telemetry measures to objectively set the comfort levels in the Nucleus 24 cochlear implant"; J Am Acad Audiol. 17(6):413-431 32

46 Ko W. H.; Megerian C. A.; Semaan M.; Young D. J.; & Zurcher M. A.; (2006); "Effect of incus removal on middle ear acoustic sensor for a fully implantable cochlear prosthesis"; Annu Int Conf IEEE Eng Med Biol Proc 32

47 Kos M. I.; Degive C.; Boex C.; Maire R.; & Guyot J. P.; (2006); "[Professional occupation after cochlear implantation]"; Rev Med Suisse. 2(81):2226-2228 33

48 Kral A.; Tillein J.; Heid S.; Klinke R.; & Hartmann R.; (2006); "Cochlear implants: cortical plasticity in congenital deprivation"; Prog.Brain Res. 157(283-313 33

49 Kunda L. D.; Stidham K. R.; Inserra M. M.; Roland P. S.; Franklin D.; & Roberson J. B.; (2006); "Silicone allergy: a new cause for cochlear implant extrusion and its management"; Otol Neurotol. 27(8):1078-1082 34

50 Kunisue K.; Fukushima K.; Nagayasu R.; Kawasaki A.; & Nishizaki K.; (2006); "Longitudinal formant analysis after cochlear implantation in school-aged children"; Int J Pediatr Otorhinolaryngol. 70(12):2033-2042 34

51 Law Z. W. Y. & So L. K. H.; (2006); "Phonological abilities of hearing-impaired Cantonese-speaking children with cochlear implants or hearing aids"; Journal of Speech, Language, and Hearing Research. 49(6):1342-135 35

52 Legent F.; Avenard M.; Andrieu G.; Bordure P.; & Marie J. P.; (2006); "[Surgical treatment of otosclerosis]"; Bull Acad Natl Med. 190(4-5):915-926 35

67 Morimoto A. K.; Wiggins R. H., III; Hudgins P. A.; Hedlund G. L.; Hamilton B.; Mukherji S. K.; Telian S. A.; & Harnsberger H. R.; (2006); "Absent semicircular canals in CHARGE syndrome: radiologic spectrum of findings"; American Journal of Neuroradiology. 27(8):1663-1671 43

68 Nikolaraizi M. & Hadjikakou K.; (2006); "The role of educational experiences in the development of deaf identity"; The Journal of Deaf Studies and Deaf Education. 11(4):477-492 44

69 Nikolopoulos T. P.; Archbold S. M.; & O'Donoghue G. M.; (2006); "Does cause of deafness influence outcome after cochlear implantation in children?"; Pediatrics. 118(4):1350-1356 44

70 Okano T.; Nakagawa T.; Kita T.; Endo T.; & Ito J.; (2006); "Cell-gene delivery of brain-derived neurotrophic factor to the mouse inner ear"; Mol Ther. 14(6):866-871 45

71 Oweiss K. G. & Suhail Y.; (2006); "Hearing aids and cochlear implants under adverse conditions"; ICASSP IEEE Int Conf Acoust Speech Signal Process Proc 46

72 Padilla Romero M. J.; Sainz Quevedo M.; Roldan Segura C.; Garcia Negro A. S.; & Camacho Castro A. C.; (2006); "[Subjetive benefits and limitations in relation with the cochlear implant reported by adolescent and adult patients]"; Acta Otorrinolaringol Esp. 57(10):455-461 46

73 Patrick J. F.; Busby P. A.; & Gibson P. J.; (2006); "The development of the Nucleus(R) FreedomTM cochlear implant system"; Trends in Amplification. 10(4):175-200 47

74 Poulsen C.; Picton T. W.; & Paus T.; (2006); "Age-related changes in transient and oscillatory brain responses to auditory stimulation in healthy adults 19-45 years old"; Cerebral Cortexbhl056 47

75 Pretorius L. L.; Hanekom J. J.; van Wieringen A.; & Wouters J.; (2006); "An analytical method to determine phoneme recognition abilities of South African cochlear implant users"; Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie. 25(4):195-208 48

76 Propst E. J.; Blaser S.; Stockley T. L.; Harrison R. V.; Gordon K. A.; & Papsin B. C.; (2006); "Temporal bone imaging in GJB2 deafness"; Laryngoscope. 116(12):2178-2186 48

77 Psarommatis I.; Riga M.; Douros K.; Koltsidopoulos P.; Douniadakis D.; Kapetanakis I.; & Apostolopoulos N.; (2006); "Transient infantile auditory neuropathy and its clinical implications"; Int J Pediatr Otorhinolaryngol. 70(9):1629-1637 49

78 Ricketts T. A.; Grantham D. W.; Ashmead D. H.; Haynes D. S.; & Labadie R. F.; (2006); "Speech recognition for unilateral and bilateral cochlear implant modes in the presence of uncorrelated noise sources"; Ear Hear. 27(6):763-773 ..... .49

79 Sanpetrino N. M. & Smith R. L.; (2006); "The growth of loudness functions measured in cochlear implant listeners using Absolute Magnitude Estimation and compared using Akaike's Information Criteria"; Annu Int Conf IEEE Eng Med Biol Proc 50

80 Schafer E. C. & Thibodeau L. M.; (2006); "Speech recognition in noise in children with cochlear implants while listening in bilateral, bimodal, and FM-system arrangements"; American Journal of Audiology. 15(2):114-126 51

81 Schroeder L.; Petrou S.; Kennedy C.; McCann D.; Law C.; Watkin P. M.; Worsfold S.; & Yuen H. M.; (2006); "The economic costs of congenital bilateral permanent childhood hearing impairment"; Pediatrics. 117(4):1101-1112 51

82 Siddiq M. A.; (2006); "Otosclerosis: a review of aetiology, management and outcomes"; Br J Hosp Med (Lond). 67(9):470, 472-470, 476..... 52

83 Siemering K.; Manji S. S. M.; Hutchison W. M.; Du Sart D.; Phelan D.; & Dahl H. H.; (2006); "Detection of mutations in genes associated with hearing loss using a microarray-based approach"; Molecular Diagnostics. 8(4):483-489 52

84 Skubisz K. C.; (2006); "Responses to short-term auditory stimulation through contralateral hearing aid use in pediatric cochlear implant users"; Dissertation..... 53

85 Smith M. W. & Faulkner A.; (2006); "Perceptual adaptation by normally hearing listeners to a simulated "hole" in hearing"; J Acoust Soc Am. 120(6):4019-4030 53

86 Snik A. F. M.; van Duijnhoven N. T. L.; Mylanus E. A. M.; & Cremers C. W. R. J.; (2006); "Estimated cost-effectiveness of active middle-ear implantation in hearing-impaired patients with severe external otitis"; Archives of Otolaryngology - Head and Neck Surgery. 132(11):1210-1215 54

87 Souza P. E. & Tremblay K. L.; (2006); "New perspectives on assessing amplification effects"; Trends in Amplification. 10(3):119-143..... 54

88 Stieve M.; Schwab B.; Haupt C.; Bisdas S.; Heermann R.; & Lenarz T.; (2006); "Intraoperative computed tomography in otorhinolaryngology"; Acta Otolaryngol. 126(1):82-87 55

89 Strauss D. J. & Delb W.; (2006); "On the optimal extraction of neural correlates of binaural interaction for bilateral cochlear implant adjustments"; IEEE Trans Biomed.Eng CD-ROM 56

90 Tan J. & Shepherd R. K.; (2006); "Aminoglycoside-induced degeneration of adult spiral ganglion neurons involves differential modulation of tyrosine kinase B and p75 neurotrophin receptor signaling"; American Journal of Pathology. 169(2):528-543..... 56

91 Taylor F. & Hine C.; (2006); "Cochlear implants: informing commissioning decisions, based on need"; J Laryngol Otol. 120(12):1008-1013 57

92 Tehovnik E. J.; Tolias A. S.; Sultan F.; Slocum W. M.; & Logothetis N. K.; (2006); "Direct and indirect activation of cortical neurons by electrical microstimulation"; Journal of Neurophysiology. 96(2):512-521 57

93 Teufert K. B.; Linthicum F. H.; & Connell S. S.; (2006); "The effect of organ of corti loss on ganglion cell survival in humans"; Otol Neurotol. 27(8):1146-1151 57

94 Thawin C.; Kanchanalarp C.; Lertsukprasert K.; Cheewaruangroj W.; Khantapasuantara K.; & Ruencharoen S.; (2006); "Auditory performance of cochlear implant children aged 2-5 years"; J Med Assoc Thai. 89(11):1923-1927 58

95 Tian H. & Zhang D.; (2006); "[The measurement of pneumatized mastoid and facial recess in cochlear implant recipients younger than three years old]"; Lin.Chuang.Er Bi Yan Hou Ke Za Zhi. 20(10):441-443 59

96 Torres S.; Moreno-Torres I.; & Santana R.; (2006); "Quantitative and qualitative evaluation of linguistic input support to a prelingually deaf child with cued speech: a case study"; The Journal of Deaf Studies and Deaf Education. 11(4):438-448 59

97 Umat C.; McDermott H. J.; & McKay C. M.; (2006); "The effect of intensity on pitch in electric hearing and its relationship to the speech perception performance of cochlear implantees"; J Am Acad Audiol. 17(10):733-746 60

98 van Wermeskerken G. K.; van Olphen A. F.; & van Zanten G. A.; (2006); "A comparison of intra- versus post-operatively acquired electrically evoked compound action potentials"; Int J Audiol. 45(10):589-594 60

99 Vondrasek M.; Sovka P.; & Tichy T.; (2006); "Virtual channels in Nucleus(R) 24 cochlear implants"; Analysis of Biomedical Signals and Imagesxvi+385..... 60

100 Vongpaisal T.; Trehub S. E.; & Schellenberg E. G.; (2006); "Song recognition by children and adolescents with cochlear implants"; Journal of Speech, Language, and Hearing Research. 49(5):1091-1103..... 61

101 Watanabe N.; Takahashi M.; Miyamoto N.; Murakami S.; & Inoue H.; (2006); "A new cochlear implant device of Advanced Bionics - experience and short term results of the use of the HiRes 90K implant"; Oto-Rhino-Laryngology Tokyo..... 61

102 Wei B. P.; Shepherd R. K.; Robins-Browne R. M.; Clark G. M.; & O'Leary S. J.; (2006); "Pneumococcal meningitis threshold model: A potential tool to assess infectious risk of new or existing inner ear surgical interventions"; Otol Neurotol. 27(8):1152-1161..... 62

103 Wei B. P.; Robins-Browne R. M.; Shepherd R. K.; Azzopardi K.; Clark G. M.; & O'Leary S. J.; (2006); "Protective effects of local administration of ciprofloxacin on the risk of pneumococcal meningitis after cochlear implantation"; Laryngoscope. 116(12):2138-2144 62

104 Willeboer C. & Smoorenburg G. F.; (2006); "Comparing cochlear implant users' speech performance with processor fittings based on conventionally determined T and C levels or on compound action potential thresholds and live-voice speech in a prospective balanced crossover study"; Ear Hear. 27(6):789-798 63

105 Wootten C. T.; Backous D. D.; & Haynes D. S.; (2006); "Management of cerebrospinal fluid leakage from cochleostomy during cochlear implant surgery"; Laryngoscope. 116(11):2055-2059 64

106 Xi X.; Han D. Y.; & Li X. Q.; (2006); "[Pre-operative electrophysiological evaluation for pediatric cochlear implant recipients with auditory neuropathy or auditory dys-synchrony]"; Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 41(12):956-959 64

107 Yang H.; Cao K. L.; Chen X. W.; Wang Y.; Wei C. G.; Jin X.; & Wei B. J.; (2006); "[Cochlear implantation in patients with otitis media-related diseases]"; Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 41(12):908-912 64

108 Yao W. N.; Turner C. W.; & Gantz B. J.; (2006); "Stability of low-frequency residual hearing in patients who are candidates for combined acoustic plus electric hearing"; Journal of Speech, Language, and Hearing Research. 49(5):1085-1090 65

109 Yonehara E.; Mezzalira R.; Porto P. R.; Bianchini W. A.; Calonga L.; Curi S. B.; & Stoler G.; (2006); "Can cochlear implants decrease tinnitus?"; Int Tinnitus.J. 12(2):172-174 65

110 Zhang J.; Xu K.; Simaan N.; & Manolidis S.; (2006); "A pilot study of robot-assisted cochlear implant surgery using steerable electrode arrays"; Med Image Comput Comput Assist Interv Int Conf Med Image Comput Comput Assist Interv. 9(Pt 1):33-40 66

1 **"Preliminary results on correlation between neural response imaging and 'most comfortable levels' in cochlear implantation".** Akin, I.; Kuran, G.; Saka, C.; Vural, M.; (2006); J Laryngol Otol. 120(4):261-265

During cochlear implantation, precise placement of the cochlear electrodes against the cochlear nerve is one of the most important steps, necessary to enable the patient to be aware of the stimulus from the implanted device. Neural response imaging (NRI) is a new tool which measures the evoked compound action potential generated as a result of electrical stimulation of the cochlea by properly placed electrodes during surgery.The aim of this study was to examine the correlation between intra-operative NRI recordings and 'most comfortable levels' (M levels) measured during standard fitting with the SoundWave fitting software, in cochlear implantation patients. Seven adult subjects were included in the study. The average duration of profound bilateral deafness was seven years (range = 19 years) and the mean age at implantation was 24 years (range = 17-34 years). All subjects underwent implantation and reached the one-month fitting session; one patient reached the two-month fitting session. The intra-operative NRI threshold (tNRI) was observed to be much higher than the first fitting M levels. The tNRI was 203 per cent of the sequential M value and 246 per cent of the paired M value. All but one intra-operative tNRI values were greater than 150 clinical units (CU), and all first fitting M levels were on average below 100 CU. No obvious correlation was found between individual intra-operative tNRI and first fitting M levels. The M levels at one month were much higher than the first fitting M levels, with much more dispersion.

2 **"Micromanipulator for enhancing surgeon's dexterity in cochlear atraumatic surgery".** Ares, M.; Echeverria, M.; Manrique, M.; Savall, J.; (2006); Annu Int Conf IEEE Eng Med Biol Proc

The hybrid stimulation in cochlear implants requires changes in the design of electrode arrays. A new generation of flat electrode arrays that does not damage the cochlea is being developed. For the insertion of these flat array electrodes a groove must be milled in the antero-inferior area of the round window niche. Even for the most experienced surgeon, it is very difficult to carry out this operation without damaging the cochlea. That is why external help is needed. For helping the surgeon to mill the groove, a compliant mechanism based micromanipulator has been designed, manufactured and tested. A surgical milling tool is attached to a specially designed compliant mechanism and positioned properly along the auditory canal. The compliant mechanism guides the motion of the surgical tool, keeping tactile feedback and enhancing the dexterity of the surgeon for an accurate milling of the groove.

3 **"Active electrode arrays by chip embedding in a flexible silicone carrier".** Baert, K.; Beyne, E.; Gonzalez, M.; Vanden Bulcke, M.; Webers, T.; Winter, C.; (2006); Annu Int Conf IEEE Eng Med Biol Proc

Future cochlear implants demand a higher density of stimulation sites (electrodes) and enhanced functionality (e.g. feedback information). The

current generation of implanted cochlear prostheses is making use of a completely "passive scheme" and cannot meet these requirements. An "all-Silicon" concept integrating active components with passive electrodes in Silicon has been proposed but does not offer the flexibility/stretchability of current silicone-based devices. This paper introduces a novel concept based on Silicon chip embedding in a flexible silicone carrier. The process and experimental results will be presented. The concept is also applicable to other types of implanted electrodes, e.g. retinal implants.

4 **"Speech processing for cochlear implants with the Discrete Wavelet Transform: Feasibility study and performance evaluation".** Baselli, G.; Grandori, F.; Paglialonga, A.; Parazzini, M.; Ravazzani, P.; Tognola, G.; (2006); Annu Int Conf IEEE Eng Med Biol Proc

An innovative approach is investigated for speech processing in cochlear implants (CI). Differently from the traditional filter-bank spectral analysis strategies, the proposed method analyses the speech signal by means of the discrete wavelet transform (DWT). Preliminary tests were conducted in order to compare the WT and the filter-bank analysis methods. Additionally, the intelligibility of the speech processed with the proposed WT strategy was tested on normal hearing people by means of the acoustic simulations and a comparison was made with respect to traditional CI algorithms. Results showed that the WT could be a suitable method for speech coding in CIs. The information loss was minimal and, in speech recognition tests, the WT performance was similar to traditional filter-bank strategies.

5 **"Speech recognition in normal hearing and sensorineural hearing loss as a function of the number of spectral channels".** Baskent, D.; (2006); J Acoust Soc Am. 120(5 Pt 1):2908-2925

Speech recognition by normal-hearing listeners improves as a function of the number of spectral channels when tested with a noiseband vocoder simulating cochlear implant signal processing. Speech recognition by the best cochlear implant users, however, saturates around eight channels and does not improve when more electrodes are activated, presumably due to reduced frequency selectivity caused by channel interactions. Listeners with sensorineural hearing loss may also have reduced frequency selectivity due to cochlear damage and the resulting reduction in the nonlinear cochlear mechanisms. The present study investigates whether such a limitation in spectral information transmission would be observed with hearing-impaired listeners, similar to implant users. To test the hypothesis, hearing-impaired subjects were selected from a population of patients with moderate hearing loss of cochlear origin, where the frequency selectivity would be expected to be poorer compared to normal hearing. Hearing-impaired subjects were tested for vowel and consonant recognition in steady-state background noise of varying levels using a noiseband vocoder and as a function of the number of spectral channels. For comparison, normal-hearing subjects were tested with the same stimuli at different presentation levels. In quiet and low background noise, performance by normal-hearing and hearing-impaired subjects was similar. In higher background noise, performance by hearing-

impaired subjects saturated around eight channels, while performance by normal-hearing subjects continued to increase up to 12-16 channels with vowels, and 10-12 channels with consonants. A similar trend was observed for most of the presentation levels at which the normal-hearing subjects were tested. Therefore, it is unlikely that the effects observed with hearing-impaired subjects were due to insufficient audibility or high presentation levels. Consequently, the results with hearing-impaired subjects were similar to previous results obtained with implant users, but only for background noise conditions.

6 **"Revision BAHA Surgery".** Battista, R. A. & Littlefield, P. D.; (2006); Otolaryngol Clin North Am. 39(4):801-13, viii

The osseointegrated auditory implant (BAHA) is a system used for hearing rehabilitation through direct bone conduction. Although BAHA surgery is not difficult, the surgeon must observe meticulous technique to prevent complications. Indications for revision BAHA surgery can be divided into (1) failure of fixture osseointegration; (2) bone overgrowth; or (3) skin reaction or skin loss. This article discusses the conditions that might predispose a patient to require BAHA revision, and the steps, if any, that can be taken to prevent these complications. Specific surgical steps for revision of each of these three conditions are also addressed.

7 **"Central auditory development in children with bilateral cochlear implants".** Bauer, P. W.; Sharma, A.; Martin, K.; Dorman, M.; (2006); Archives of Otolaryngology - Head and Neck Surgery. 132(10):1133-1136

Objective To examine the time course of maturation of P1 latencies in infant sequential and simultaneous bilateral cochlear implant recipients. Design Retrospective case series. Setting Pediatric collaborative cochlear implant program. Patients Four children who received bilateral cochlear implants prior to age 2 years. Intervention Cortical auditory evoked potential was completed to determine the latency of the P1 response in 4 children with bilateral cochlear implants. Main Outcome Measures Longitudinal development of the latency of the P1 cortical auditory evoked potential in children who received bilateral cochlear implants prior to age 2 years. Results In 2 patients who received sequential bilateral implants, P1 latencies recorded from the first implanted ear were within normal limits after 3 to 6 months of implant use. By comparison, P1 latencies from the second implanted ear reached normal limits as early as 1 month after implant use. In 2 patients who received simultaneous bilateral implants, P1 latencies from both ears were also within normal limits in a very short time frame (ie, by 1 month poststimulation). Conclusions Our data suggest a high degree of plasticity of the central auditory pathways after early bilateral implantation. We find that P1 latencies provide a clinically useful biomarker of central auditory system development in children after cochlear implantation.

8 **"Molecular investigation in children candidates and submitted to cochlear implantation".** Bernardes, R.; Bortoncello, S.; Christiani, T. V.; Sartorato, E. L.; Silva, R. C.; Porto, P. R.; (2006); Rev Bras Otorrinolaringol (Engl Ed). 72(3):333-336

AIM: Recent progresses in molecular biology have been made in the diagnosis of sensorineural hearing loss. The high prevalence of a connexin 26 gene mutation, and its easy identification have made the diagnosis possible. The most frequent gene mutation is called 35delG. The purpose of this study was to evaluate the prevalence of 35delG mutation in children submitted to cochlear implantation who had severe and profound hearing loss previously diagnosed as idiopathic. METHOD: The study was done at the Cochlear Implantation Clinic of the Otolaryngology Department and at the Laborat≤rio Genθtica Humana-CBMEG, UNICAMP-SP. 32 children with severe to profound sensorineural hearing loss were evaluated. The detection of the 35delG mutation was made by a allele-specific PCR, using primers and polymerase chain reaction. RESULTS: 69% had a normal exam, 12% were homozygous for the mutation, 19% of the cases were heterozygous. The 35delG mutation in heterozygous is not a cause of hearing loss. CONCLUSION: The data confirm the high prevalence of the 35delG mutation in nonsyndromic bilateral profound sensorineural hearing loss. It was also possible to diagnose the cause of hearing loss as genetic in a significant percentage of patients. That stresses the importance of the molecular investigation in those cases formerly classified as idiopathic.

9 **"Effects of programming threshold and maplaw settings on acoustic thresholds and speech discrimination with the MED-EL COMBI 40+ cochlear implant".** Boyd, P. J.; (2006); Ear Hear. 27(6):608-618

OBJECTIVES: The principal task in the programming of a cochlear implant (CI) speech processor is the setting of the electrical dynamic range (output) for each electrode, to ensure that a comfortable loudness percept is obtained for a range of input levels. This typically involves separate psychophysical measurement of electrical threshold ([theta] e) and upper tolerance levels using short current bursts generated by the fitting software. Anecdotal clinical experience and some experimental studies suggest that the measurement of [theta]e is relatively unimportant and that the setting of upper tolerance limits is more critical for processor programming. The present study aims to test this hypothesis and examines in detail how acoustic thresholds and speech recognition are affected by setting of the lower limit of the output ("Programming threshold" or "PT") to understand better the influence of this parameter and how it interacts with certain other programming parameters. DESIGN: Test programs (maps) were generated with PT set to artificially high and low values and tested on users of the MED-EL COMBI 40+ CI system. Acoustic thresholds and speech recognition scores (sentence tests) were measured for each of the test maps. Acoustic thresholds were also measured using maps with a range of output compression functions ("maplaws"). In addition, subjective reports were recorded regarding the presence of "background threshold stimulation" which is occasionally reported by CI users if PT is set to relatively high values when using the CIS strategy. RESULTS:

Manipulation of PT was found to have very little effect. Setting PT to minimum produced a mean 5 dB (S.D. = 6.25) increase in acoustic thresholds, relative to thresholds with PT set normally, and had no statistically significant effect on speech recognition scores on a sentence test. On the other hand, maplaw setting was found to have a significant effect on acoustic thresholds (raised as maplaw is made more linear), which provides some theoretical explanation as to why PT has little effect when using the default maplaw of c = 500. Subjective reports of background threshold stimulation showed that most users could perceive a relatively loud auditory percept, in the absence of microphone input, when PT was set to double the behaviorally measured electrical thresholds ([theta]e), but that this produced little intrusion when microphone input was present. CONCLUSIONS: The results of these investigations have direct clinical relevance, showing that setting of PT is indeed relatively unimportant in terms of speech discrimination, but that it is worth ensuring that PT is not set excessively high, as this can produce distracting background stimulation. Indeed, it may even be set to minimum values without deleterious effect.

10 **"Wavelet packet filterbank for speech processing strategies in cochlear implants".** Buchner, A.; Edler, B.; Giese, A.; Nogueira, W.; (2006); ICASSP IEEE Int Conf Acoust Speech Signal Process Proc

Current speech processing strategies for cochlear implants use a filterbank which decomposes the audio signals into multiple frequency bands each associated with one electrode. Pitch perception with cochlear implants is related to the number of electrodes inserted in the cochlea and to the rate of stimulation of these electrodes. The filterbank should, therefore, be able to analyze the time-frequency features of the audio signals while also exploiting the time-frequency features of the implant. This study investigates the influence on speech intelligibility in cochlear implant users when filterbanks with different time-frequency resolutions are used. Three filterbanks, based on the structure of a wavelet packet transform but using different basis functions, were designed. The filterbanks were incorporated into a commercial speech processing strategy and were tested on device users in an acute study.

11 **"Evaluation of Advanced Bionics high resolution mode".** Buechner, A.; Frohne-Buechner, C.; Gaertner, L.; Lesinski-Schiedat, A.; Battmer, R. D.; Lenarz, T.; (2006); Int J Audiol. 45(7):407-416

The objective of this paper is to evaluate the advantages of the Advanced Bionic high resolution mode for speech perception, through a retrospective analysis. Forty-five adult subjects were selected who had a minimum experience of three months' standard mode (mean of 10 months) before switching to high resolution mode. Speech perception was tested in standard mode immediately before fitting with high resolution mode, and again after a maximum of six months high resolution mode usage (mean of two months). A significant improvement was found, between 11 and 17%, depending on the test material. The standard mode preference does not give any indication about the improvement when switching to high resolution. Users who are converted within any study achieve a higher performance improvement than

those converted in the clinical routine. This analysis proves the significant benefits of high resolution mode for users, and also indicates the need for guidelines for individual optimization of parameter settings in a high resolution mode program.

12 **"Auditory cortical responses in patients with cochlear implants".** Burdo, S.; Razza, S.; Di, B. F.; Tognola, G.; (2006); Acta Otorhinolaryngol Ital. 26(2):69-77

Currently, the most commonly used electrophysiological tests for cochlear implant evaluation are Averaged Electrical Voltages (AEV), Electrical Advisory Brainstem Responses (EABR) and Neural Response Telemetry (NRT). The present paper focuses on the study of acoustic auditory cortical responses, or slow vertex responses, which are not widely used due to the difficulty in recording, especially in young children. Aims of this study were validation of slow vertex responses and their possible applications in monitoring postimplant results, particularly restoration of hearing and auditory maturation. In practice, the use of tone-bursts, also through hearing aids or cochlear implants, as in slow vertex responses, allows many more frequencies to be investigated and louder intensities to be reached than with other tests based on a click as stimulus. Study design focused on latencies of N1 and P2 slow vertex response peaks in cochlear implants. The study population comprised 45 implant recipients (aged 2 to 70 years), divided into 5 different homogeneous groups according to chronological age, age at onset of deafness, and age at implantation. For each subject, slow vertex responses and free-field auditory responses (PTAS) were recorded for tone-bursts at 500 and 2000 Hz before cochlear implant surgery (using hearing aid amplification) and during scheduled sessions at 3rd and 12th month after implant activation. Results showed that N1 and P2 latencies decreased in all groups starting from 3rd through 12th month after activation. Subjects implanted before school age or at least before age 8 yrs showed the widest latency changes. All subjects showed a reduction in the gap between subjective thresholds (obtained with free field auditory responses) and objective thresholds (obtained with slow vertex responses), obtained in presurgery stage and after cochlear implant. In conclusion, a natural evolution of neurophysiological cortical activities of the auditory pathway, over time, was found especially in young children with prelingual deafness and implanted in preschool age. Cochlear implantation appears to provide hearing restoration, demonstrated by the sharp reduction of the gap between subjective free field auditory responses and slow vertex responses threshold obtained with hearing aids vs. cochlear implant.

13 **"ICA of auditory evoked potentials in children with cochlear implants: component selection".** Castaneda-Villa, N. & James, C. J.; (2006); Annu Int Conf IEEE Eng Med Biol Proc

Multi-channel recordings of scalp electroencephalogram (EEG) for auditory evoked potentials (AEPs) can be used to objectively evaluate hearing sensitivity in both adult and children. This paper uses independent component analysis (ICA) to decompose ongoing (i.e. unaveraged) AEPs recorded from

normal hearing children and children with cochlear implants (CIs). It is seen that ICA can decompose the ongoing EEG into independent components which appear to exhibit the expected characteristics of AEPs, along with other components such as artifacts and ongoing brain activity. This is particularly useful for children with CIs as there is significant CI artifact present in the recordings. We depict here some preliminary results of applying ICA to ongoing multi-channel EEG for both a normal hearing child as well as a child with a CI.

14 **"Role of CT and MRI in the preoperative evaluation of auditory brainstem implantation in patients with congenital inner ear pathology".** Cerini, R.; Faccioli, N.; Cicconi, D.; Schenal, G.; Cugini, C.; Giarbini, N.; Colletti, V.; Pozzi Mucelli, R.; (2006); Radiol Med (Torino). 111(7):978-988

PURPOSE: The purpose of this study was to evaluate the reliability of computed tomography (CT) and magnetic resonance imaging (MRI) in characterising cochlear nerve anomalies in auditory brainstem implant candidates with congenital hearing loss. MATERIALS AND METHODS: Seventeen patients affected by congenital sensorineural hearing loss were examined by CT and MRI. Inner ear malformations eligible for auditory brainstem implants were classified according to the Casselman classification. All patients subsequently received auditory brainstem implants. RESULTS: Suspected congenital anomalies were confirmed by CT and MRI in all 17 patients. There were 5/17 bilateral cochlear nerve aplasias and 12/17 cochleovestibular anomalies. Of these, 5/12 patients had a common cochleovestibular cavity, 2/12 had bilateral cochlear aplasia and cochlear nerve agenesis, 1/12 had type I incomplete partition, 2/12 had type II incomplete partition and 2/12 had cochlear hypoplasia. CONCLUSIONS: Preoperative CT and MRI assessment of patients with sensorineural hearing loss is reliable. MRI provided additional information, identifying the possible absence of cochlear nerve and excluding other central nervous system (CNS) diseases.

15 **"Unintelligible low-frequency sound enhances simulated cochlear-implant speech recognition in noise".** Chang, J. E.; Bai, J. Y.; Zeng, F. G.; (2006); IEEE Trans Biomed.Eng. 53(12 Pt 2):2598-2601

Speech can be recognized by multiple acoustic cues in both frequency and time domains. These acoustic cues are often thought to be redundant. One example is the low-frequency sound component below 300 Hz, which is not even transmitted by the majority of communication devices including telephones. Here, we showed that this low-frequency sound component, although unintelligible when presented alone, could improve the functional signal-to-noise ratio (SNR) by 10-15 dB for speech recognition in noise when presented in combination with a cochlear-implant simulation. A similar low-frequency enhancement effect could be obtained by presenting the low-frequency sound component to one ear and the cochlear-implant simulation to the other ear. However, a high-frequency sound could not produce a similar speech enhancement in noise. We argue that this low-frequency enhancement effect cannot be due to linear addition of intelligibility between

low- and high-frequency components or an increase in the physical SNR. We suggest a brain-based mechanism that uses the voice pitch cue in the low-frequency sound to first segregate the target voice from the competing voice and then to group appropriate temporal envelope cues in the target voice for robust speech recognition under realistic listening situations.

16 **"Effects of talker variability on vowel recognition in cochlear implants".** Chang, Y. p. & Fu, Q. J.; (2006); Journal of Speech, Language, and Hearing Research. 49(6):1331-1341

PURPOSE: To investigate the effects of talker variability on vowel recognition by cochlear implant (CI) users and by normal-hearing (NH) participants listening to 4-channel acoustic CI simulations. METHOD: CI users were tested with their clinically assigned speech processors. For NH participants, 3 CI processors were simulated, using different combinations of carrier type and temporal envelope cutoff frequency (noise band/160 Hz, sine wave/160 Hz, and sine wave/20 Hz). Vowel recognition was measured for 4 talkers, presented in either a single-talker context (1 talker per test block) or a multi-talker context (4 talkers per test block). RESULTS: CI users' vowel recognition was significantly poorer in the multi-talker context than in the single-talker context. When noise-band carriers were used in the simulations, NH performance was not significantly affected by talker variability. However, when sine-wave carriers were used in the simulations, NH performance was significantly affected by talker variability in both envelope filter conditions. CONCLUSIONS: Because fundamental frequency was not preserved by the 20-Hz envelope filter and only partially preserved by the 160-Hz envelope filter, both spectral and temporal cues contributed to the talker variability effects observed with sine-wave carriers. Similarly, spectral and temporal cues may have contributed to the talker variability effects observed with CI participants.

17 **"Auditory stream segregation with cochlear implants: a preliminary report".** Chatterjee, M.; Sarampalis, A.; Oba, S. I.; (2006); Hear Res. 222(1-2):100-107

Auditory stream segregation was measured in cochlear implant (CI) listeners using a subjective "Yes-No" task in which listeners indicated whether a sequence of stimuli was perceived as two separate streams or not. Stimuli were brief, 50-ms pulse trains A and B, presented in an A_B_A_A_B_A... sequence, with 50 ms in between consecutive stimuli. All stimuli were carefully loudness-balanced prior to the experiments. The cochlear electrode location of A was fixed, while the location of B was varied systematically. Measures of electrode discrimination and subjective perceptual difference were also included for comparison. There was strong intersubject variation in the pattern of results. One of the participants participated in a second series of experiments, the results of which indicated that he was able to perceptually segregate stimuli that were different in cochlear electrode location, as well as stimuli that were different in temporal envelope. Although preliminary, these results suggest that it is possible for some cochlear implant listeners to

perceptually segregate stimuli based on differences in cochlear location as well as temporal envelope.

18 **"[High prevalence of connexin-26 (GJB2) mutation in cochlear implant recipients]".** Chen, D. Y.; Chen, X. W.; Cao, K. L.; Jin, X.; Zuo, J.; Wei, C. G.; Fang, F. D.; (2006); Zhonghua Yi Xue Za Zhi. 86(44):3114-3117

OBJECTIVE: To determine the prevalence of GJB2 gene mutations in patients undergoing cochlear implantation. METHODS: We enrolled 115 cochlear implant recipients for mutation screening. Genomic DNA was extracted from the blood of all patients, amplified in PCR and analyzed for single strand conformation polymorphism (SSCP) or direct sequencing to detect mutations of GJB2 gene. RESULTS: The result shows that the GJB2 mutations are detected in 36.5% (42/115) of the cochlear implant recipients, and especially 41% (41/100) of the non-syndromic deafness patients, only 1 inner ear malformation patient was detected with GJB2 mutations. This study found 11 different variations in the GJB2 gene. The 235delC mutation was the most prevalent mutation accounting for 18.3% (41/230) in all cochlear implant recipients and 21% (42/200) in non-syndromic deafness group. 187G > T and 230G > A mutations were novel mutation of GJB2 gene in the Chinese population. CONCLUSION: Mutations in the GJB2 gene were a major cause of deafness in cochlear implant recipients, the carrier frequency of 235delC mutation was highest.

19 **"Loudness normalization for cochlear implant using pulse-rate modulation to convey Mandarin tonal information: A model-based study".** Chen, F. & Zhang, Y. T.; (2006); Annu Int Conf IEEE Eng Med Biol Proc

Cochlear implant (CI) devices employ electrical pulsatile stimulation of the auditory nerves (AN) to restore partial hearing to a profoundly deafened person. In order to improve the speech perception for CI users speaking tonal language, such as Mandarin, the pulse-rate has been suggested to be modulated according to the Mandarin tonal patterns to convey the Mandarin tonal information. However, recent psychological experiments have found that the pulse-rate modulation will produce accompanying variation of perceived loudness. The purpose of this paper is to introduce an amplitude compensation scheme to normalize the loudness perception when the pulse-rate is modulated to convey the Mandarin tonal information. Based on an integrate-and-fire AN model, a loudness perception model and a pitch perception were implemented. Result of model-based simulation showed that using the proposed amplitude compensation scheme, the estimated loudness was normalized while the Mandarin tonal information could still be efficiently transmitted. It is believed that, when the proposed electrical pulsatile stimulation incorporating both pulse-rate modulation and amplitude compensation is integrated with present CI devices, it would more efficiently enhance the speech identification for cochlear implantee speaking tonal languages, such as Mandarin.

20 **"Effects of directional microphone and adaptive multichannel noise reduction algorithm on cochlear implant performance".** Chung, K.; Zeng, F. G.; Acker, K. N.; (2006); J Acoust Soc Am. 120(4):2216-2227

Although cochlear implant (CI) users have enjoyed good speech recognition in quiet, they still have difficulties understanding speech in noise. We conducted three experiments to determine whether a directional microphone and an adaptive multichannel noise reduction algorithm could enhance CI performance in noise and whether Speech Transmission Index (STI) can be used to predict CI performance in various acoustic and signal processing conditions. In Experiment I, CI users listened to speech in noise processed by 4 hearing aid settings: omni-directional microphone, omni-directional microphone plus noise reduction, directional microphone, and directional microphone plus noise reduction. The directional microphone significantly improved speech recognition in noise. Both directional microphone and noise reduction algorithm improved overall preference. In Experiment II, normal hearing individuals listened to the recorded speech produced by 4- or 8-channel CI simulations. The 8-channel simulation yielded similar speech recognition results as in Experiment I, whereas the 4-channel simulation produced no significant difference among the 4 settings. In Experiment III, we examined the relationship between STIs and speech recognition. The results suggested that STI could predict actual and simulated CI speech intelligibility with acoustic degradation and the directional microphone, but not the noise reduction algorithm. Implications for intelligibility enhancement are discussed.

21 **"Prevalence of cochlear implants in postlingually deafened adults in a Swedish region".** Claeson, M. & Ringdahl, A.; (2006); Int J Audiol. 45(11):670-674

Cochlear implantation (CI) rates vary between countries, depending on identification routines and economic restrictions. The present study aimed at determining the prevalence of CIs in postlingually deafened, aged 20-69 years old, in G÷teborg, Sweden. Three patient databases with information on PTA, a questionnaire, medical records and consultations identified 88 subjects with sensorineural hearing loss >/=80 dB HL (PTA of 500, 1000, 3000 Hz), PB word score of </=30% (better ear), regular use of hearing-aid, and oral language. The prevalence of CIs was 11.8 per 100 000 population, and of subjects fulfilling the audiometric candidacy criteria 18.6 per 100 000. The mean PTA (op. ear) of subjects awaiting operation was 97 dB HL (SD 12.3), and of already implanted subjects 106 dB HL (SD 10.2). Mean PB word score was 9% (SD 8.9) and 3% (SD 4.9) respectively. Subjects awaiting operation had significantly better residual hearing, emphasizing recent changes in candidacy criteria. Comparing with prevalence from other countries demonstrated that more patients could be candidates for cochlear implantation.

22 **"The age at which young deaf children receive cochlear implants and their vocabulary and speech-production growth: is there an added value for early implantation?".** Connor, C. M.; Craig, H. K.; Raudenbush, S. W.; Heavner, K.; Zwolan, T. A.; (2006); Ear Hear. 27(6):628-644

OBJECTIVE: The age at which a child receives a cochlear implant seems to be one of the more important predictors of his or her speech and language outcomes. However, understanding the association between age at implantation and child outcomes is complex because a child's age, length of device use, and age at implantation are highly related. In this study, we investigate whether there is an added value to earlier implantation or whether advantages observed in child outcomes are primarily attributable to longer device use at any given age. DESIGN: Using hierarchical linear modeling, we examined latent-growth curves for 100 children who had received their implants when they were between 1 and 10 yr of age, had used oral communication, and had used their devices for between 1 and 12 yr. Children were divided into four groups based on age at implantation: between 1 and 2.5 yr, between 2.6 and 3.5 yr, between 3.6 and 7 yr, and between 7.1 and 10 yr. RESULTS: Investigation of growth curves and rates of growth over time revealed an additional value for earlier implantation over and above advantages attributable to longer length of use at any given age. Children who had received their implants before the age of 2.5 yr had exhibited early bursts of growth in consonant-production accuracy and vocabulary and also had significantly stronger outcomes compared with age peers who had received their implants at later ages. The magnitude of the early burst diminished systematically with increasing age at implantation and was not observed for children who were older than 7 yr at implantation for consonant-production accuracy or for children who were over 3.5 yr old at implantation for vocabulary. The impact of age at implantation on children's growth curves differed for speech production and vocabulary. CONCLUSIONS: There seems to be a substantial benefit for both speech and vocabulary outcomes when children receive their implant before the age of 2.5 yr. This benefit may combine a burst of growth after implantation with the impact of increased length of use at any given age. The added advantage (i.e., burst of growth) diminishes systematically with increasing age at implantation.

23 **"Polymer-based microelectrode arrays".** Corbett, S.; Johnson, T.; Ketterl, J.; (2006); Mater Res Soc Symp Proc

We have developed flexible, polymer-based electrodes for potential medical applications including neural recording and stimulation. Using various combinations of liquid crystal polymer (LCP) substrates, implantable grade silicone and polyimide, we have developed and tested several prototype multi-layer, polymer electrodes. We report here on two specific electrodes. In the first case, a multilayer electrode consisting of high-melt temperature liquid crystal polymer (LCP) material with patterned electrodes of sputter deposited and plated gold, laminated together with a lower-melt temperature LCP, was produced. Iridium oxide was deposited on the exposed electrode sites to facilitate effective charge transfer for neural stimulation. The electrode was designed for acute implantation in a cat cochlea and contained 12 contacts,

with a pitch of 200 microns. The small contact spacing allowed testing of electric field focusing techniques both in vitro and in vivo. We subjected the electrodes to electrical and mechanical tests to assess its likely suitability as a long-term biomedical implant. Chronic electrical leakage testing indicated ionic permeability of the low and high temperature LCP interface that was higher than that desired. In a second case, we produced a mock circuit using high-melt LCP and medical grade low durometer silicone in place of the low-melt LCP as the interlayer adhesive. Mechanical and electrical testing of the hybrid design indicated the potential to fabricate cochlear electrodes containing up to 72 contacts with a footprint and mechanical performance similar or better than current commercially available cochlear implant arrays (containing up to 24 elements). Multi-layer polymer electrode technology offers the opportunity to create new electrodes with higher numbers of channels, offering improved performance in neural stimulation applications including cochlear implants , retinal arrays, deep brain stimulators and paraplegic remobilization devices.

24 **"Maturation of speech and language functional neuroanatomy in pediatric normal controls".** Devous, M. D., Sr.; Altuna, D.; Furl, N.; Cooper, W.; Gabbert, G.; Ngai, W. T.; Chiu, S.; Scott, J. M., III; Harris, T. S.; Payne, J. K.; Tobey, E. A.; (2006); Journal of Speech, Language, and Hearing Research. 49(4):856-866

PURPOSE: This study explores the relationship between age and resting-state regional cerebral blood flow (rCBF) in regions associated with higher order language skills using a population of normal children, adolescents, and young adults. METHOD: rCBF was measured in 33 normal participants between the ages of 7 and 19 years using single photon emission computed tomography. Participants' ages were regressed on rCBF values (normalized to whole-brain CBF) in 2 ways: (a) within anatomically defined, language-related regions of interest (ROIs) including Wernicke's area, Broca's area, angular gyrus, planum temporale, and Heschl's gyrus and (b) within clusters of voxels found to be significantly related to age in voxel-wise analyses. RESULTS: rCBF in all anatomically defined ROIs except Heschl's gyrus declined as a function of age. Additionally, voxel-wise analyses revealed clusters where rCBF declined with age in left inferior parietal, left superior temporal, and right middle temporal regions--areas often implicated in higher order language functions. CONCLUSIONS: These data suggest that ongoing maturation (e.g., dendritic pruning) in higher order cognitive areas (e.g., angular gyrus) continues into adolescence, as reflected by declining rCBF, while the primary auditory area (Heschl's gyrus) has become a stable neuronal population by age 7 years.

25 **"Psychophysical assessment of spatial spread of excitation in electrical hearing with single and dual electrode contact maskers".** Dingemanse, J. G.; Frijns, J. H.; Briaire, J. J.; (2006); Ear Hear. 27(6):645-657

OBJECTIVE: To evaluate psychophysically the spatial spread of excitation in electrical hearing with a new dual contact masker and to investigate under which conditions it is possible to stimulate fibers in the immediate

neighborhood of an electrode contact, which were not excited by neighboring electrode contacts. DESIGN: In this study a psychophysical forward masking paradigm with a dual contact masker was used to avoid off-site listening, the electrical analogue of off-frequency listening. The masker stimulus (300 msec) is presented nonsimultaneously on two electrode contacts, one on the apical side and another on the basal side of the probe contact, followed by a probe stimulus of 20 msec.Unmasked probe thresholds were compared with masked ones at a number of masker-probe distances, whereas growth of masking curves were measured for a fixed masker contact pair.Standard selectivity measurements (single contact masking) and the recovery of forward masking with one masker contact were included for comparison with existing methods.All experiments were carried out with six participants who use the Clarion CII device with a HiFocus I electrode array. RESULTS: For dual contact masking the amount of masking was significantly greater than for single contact masking and the width of the masking patterns was on average 1.1 mm broader than for single contact masking, resulting in a broad region of excitation, with masker-probe overlap for distances greater than 3 mm. Masking widths for dual and single contact masking were highly correlated.Growth of masking curves were highly nonlinear. They showed a strong elevation of the slope that starts for most subjects around the middle of the dynamic range or above. For 4 out of 6 subjects, no probe threshold was found above a masker amplitude of about 400-500 microA. The ratio of the maximum measurable masked probe thresholds and unmasked probe threshold ranged from 1.7 to 2.6 (S4 excluded).Recovery of masking functions follow an exponential decay. Time constants tau for the recovery process ranged from 21.6 msec to 114.9 msec. CONCLUSIONS: With a dual contact masker (1) off-site listening can be avoided, leading to larger estimates of the width of excitation patterns than in single contact masking, (2) it can be estimated for which stimulation level there is complete overlap of excitation patterns of adjacent electrode contacts, (3) it can be shown that stimulation of nerve fibers in the immediate neighborhood of an electrode contact which were not excited by neighboring electrode contacts is only possible if the probe stimulation amplitude is sufficiently high in comparison with amplitudes on neighboring contacts.

26 **"Effects of vowel context on the recognition of initial and medial consonants by cochlear implant users".** Donaldson, G. S. & Kreft, H. A.; (2006); Ear Hear. 27(6):658-677

OBJECTIVE: Scores on consonant-recognition tests are widely used as an index of speech-perception ability in cochlear implant (CI) users. The consonant stimuli in these tests are typically presented in the /alpha/ vowel context, even though consonants in conversational speech occur in many other contexts. For this reason, it would be useful to know whether vowel context has any systematic effect on consonant recognition in this population. The purpose of the present study was to compare consonant recognition for the /alpha, i/, and /u/ vowel contexts for consonants presented in both initial (Cv) and medial (vCv) positions. DESIGN: Twenty adult CI users with one of three different implanted devices underwent consonant-confusion testing. Twelve stimulus conditions that differed according to vowel context (/alpha, i,

u/), consonant position (Cv, vCv), and talker gender (male, female) were assessed in each subject. RESULTS: Mean percent-correct consonant-recognition scores were slightly (5 to 8%) higher for the /alpha/ and /u/ vowel contexts than for the /i/ vowel context for both initial and medial consonants. This general pattern was observed for both male and female talkers, for subjects with better and poorer average consonant-recognition performance, and for subjects using low, medium, and high stimulation rates in their speech processors. In contrast to the mean data, many individual subjects demonstrated large effects of vowel context. For 10 of 20 subjects, consonant-recognition scores varied by 15% or more across vowel contexts in one or more stimulus conditions. Similar to the mean data, these differences generally reflected better performance for the /alpha/ and /u/ vowel contexts than for the /i/ vowel context. An analysis of consonant features showed that overall performance was best for the voicing feature, followed by the manner and place features, and that the place feature showed the strongest effect of vowel context. Vowel-context effects were strongest for the six consonants /d, j, n, k, m/, and /l/. For three of these consonants (/j, n, k/), the back vowels /alpha/ and /u/ produced substantially (30 to 35%) higher mean scores than the front vowel /i/. For each of the remaining three consonants, a unique pattern was observed in which a different single vowel produced substantially higher scores than the others. Several additional consonants (/s, g, w, b/, and /d/) showed strong context effects in either the initial consonant or medial consonant position. Overall, voiceless stop, nasal, and glide-liquid consonants showed the strongest effects of vowel context, whereas the voiceless fricative and voiceless affricate consonants were least affected. Consistent with the feature analysis, a qualitative assessment of phoneme errors for the six key consonants indicated that vowel-context effects stem primarily from changes in the number of place-of-articulation errors made in each context. CONCLUSIONS: Vowel context has small but significant effects on consonant-recognition scores for the "average" CI listener, with the back vowels /alpha/ and /u/ producing better performance than the front vowel /i/. In contrast to the average results, however, the effects of vowel context are sizable in some individual subjects. This suggests that it may be beneficial to assess consonant recognition using two vowels, such as /alpha/ and /i/, which produce better and poorer performance, respectively. The present results underscore previous findings that poor transmission of spectral speech cues limits consonant-recognition performance in CI users. Spectral cue transmission may be hindered not only by poor spectral resolution in these listeners but also by the brief duration and dynamic nature of consonant place-of-articulation cues.

27 **"A cochlear system with implant DSP".** Dong, M.; Mai, S.; Wang, Z.; Zhang, C.; (2006); ICASSP IEEE Int Conf Acoust Speech Signal Process Proc

Cochlear implants have achieved great success in restoring hearing to profoundly deaf people. New generation implants pose more restrict requirements on processing precision and make traditional cochlear systems insufficient to deal with the large amount of data which should be transmitted via the wireless link. A new cochlear system with implant DSP is proposed to

address the data rate problem. This system needs to transmit only voice-band signals with a data rate of 100 Kbps and the data rate bottleneck is removed for future development. By optimizing the speech processing algorithm and the inductive wireless link, the power consumption of this system increases less than 10% when compared with the traditional system.

28 **"Cross-modal reorganization and speech perception in cochlear implant users".** Doucet, M. E.; Bergeron, F.; Lassonde, M.; Ferron, P.; Lepore, F.; (2006); Brain. 129(12):3376-3383

Recent work suggests that once the auditory cortex of deaf persons has been reorganized by cross-modal plasticity, it can no longer respond to signals from a cochlear implant (CI) installed subsequently. To further examine this issue, we compared the evoked potentials involved in the processing of visual stimuli between CI users and hearing controls. The stimuli were concentric circles replaced by a different overlapping shape, inducing a shape transformation, known to activate the ventral visual pathway in human adults. All CI users had their device implanted for >1 year, but obtained different levels of auditory performance following training to establish language comprehension. Seven of the 13 patients showed good capacities for speech recognition with the CI (good performers) while the six others demonstrated poor speech recognition abilities (poor performers). The evoked potentials of all patients showed larger amplitudes, with different distributions of scalp activations between the two groups. The poor performers exhibited broader, anteriorly distributed, high P2 amplitudes over the cortex whereas the good performers showed significantly higher P2 amplitudes over visual occipital areas. These results suggest the existence of a profound cross-modal reorganization in the poor performers and an intramodal reorganization in the good performers. We interpret these data on the basis of enhanced audiovisual coupling as the key to a long-term functional improvement in speech discrimination in CI users.

29 **"Role of 3D CT in the evaluation of the temporal bone".** Fatterpekar, G. M.; Doshi, A. H.; Dugar, M.; Delman, B. N.; Naidich, T. P.; Som, P. M.; (2006); RadioGraphics. 26(suppl_1):S117-S132

In recent years, three-dimensional (3D) multiplanar reformatted images from conventional cross-sectional computed tomographic (CT) data have been increasingly used to better demonstrate the anatomy and pathologic conditions of various organ systems. Three-dimensional volume-rendered (VR) CT images can aid in understanding the temporal bone, a region of complex anatomy containing multiple small structures within a relatively compact area, which makes evaluation of this region difficult. These images can be rotated in space and dissected in any plane, allowing assessment of the morphologic features of individual structures, including the small ossicles of the middle ear and the intricate components of the inner ear. The use of submillimeter two-dimensional reconstruction from CT data in addition to 3D reformation allows depiction of microanatomic structures such as the osseous spiral lamina and hamulus. Furthermore, 3D VR CT images can be used to evaluate various conditions of the temporal bone, including congenital malformations, vascular anomalies, inflammatory or neoplastic conditions,

and trauma. The additional information provided by 3D reformatted images allows a better understanding of temporal bone anatomy and improves the ability to evaluate related disease, thereby helping to optimize surgical planning.

30 **"Vestibular impairment and cochlear implantation".** Filipo, R.; Patrizi, M.; La Gamma, R.; D'Elia, C.; La Rosa, G.; Barbara, M.; (2006); Acta Otolaryngol. 126(12):1266-1274

CONCLUSION: Cochlear implantation (CI) may induce vestibular impairment soon after surgery as well as after implant activation. This impairment seems to be independent from the cause of deafness and can be considered a possible complication from the intra-operative trauma and, to minor degree, from the ongoing electric stimulation. It would also seem that vestibular damage occurs independently from the likelihood of post-operative hearing deterioration. In unilateral selected CI cases, vestibular examination can be proposed as additional pre-operative exam for selection of the ear to be implanted. OBJECTIVES: This study has been planned in order to get evidence of eventual impairment of the vestibular apparatus after cochlear implantation as well as to verify whether the impairment could be related to different variables, such as cause of deafness, concomitant hearing deterioration, surgical trauma and duration of electrical stimulation. METHOD: Charts from two different populations of implantees have been reviewed, 21 from a prospective, 72 from a retrospective study, respectively. All the patients were implanted with Clarion(R) devices of different generation. Vestibular testing was based on rotatory, caloric (when possible) and stabilometric measurements, which were carried out pre-operatively and at the following different times: 5 weeks after CI surgery, and 30, 60 and 90 days after CI activation. Hearing thresholds were also assessed in those patients who showed signs of vestibular impairment as well as in a group of patients without vestibular disorders (control). Patients belonging to the retrospective group were all asked to fill a questionnaire regarding their balance condition. Results. In 14.3% of the prospective study group, a grade I and II spontaneous nystagmus was evidenced pre-operatively and remained unchanged during the whole assessment period. A grade II spontaneous nystagmus was present in 3 patients (21.4%) of the same group after surgery. In the immediate post-operative period, vestibular impairment was displayed as true rotational vertigo in 21.4% and unsteadiness in 42.8% of the study group. Severe unsteadiness was present during the first 2 days after activation in 14.3% of the subjects. In 21.4% of the patients a VPPB episode occured. In the retrospective study group, 26.4% of the subjects referred pre-operative dizziness and 25 patients (34.7%) referred immediate post-operative vertigo episodes, which remained in a milder form after CI activation in 12% of them. The hearing threshold showed to deteriorate in both vestibular-impaired and control CI population without significant difference.

31 **"Customized selection of frequency maps in an acoustic simulation of a cochlear implant".** Fitzgerald, M. B.; Morbiwala, T. A.; Svirsky, M. A.; (2006); Annu Int Conf IEEE Eng Med Biol Proc

Cochlear implants can restore hearing to deaf individuals by electrically stimulating the auditory nerve. They do so by assigning different frequencies to different stimulating electrodes via a frequency map. We have developed a device that enables us to change the frequency map in real time. Here, in normal-hearing adults listening to an acoustic simulation of a cochlear implant, we investigate what frequency maps are initially preferred, and how the ability to understand speech with that preferred map compares with two other maps. We show that naive listeners prefer a map that balances the need for low-frequency information with the desire for a naturally-sounding stimulus, and that initial performance with this listener-selected map is better than that with a map that distorts the signal to provide low-frequency information.

32 **"An exploration of demographic bias in a questionnaire survey of hearing-impaired children: implications for comparisons of children with and without cochlear implants".** Fortnum, H. M.; Stacey, P. C.; Summerfield, A. Q.; (2006); Int J Pediatr Otorhinolaryngol. 70(12):2043-2054

OBJECTIVES: Responders to questionnaire surveys, who are self-selecting, are generally accepted to be unrepresentative of the total available population, at least in demographic terms. Since demographic and other variables are known to be predictive of outcome, it is important to understand the extent of that unrepresentativeness when using survey data to report comparisons of outcome. This paper aims (i) to evaluate the extent to which a sample of hearing-impaired children surveyed by postal questionnaire was representative of the population of hearing-impaired children in the United Kingdom (UK), and (ii) to identify demographic differences between children with and without cochlear implants. METHODS: Data from a previously reported total ascertainment of hearing-impaired children in the UK which identified 17,160 with permanent bilateral hearing impairment >40 dB HL were compared with data collected by postal questionnaire for a sample of 3224 children, including 527 with cochlear implants. RESULTS: The sampled children were similar to the ascertained population in gender, age at onset of hearing impairment, and number of additional disabilities, but came from more recent birth cohorts and from more affluent families. Compared with profoundly impaired non-implanted children, implanted children had greater degrees of hearing loss, fewer additional disabilities, a later age of onset, were younger, came from more affluent families, were more likely to use spoken language at home, and to be taught using spoken language only. CONCLUSIONS: Comparisons of outcomes and generalisation of results require adjustment for relevant variables to avoid confounding estimates of the effectiveness of interventions including cochlear implantation.

33 **"Acoustic change complexes recorded in adult cochlear implant listeners".** Friesen, L. M. & Tremblay, K. L.; (2006); Ear Hear. 27(6):678-685

OBJECTIVES: The objectives of this study were to determine: 1) whether the acoustic change complex (ACC) could be reliably recorded in cochlear implant listeners and, 2) whether different speech sounds evoke distinct ACC patterns. DESIGN: Eight adults wearing the Nucleus-24 cochlear implant (CI) were tested using naturally produced speech tokens /si/ and /i/. Stimuli were tokens from the standardized UCLA version of the Nonsense Syllable Test. Using a repeated-measures design, participants were tested and retested within a 3-wk period. RESULTS: Intraclass correlation coefficients for grand mean and individual-response waveforms recorded from the syllables /si/ and /i/ ranged from 0.63 to 0.89 from test to retest. Also, ACC latencies signaling the onset of a vowel in /i/ were significantly earlier than those evoked by /si/. CONCLUSIONS: The ACC can be reliably recorded in individuals wearing CI. Furthermore, the naturally produced speech syllables /si/ and /i/ evoke distinct ACC patterns. Because of its good stability and the ease with which it can be recorded in individual CI listeners, the ACC can be evoked using complex signals (such as naturally produced speech syllables) when studying central auditory function in CI listeners.

34 **"Recognition of simulated telephone speech by cochlear implant users".** Fu, Q. J. & Galvin, J. J., III; (2006); American Journal of Audiology. 15(2):127-132

PURPOSE: To evaluate cochlear implant users' understanding of telephone speech. METHOD: Telephone speech was simulated by band-limiting broadband speech stimuli. Multitalker vowel, consonant, and sentence recognition was measured for both simulated telephone speech and broadband speech in 10 postlingually deafened adult cochlear implant users. The study was approved by the St. Vincent's Hospital institutional review board, and signed, informed consent was obtained from all participants. RESULTS: There was no significant difference in vowel recognition scores between broadband and telephone speech. However, mean consonant and sentence recognition scores were significantly poorer with telephone speech. CONCLUSIONS: The limited telephone bandwidth significantly reduced cochlear implant users' understanding of telephone speech. The effect of band-limited speech was highly variable, suggesting that the contribution of high-frequency information to speech recognition varied significantly among the cochlear implant users.

35 **"Smooth GMM based multi-talker spectral conversion for spectrally degraded speech".** Fu, Q. J.; Liu, C.; Narayanan, S. S.; (2006); ICASSP IEEE Int Conf Acoust Speech Signal Process Proc

Because of the limited spectro-temporal resolution associated with the implant device, cochlear implant (CI) patients are more susceptible to talker variability than normal hearing (NH) listeners. In the present study, the effect of a smooth GMM based spectral conversion algorithm on multi-talker sentence recognition was tested in CI patients. In a model of CI speech processing (4-

16 channels of spectrally degraded speech), talker distortion was significantly reduced with relatively few (similar to 64) GMM components. CI patients' sentence recognition was measured for one male (M1) and one female (F1) talker, as well as for spectrally converted speech (from M1 to F1 and from F1 to M1). Overall, CI users were sensitive to talker differences; some subjects performed better with M1, others with F1. After converting the spectrum of the less-understood talker to that of the better-understood talker, recognition of the less-understood talker's speech was significantly improved. The results suggest that smooth GMM-based spectral conversion may improve CI patients' multi-talker speech recognition.

36 **"Simultaneous multigene mutation detection in patients with sensorineural hearing loss through a novel diagnostic microarray: A new approach for newborn screening follow-up".** Gardner, P.; Oitmaa, E.; Messner, A.; Hoefsloot, L.; Metspalu, A.; Schrijver, I.; (2006); Pediatrics. 118(3):985-994

OBJECTIVE. The advent of universal newborn hearing screening in the United States and other countries, together with the identification of genes involved in the process of hearing, have led to an increase in both the need and opportunity for accurate molecular diagnosis of patients with hearing loss. Deafness and hearing impairment have a genetic cause in at least half the cases. The molecular genetic basis for the majority of these patients remains obscure, however, because of the absence of associated clinical features in [~]70% (ie, nonsyndromic hearing loss) of patients, genetic heterogeneity, and the lack of molecular genetic tests that can evaluate a large number of mutations across multiple genes. DESIGN. We report on the development of a diagnostic panel with 198 mutations underlying sensorineural (mostly nonsyndromic) hearing loss. This panel, developed on a microarray, is capable of simultaneous evaluation of multiple mutations in 8 genes (GJB2, GJB6, GJB3, GJA1, SLC26A4, SLC26A5 and the mitochondrial genes encoding 12S rRNA and tRNA-Ser[UCN]). RESULTS. The arrayed primer extension array for sensorineural hearing loss is based on a versatile platform technology and is a robust, cost-effective, and easily modifiable assay. Because hearing loss is a major public health concern and common at all ages, this test is suitable for follow-up after newborn hearing screening and for the detection of a genetic etiology in older children and adults. CONCLUSIONS. Comprehensive and relatively inexpensive genetic testing for sensorineural hearing loss will improve medical management for affected individuals and genetic counseling for their families.

37 **"[Comparison of the clinic results of speech processing strategies and latest advances on cochlear implant]".** Guan, T. & Ye, D.; (2006); Sheng Wu Yi Xue Gong Cheng Xue Za Zhi. 23(5):1138-1141

Cochlear implant (CI) is a neural prosthetic device used to provide the sensation of sound to those who are profoundly deaf by delivering electrical stimulus to auditory nerve directly . It is becoming one of the main research frontiers in the area of otology and rehabilitation engineering . This symposium proposes an introduction about the new achievements of cochlear

implant research , which consists of the following parts: the structure of CI, new speech processing strategies, comparison of the clinical results of speech processing strategies and the hotspots of the research.

38 **"[Cochlear implant or regular hearing aid?]".** Haenggeli, C. A.; Kos, M. I.; Pellizone, M.; Guyot, J. P.; (2006); Rev Med Suisse. 2(81):2230-2, 2234

A significant number of deaf patients that have received cochlear implants now achieve higher word recognition scores then those with conventional auditory prostheses. This situation makes the choice of which type of auditory rehabilitation to propose a complex matter in patients with remaining auditory function. Our paper aims at providing some arguments to these new questions by presenting the clinical experience and practice of the Centre romand d'implants cochlθaires. We also address related legal issues. Clinical tools, such as testing the comprehension of lists of logatoms have proved very useful for the evaluation of these particular patients. The evaluation of cochlear implant candidates remains a highly individualized process, necessitating a case by case approach by an experienced multidisciplinary cochlear implant team.

39 **"Cochlear implants for DFNA17 deafness".** Hildebrand, M. S.; de Silva, M. G.; Gardner, R. J.; Rose, E.; de Graaf, C. A.; Bahlo, M.; Dahl, H. H.; (2006); Laryngoscope. 116(12):2211-2215

BACKGROUND: Nonsyndromic autosomal-dominant, adult-onset sensorineural hearing loss resulting from DFNA17 was described in a single American kindred in 1997, and the causative gene was subsequently identified as MYH9. OBJECTIVE: The objective of this study was to report clinical and genetic analyses of an Australian family with nonsyndromic adult-onset sensorineural hearing loss. METHODS: The clinical presentation of the family was detailed and identification of the causative gene was conducted by SNP genotyping and direct sequencing. RESULTS: Sequence analysis of the MYH9 gene revealed the same missense mutation as in the original DFNA17 family. We are not aware of a link between the two kindreds, making the present one only the second DFNA17 family to be reported. CONCLUSIONS: One important point of clinical relevance is the excellent outcome with cochlear implants in the Australian family compared with a "poor" response in the American family. Thus, cochlear implants should be strongly considered for clinical management of patients with DFNA17 deafness.

40 **"MED-EL cochlear implants: state of the art and a glimpse into the future".** Hochmair, I.; Nopp, P.; Jolly, C.; Schmidt, M.; Schosser, H.; Garnham, C.; Anderson, I.; (2006); Trends in Amplification. 10(4):201-219

Cochlear implantation is an accepted treatment method for adults and children with severe to profound hearing loss. Confidence in technology has led to changes in individuals who can receive a cochlear implant and changes in expected benefit with a cochlear implant. This article describes the research and development activities at MED-EL, which make possible the implementation of new speech-coding strategies as well as the application of

acoustic and electric stimulation via a combined speech processor in MED-EL devices. Research on benefits from bilateral cochlear implantation and electric-acoustic stimulation are also reviewed. Finally, the potential of drug delivery systems is considered as a way to improve cochlear implant outcomes, and results from preliminary evaluations of a hybrid cochlear implant system with drug delivery capabilities are reported.

41 **"Vowel recognition via cochlear implants and noise vocoders: effects of formant movement and duration".** Iverson, P.; Smith, C. A.; Evans, B. G.; (2006); J Acoust Soc Am. 120(6):3998-4006

Previous work has demonstrated that normal-hearing individuals use fine-grained phonetic variation, such as formant movement and duration, when recognizing English vowels. The present study investigated whether these cues are used by adult postlingually deafened cochlear implant users, and normal-hearing individuals listening to noise-vocoder simulations of cochlear implant processing. In Experiment 1, subjects gave forced-choice identification judgments for recordings of vowels that were signal processed to remove formant movement and/or equate vowel duration. In Experiment 2, a goodness-optimization procedure was used to create perceptual vowel space maps (i.e., best exemplars within a vowel quadrilateral) that included F1, F2, formant movement, and duration. The results demonstrated that both cochlear implant users and normal-hearing individuals use formant movement and duration cues when recognizing English vowels. Moreover, both listener groups used these cues to the same extent, suggesting that postlingually deafened cochlear implant users have category representations for vowels that are similar to those of normal-hearing individuals.

42 **"Application and usage of tactile aid in Iran".** Karimi-Yazdi, A.; Sazgar, A. A.; Nadimi-Tehran, A.; Faramarzi, A.; Nassaj, F. E.; Yahyavi, S.; (2006); Arch Iran Med. 9(4):344-347

BACKGROUND: Most deaf and severe to profound sensorineural hearing loss patients are incapable to communicate well because of a lack of receiving sound signals. Cochlear implant is one of the effective measures, which has been of great help to the deaf. Up to now, more than 1000 cochlear implants have been accomplished successfully in Iran. Since cochlear implantation is faced with numerous problems and difficulties, we should establish other methods for sound communication. Tactile aids can be a very effective help regarding this issue. METHODS: We designed and accomplished a study on the use of tactile aid, along with rehabilitation and training of these patients in our department. We designed four educational stages to check the improvement of subjects who used one-, two-, and seven-channel tactile aids. RESULTS: Hundred percent of the cases passed the first stage (detection) successfully. In the second stage (beginning pattern perception) all the cases with two and seven channel tactile aids were able to distinguish all kinds of sounds. They could differentiate between speech and non-speech sounds. In the third stage (recognition of speech), all the cases were able to recognize environmental and "sound maker" sounds, but only 43% of the individuals were able to recognize speech sounds and repeat

correctly with two-channel tactile aids. In the fourth stage (comprehension of words), identification and repetition of the words were only possible with seven-channel tactile aids. CONCLUSION: The results of our study show that tactile aids are well accepted by the patients with severe to profound sensorineural hearing loss who do not benefit from usual hearing aids.

43 **"Language ability after early detection of permanent childhood hearing impairment".** Kennedy, C. R.; McCann, D. C.; Campbell, M. J.; Law, C. M.; Mullee, M.; Petrou, S.; Watkin, P.; Worsfold, S.; Yuen, H. M.; Stevenson, J.; (2006); New England Journal of Medicine. 354(20):2131-2141

Background Children with bilateral permanent hearing impairment often have impaired language and speech abilities. However, the effects of universal newborn screening for permanent bilateral childhood hearing impairment and the effects of confirmation of hearing impairment by nine months of age on subsequent verbal abilities are uncertain. Methods We studied 120 children with bilateral permanent hearing impairment identified from a large birth cohort in southern England, at a mean of 7.9 years of age. Of the 120 children, 61 were born during periods with universal newborn screening and 57 had hearing impairment that was confirmed by nine months of age. The primary outcomes were language as compared with nonverbal ability and speech expressed as z scores (the number of standard deviations by which the score differed from the mean score among 63 age-matched children with normal hearing), adjusted for the severity of the hearing impairment and for maternal education. Results Confirmation of hearing impairment by nine months of age was associated with higher adjusted mean z scores for language as compared with nonverbal ability (adjusted mean difference for receptive language, 0.82; 95 percent confidence interval, 0.31 to 1.33; and adjusted mean difference for expressive language, 0.70; 95 percent confidence interval, 0.13 to 1.26). Birth during periods with universal newborn screening was also associated with higher adjusted z scores for receptive language as compared with nonverbal ability (adjusted mean difference, 0.60; 95 percent confidence interval, 0.07 to 1.13), although the z scores for expressive language as compared with nonverbal ability were not significantly higher. Speech scores did not differ significantly between those who were exposed to newborn screening or early confirmation and those who were not. Conclusions Early detection of childhood hearing impairment was associated with higher scores for language but not for speech in midchildhood.

44 **"They only see it when the sun shines in my ears: exploring perceptions of adolescent hearing aid users".** Kent, B. & Smith, S.; (2006); The Journal of Deaf Studies and Deaf Education. 11(4):461-476

Hard-of-hearing (HOH) young people may encounter multiple challenges to their educational, social, and emotional development. The benefits of wearing hearing aids to enhance communication may be countered by negative stigma associated with hearing aids. This study explored the experience of 16 bilaterally, moderately to severely HOH adolescents in mainstream education to understand their perceptions of using hearing aids. A core category of "normality" emerged from the data, which captures the predominant issue for

these young people. The sense of being normal may be situationally determined, but those who are able to perceive their use of hearing aids in a given context as normal most frequently use them. Regardless of the age of diagnosis or length of time since fitting, if use of hearing aids is perceived as not normal then their use is disguised or negated. The perceptions of the young people indicate that psychosocial supports focused on promoting their identity as HOH young people and normalizing the use of hearing aids should be a key feature of interventions.

45 **"Use of neural response telemetry measures to objectively set the comfort levels in the Nucleus 24 cochlear implant".** King, J. E.; Polak, M.; Hodges, A. V.; Payne, S.; Telischi, F. F.; (2006); J Am Acad Audiol. 17(6):413-431

Cochlear implant programming necessitates accurate setting of programming levels, including maximum stimulation levels, of all active electrodes. Frequently, clinical techniques are adequate for setting these levels; however, they are sometimes insufficient (e.g., very young children). In the Nucleus 24, several methods have been suggested for estimation of comfort levels (C levels) from neural response telemetry (NRT); however, many require co-application of clinical measurements. Data was obtained from 21 adult Nucleus 24 recipients to develop reliable predictions of C levels. Multiple regression analysis was performed on NRT threshold, slope of the NRT growth function, age, length of deafness, length of cochlear implant use and electrode impedance to examine predictive ability. Only the NRT threshold and slope of the growth function measures were significant predictors yielding R2 values from 0.391 to 0.769. Results demonstrated that these measures may provide an alternative means of estimating C levels when other clinical measures are unavailable.

46 **"Effect of incus removal on middle ear acoustic sensor for a fully implantable cochlear prosthesis".** Ko, W. H.; Megerian, C. A.; Semaan, M.; Young, D. J.; Zurcher, M. A.; (2006); Annu Int Conf IEEE Eng Med Biol Proc

System miniaturization and steady progress towards a totally implantable prosthetic system is the current trend in cochlear implant technology. To achieve this objective, the external microphone of present implants needs to be implantable. This goal can be accomplished by placing a miniature accelerometer on the ossicular chain in the middle ear to detect and convert bone vibrations into an electrical signal for further processing and stimulating cochlear electrodes. This paper describes the characterization of the umbo of a human temporal bone before and after the removal of the incus to determine the impact of the resulting change in umbo mechanics and attached accelerometer performance. With the removal of the incus, the umbo vibration acceleration frequency response in the direction perpendicular to the tympanic membrane increases by 5 dB below 2 kHz. Above 2 kHz the response diverges due to the change of ossicular chain resonant frequency caused by the removal of the incus. However, at each frequency the umbo vibration acceleration exhibits a linear function of the input sound pressure level (SPL) with a slope of 20 dB per decade before and after removal of the

incus, A commercial accelerometer attached to the umbo shows similar characteristics. From the measurement results of umbo characterization, a miniaturized implantable accelerometer with a packaged mass below 20 milligrams, a sensing resolution of 35µg _{rms}/?Hz, and a bandwidth of 10 kHz would be required to detect normal conversation.

47 **"[Professional occupation after cochlear implantation].** Kos, M. I.; Degive, C.; Boex, C.; Maire, R.; Guyot, J. P.; (2006); Rev Med Suisse. 2(81):2226-2228

This study verifies whether cochlear implants helps deaf adults to maintain or develop their professional occupations. Sixty-seven patients received a questionnaire concerning their professional activities before and after implantation. At the time of implantation 34 were professionally active. After the implantation 29 remained active, 4 of them reporting positive developments in their careers. Five patients became inactive. The previously inactive patients remained inactive. There was no difference in auditory performances between professionally active or inactive patients. Cochlear implants enable most implanted adults to maintain and even progress in their professions. However, deafness still represents an obstacle to social integration as inactive patients who searched for a job were rejected after the job interviews.

48 **"Cochlear implants: cortical plasticity in congenital deprivation".** Kral, A.; Tillein, J.; Heid, S.; Klinke, R.; Hartmann, R.; (2006); Prog.Brain Res. 157(283-313

Congenital auditory deprivation (deafness) leads to a dysfunctional intrinsic cortical microcircuitry. This chapter reviews these deficits with a particular emphasis on layer-specific activity within the primary auditory cortex. Evidence for a delay in activation of supragranular layers and reduction in activity in infragranular layers is discussed. Such deficits indicate the incompetence of the primary auditory cortex to not only properly process thalamic input and generate output within the infragranular layers, but also incorporate top-down modulations from higher order auditory cortex into the processing within primary auditory cortex. Such deficits are the consequence of a misguided postnatal development. Maturation of primary auditory cortex in deaf animals shows evidence of a developmental delay and further alterations in gross synaptic currents, spread of activation, and morphology of local field potentials recorded at the cortical surface. Additionally, degenerative changes can be observed. When hearing is initiated early in life (e.g., by chronic cochlear-implant stimulation), many of these deficits are counterbalanced. However, plasticity of the auditory cortex decreases with increasing age, so that a sensitive period for plastic adaptation can be demonstrated within the second to sixth months of life in the deaf cat. Potential molecular mechanisms of the existence of sensitive period are discussed. Data from animal research may be compared to electroencephalographic data obtained from cochlear-implanted congenitally deaf children. After cochlear implantation in humans, three phases of plastic adaptation can be observed: a fast one, taking place within the first few weeks

after implantation, showing no sensitive period; a slower one, taking place within the first months after implantation (a sensitive period up to 4 years of age); and possibly a third, and the longest one, related to increasing activation of higher order cortical areas.

49 **"Silicone allergy: a new cause for cochlear implant extrusion and its management".** Kunda, L. D.; Stidham, K. R.; Inserra, M. M.; Roland, P. S.; Franklin, D.; Roberson, J. B.; (2006); Otol Neurotol. 27(8):1078-1082

OBJECTIVE: We introduce silicone allergy as a rare cause for cochlear implant extrusion and discuss its management. STUDY DESIGN: Retrospective case series and literature review. SETTING: Tertiary referral centers. PATIENTS: Primary eligibility criteria included patients who experienced a delayed extrusion of their cochlear implants with negative wound cultures and had a suspected or a test-proven allergy to silicone components of an implant. INTERVENTIONS: Silicone allergy testing, explantation of a cochlear implant containing allergenic silicone materials, reimplantation with a custom-made cochlear implant excluding an allergenic silicone component. OUTCOME MEASURES: Uneventful wound healing and extrusion-free long-term follow-up after the reimplantation with a custom-made cochlear implant excluding an allergenic silicone component. RESULTS: Three known cases of cochlear implant extrusion as a result of silicone allergy have been noted from 1991 through 2004 in three cochlear implant programs in the United States. All three devices extruded, resulting in explantation of the old device and reimplantation with a new custom-made device eliminating the allergenic silicone component. Wound cultures were negative in all cases. All three patients experienced a delayed extrusion of their devices. Two of these patients had a test-proven allergy to the implant's silicone components, whereas the third patient was presumed to have a hypersensitivity solely on the basis of a clinical presentation. CONCLUSION: We propose that silicone allergy is a rare cause of cochlear implant extrusion. Patients experiencing cochlear implant extrusion, particularly with a delayed onset and negative wound culture results, should be tested for silicone allergy.

50 **"Longitudinal formant analysis after cochlear implantation in school-aged children".** Kunisue, K.; Fukushima, K.; Nagayasu, R.; Kawasaki, A.; Nishizaki, K.; (2006); Int J Pediatr Otorhinolaryngol. 70(12):2033-2042

INTRODUCTION: The purpose of this investigation was to describe the correlation between vocal and hearing development by longitudinal analysis of sound spectrograms, as a basic system for evaluating progress in vocal development. SUBJECTS AND METHODS: Two school-aged children with prelingual deafness were evaluated diachronically to assess speech perception and speech intelligibility after cochlear implantation. One child had non-syndromic hearing impairment without any known neurological deficit except for hearing loss, while the other had hearing impairment accompanied by mild mental retardation and attention deficit disorder. Their voices were recorded for monthly follow-up after cochlear implantation; these were used

for formant analysis and compared with their mother's voice, and alteration of the formant data was also compared with monosyllable speech perception. RESULTS: Formant analysis demonstrated high concordance was observed between monosyllable speech perception and speech intelligibility. F1-F2 forms of the patients more closely resembled those of their mothers after 1 year's follow-up. The time point at which speech development altered was very similar in both cases although the final outcomes were different. CONCLUSION: Fair improvement of articulation after cochlear implant was demonstrated by the F1-F2 gram analysis. This procedure can be used for data sharing and cooperation between medical and educational specialists.

51 **"Phonological abilities of hearing-impaired Cantonese-speaking children with cochlear implants or hearing aids".** Law, Z. W. Y. & So, L. K. H.; (2006); Journal of Speech, Language, and Hearing Research. 49(6):1342-1353

PURPOSE: This article examined the phonological skills of 2 groups of Cantonese-speaking children with prelingual, profound bilateral hearing loss. The phonological abilities of 7 children fitted with hearing aids were compared with the abilities of 7 children who wore cochlear implants. METHOD: Participants in each group ranged in age from 5;1 to 6;4 years. The participants were asked to name 57 pictures and retell 2 stories. Phonological abilities were described in terms of the participants' phonological units and the phonological processes used. The participants' perception of single words was assessed using a Cantonese phonology test that includes tonal, segmental, and semantic distracters. RESULTS: All except 1 participant had incomplete phonetic repertories. All participants showed complete vowel and tone inventories. The study group used both developmental rules and nondevelopmental phonological rules. For perception of single words, participants chose the target word most often. The cochlear implant users had a significantly higher percentage correct score for consonant production than hearing aid users. CONCLUSIONS: The prediction that Cantonese children wearing cochlear implants would have better phonological skills than children having hearing aids with a similar degree of hearing loss was confirmed. Cochlear implant usage appeared to promote consonant feature production development to a greater degree than did the use of a hearing aid.

52 **"[Surgical treatment of otosclerosis]".** Legent, F.; Avenard, M.; Andrieu, G.; Bordure, P.; Marie, J. P.; (2006); Bull Acad Natl Med. 190(4-5):915-926

A significant step forward in otosclerosis surgery was made in 1956 with the advent of stapedectomy. This led to a significant reduction in surgical complications and to a high level of patient satisfaction. Hearing aids are the alternative to surgery, and have themselves undergone considerable technical improvements. In advanced otosclerosis, cochlear implants can improve hearing when stapes surgery and a conventional hearing aid are inadequate. These advances are modifying the surgical indications.

53 **"Electrophysiological validation of a human prototype auditory midbrain implant in a guinea pig model".** Lenarz, M.; Lim, H. H.; Patrick, J. F.; Anderson, D. J.; Lenarz, T.; (2006); J Assoc Res Otolaryngol. 7(4):383-398

The auditory midbrain implant (AMI) is a new treatment for hearing restoration in patients with neural deafness or surgically inaccessible cochleae who cannot benefit from cochlear implants (CI). This includes neurofibromatosis type II (NF2) patients who, due to development and/or removal of vestibular schwannomas, usually experience complete damage of their auditory nerves. Although the auditory brainstem implant (ABI) provides sound awareness and aids lip-reading capabilities for these NF2 patients, it generally only achieves hearing performance levels comparable with a single-channel CI. In collaboration with Cochlear Ltd. (Lane Cove, Australia), we developed a human prototype AMI, which is designed for electrical stimulation along the well-defined tonotopic gradient of the inferior colliculus central nucleus (ICC). Considering that better speech perception and hearing performance has been correlated with a greater number of discriminable frequency channels of information available, the ability of the AMI to effectively activate discrete frequency regions within the ICC may enable better hearing performance than achieved by the ABI. Therefore, the goal of this study was to investigate if our AMI array could achieve low-threshold, frequency-specific activation within the ICC, and whether the levels for ICC activation via AMI stimulation were within safe limits for human application. We electrically stimulated different frequency regions within the ICC via the AMI array and recorded the corresponding neural activity in the primary auditory cortex (A1) using a multisite silicon probe in ketamine-anesthetized guinea pigs. Based on our results, AMI stimulation achieves lower thresholds and more localized, frequency-specific activation than CI stimulation. Furthermore, AMI stimulation achieves cortical activation with current levels that are within safe limits for central nervous system stimulation. This study confirms that our AMI design is sufficient for ensuring safe and effective activation of the ICC, and warrants further studies to translate the AMI into clinical application.

54 **"Multichannel cochlear implantation in the scala vestibuli".** Lin, K.; Marrinan, M. S.; Waltzman, S. B.; Roland, J. T., Jr.; (2006); Otol Neurotol. 27(5):634-638

OBJECTIVE: Sensorineural hearing loss resulting from otosclerosis, meningitis, chronic otitis media, autoimmune ear disease, and trauma can be associated with partial or total obstruction of the cochlear scalae. Multichannel cochlear implantation may be difficult in a cochlea with an obstructed scala tympani. The purpose of this study is to determine the safety and efficacy of scala tympani electrode insertion. STUDY DESIGN: Retrospective chart review. SETTING: Academic medical center. PATIENTS: Eight children and adults with profound sensorineural hearing loss who underwent cochlear implantation with known scala vestibuli electrode array insertion were subjects for this study. INTERVENTIONS: Eight study subjects underwent implantation: five with the Nucleus 24RCS (Contour) device and three with the Nucleus 24M device. OUTCOME MEASURES: Imaging findings, operative

findings, and age-appropriate speech perception testing. RESULTS: All patients had full electrode insertion. Various obstructive patterns on computed tomography and magnetic resonance imaging were found, and there was a range of speech perception results. All but one patient improved based on age-appropriate monosyllabic word and sentence tests. CONCLUSION: Scala vestibuli multielectrode insertion is a viable alternative when scala tympani insertion is not possible because of abnormal anatomy or anatomical changes secondary to disease or previous implantation. We will also present an algorithm of options for decision making for implantation when encountering cochlear obstruction and difficult electrode insertion.

55 **"Simultaneous bilateral cochlear implantation in adults: a multicenter clinical study".** Litovsky, R.; Parkinson, A.; Arcaroli, J.; Sammeth, C.; (2006); Ear Hear. 27(6):714-731

OBJECTIVE: To determine the efficacy of "simultaneous" bilateral cochlear implantation (both implants placed during a single surgical procedure) by comparing bilateral and unilateral implant use in a large number of adult subjects tested at multiple sites. DESIGN: Prospective study of 37 adults with postlinguistic onset of bilateral, severe to profound sensorineural hearing loss. Performance with the bilateral cochlear implants, using the same speech processor type and speech processing strategy, was compared with performance using the left implant alone and the right implant alone. Speech understanding in quiet (CNCs and HINT sentences) and in noise (BKB-SIN Test) were evaluated at several postactivation time intervals, with speech presented at 0 degrees azimuth, and noise at either 0 degrees , 90 degrees right, or 90 degrees left in the horizontal plane. APHAB questionnaire data were collected after each subject underwent a 3-wk "bilateral deprivation" period, during which they wore only the speech processor that produced the best score during unilateral testing, and also after a period of listening again with the bilateral implants. RESULTS: By 6-mo postactivation, a significant advantage for speech understanding in quiet was found in the bilateral listening mode compared with either unilateral listening modes. For speech understanding in noise, the largest and most robust bilateral benefit was when the subject was able to take advantage of the head shadow effect; i.e., results were significantly better for bilateral listening compared with the unilateral condition when the ear opposite to the side of the noise was added to create the bilateral condition. This bilateral benefit was seen on at least one of the two unilateral ear comparisons for nearly all (32/34) subjects. Bilateral benefit was also found for a few subjects in spatial configurations that evaluated binaural redundancy and binaural squelch effects. A subgroup of subjects who had asymmetrical unilateral implant performances were, overall, similar in performance to subjects with symmetrical hearing. The questionnaire data indicated that bilateral users perceive their own performance to be better with bilateral cochlear implants than when using a single device. CONCLUSIONS: Findings with a large patient group are in agreement with previous reports on smaller groups, showing that, overall, bilateral implantation offers the majority of patients advantages when listening in simulated adverse conditions.

56 **"The preoperative imaging evaluation for cochlear implantation".** Liu, Z.-L.; Liu, B.; He, H.-L.; Wang, Z.-C.; Fu, L.; Li, Y.-X.; Zheng, J.; Chen, X.-Q.; Song, Y.; Li, Y.; Xian, J.-F.; Yang, B.-T.; Lan, B.-S.; (2006); Chin.J.Radiol.

Objective: To analyze CT and MRI findings of temporal bone and to evaluate preoperative diagnostic value for cochlear implantation. Methods: One hundred and sixty candidates for cochlear implantation were examined with axial CT scan, 64 of them also with coronal CT scan, and 119 patients with MRI. Results: All of 320 ears were well-aerated, and 206 ears had mastoid cavities extended posteriorly to the sigmoid sinus. The length from posterior-lateral tympanic wall to the outer cortex was (2.34 ± 0.42) mm (left side) and (2.25 ± 0.40) mm (right side) (U = 1.887, P < 0.05), and the width from anterior rim of the sigmoid sinus to posterior wall of the external auditory canal was (1.57 ± 0.30) mm (left side) and (1.50 ± 0.27) mm (right side) (U = 2.35, P < 0.05). Otomastoiditis occurred in 8 ears, and enlarged jugular fossa in 18 ears, narrowing of the round window niche in 2 ears, labyrinthitis ossificans in 9 ears, partial to complete ossification in 8 ears, and soft tissue obliteration in otic capsule in 1 ear with negative CT finding and isointense T<inf>1</inf> and T<inf>2</inf> signal on MRI. The congenital malformations of inner ear occurred in 67 ears, including completedysplasia in 1 ear, cochlear hypodysplasia in 6 ears, Mondini deformation in 5 ears, enlargedvestibular aqueduct in 40 ears, dysplastic semicircular canal and the vestibulae in 10 ears, and narrowing of internal auditory canal in 5 ears. Conclusion: Preoperative imaging examinations can provide critical information to ensure successful cochlear implantation.

57 **"Binaural unmasking with bilateral cochlear implants".** Long, C. J.; Carlyon, R. P.; Litovsky, R. Y.; Downs, D. H.; (2006); J Assoc Res Otolaryngol. 7(4):352-360

Nearly 100,000 deaf patients worldwide have had their hearing restored by a cochlear implant (CI) fitted to one ear. However, although many patients understand speech well in quiet, even the most successful experience difficulty in noisy situations. In contrast, normal-hearing (NH) listeners achieve improved speech understanding in noise by processing the differences between the waveforms reaching the two ears. Here we show that a form of binaural processing can be achieved by patients fitted with an implant in each ear, leading to substantial improvements in signal detection in the presence of competing sounds. The stimulus in each ear consisted of a narrowband noise masker, to which a tonal signal was sometimes added; this mixture was half-wave rectified, lowpass-filtered, and then used to modulate a 1000-pps biphasic pulse train. All four CI users tested showed significantly better signal detection when the signal was presented out of phase at the two ears than when it was in phase. This advantage occurred even though subjects only received information about the slowly varying sound envelope to be presented, contrary to previous reports that waveform fine structure dominates binaural processing. If this advantage generalizes to multichannel situations, it would demonstrate that envelope-based CI speech-processing strategies may allow patients to exploit binaural unmasking in order to

improve speech understanding in noise. Furthermore, because the tested patients had been deprived of binaural hearing for eight or more years, our results show that some sensitivity to time-varying interaural cues can persist over extended periods of binaural deprivation.

58 **"Speech perception problems of the hearing impaired reflect inability to use temporal fine structure".** Lorenzi, C.; Gilbert, G.; Carn, H.; Garnier, S.; Moore, B. C.; (2006); Proc.Natl Acad Sci U.S.A. 103(49):18866-18869

People with sensorineural hearing loss have difficulty understanding speech, especially when background sounds are present. A reduction in the ability to resolve the frequency components of complex sounds is one factor contributing to this difficulty. Here, we show that a reduced ability to process the temporal fine structure of sounds plays an important role. Speech sounds were processed by filtering them into 16 adjacent frequency bands. The signal in each band was processed by using the Hilbert transform so as to preserve either the envelope (E, the relatively slow variations in amplitude over time) or the temporal fine structure (TFS, the rapid oscillations with rate close to the center frequency of the band). The band signals were then recombined and the stimuli were presented to subjects for identification. After training, normal-hearing subjects scored perfectly with unprocessed speech, and were approximately 90% correct with E and TFS speech. Both young and elderly subjects with moderate flat hearing loss performed almost as well as normal with unprocessed and E speech but performed very poorly with TFS speech, indicating a greatly reduced ability to use TFS. For the younger hearing-impaired group, TFS scores were highly correlated with the ability to take advantage of temporal dips in a background noise when identifying unprocessed speech. The results suggest that the ability to use TFS may be critical for "listening in the background dips." TFS stimuli may be useful in evaluating impaired hearing and in guiding the design of hearing aids and cochlear implants.

59 **"[Micro-focus X-ray for cochlear implantation research on small animals]".** Lu, W. & Xu, J.; (2006); Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 41(9):702-704

OBJECTIVE: To develop an imaging system suitable for cochlear implant research on small laboratory animals. METHODS: A novel micro-focus X-ray imaging system was developed. The key features of the system were the use of a micro-focus X-ray source (less than 10 micrometers) and an appropriate choice of source-object and object-image distance. The new X-ray modality was evaluated on heads of cats, guinea pigs and rats. RESULTS: It proved to be an useful tool to provide excellent image of small animal cochlea, allowing a clear electrode position to be established, and also helped greatly in detecting the breakage of electrode array. CONCLUSIONS: Experimental studies performed in cats, guinea pigs and rats confirmed that micro-focus radiography was an important tool for cochlear implant research in laboratory.

60 **"Contribution of low-frequency acoustic information to Chinese speech recognition in cochlear implant simulations".** Luo, X. & Fu, Q. J.; (2006); J Acoust Soc Am. 120(4):2260-2266

Chinese sentence recognition strongly relates to the reception of tonal information. For cochlear implant (CI) users with residual acoustic hearing, tonal information may be enhanced by restoring low-frequency acoustic cues in the nonimplanted ear. The present study investigated the contribution of low-frequency acoustic information to Chinese speech recognition in Mandarin-speaking normal-hearing subjects listening to acoustic simulations of bilaterally combined electric and acoustic hearing. Subjects listened to a 6-channel CI simulation in one ear and low-pass filtered speech in the other ear. Chinese tone, phoneme, and sentence recognition were measured in steady-state, speech-shaped noise, as a function of the cutoff frequency for low-pass filtered speech. Results showed that low-frequency acoustic information below 500 Hz contributed most strongly to tone recognition, while low-frequency acoustic information above 500 Hz contributed most strongly to phoneme recognition. For Chinese sentences, speech reception thresholds (SRTs) improved with increasing amounts of low-frequency acoustic information, and significantly improved when low-frequency acoustic information above 500 Hz was preserved. SRTs were not significantly affected by the degree of spectral overlap between the CI simulation and low-pass filtered speech. These results suggest that, for CI patients with residual acoustic hearing, preserving low-frequency acoustic information can improve Chinese speech recognition in noise.

61 **"Effects of interaural time differences in fine structure and envelope on lateral discrimination in electric hearing".** Majdak, P.; Laback, B.; Baumgartner, W. D.; (2006); J Acoust Soc Am. 120(4):2190-2201

Bilateral cochlear implant (CI) listeners currently use stimulation strategies which encode interaural time differences (ITD) in the temporal envelope but which do not transmit ITD in the fine structure, due to the constant phase in the electric pulse train. To determine the utility of encoding ITD in the fine structure, ITD-based lateralization was investigated with four CI listeners and four normal hearing (NH) subjects listening to a simulation of electric stimulation. Lateralization discrimination was tested at different pulse rates for various combinations of independently controlled fine structure ITD and envelope ITD. Results for electric hearing show that the fine structure ITD had the strongest impact on lateralization at lower pulse rates, with significant effects for pulse rates up to 800 pulses per second. At higher pulse rates, lateralization discrimination depended solely on the envelope ITD. The data suggest that bilateral CI listeners benefit from transmitting fine structure ITD at lower pulse rates. However, there were strong interindividual differences: the better performing CI listeners performed comparably to the NH listeners.

62 **"[Experiments on prosody perception with cochlear implants.]".** Meister, H.; Tepeli, D.; Wagner, P.; Hess, W.; Walger, M.; von Wedel, H.; Lang-Roth, R.; (2006); HNO

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.

63 **"Electrical excitation of the acoustically sensitive auditory nerve: single-fiber responses to electric pulse trains".** Miller, C. A.; Abbas, P. J.; Robinson, B. K.; Nourski, K. V.; Zhang, F.; Jeng, F. C.; (2006); J Assoc Res Otolaryngol. 7(3):195-210

Nearly all studies on auditory-nerve responses to electric stimuli have been conducted using chemically deafened animals so as to more realistically model the implanted human ear that has typically been profoundly deaf. However, clinical criteria for implantation have recently been relaxed. Ears with "residual" acoustic sensitivity are now being implanted, calling for the systematic evaluation of auditory-nerve responses to electric stimuli as well as combined electric and acoustic stimuli in acoustically sensitive ears. This article presents a systematic investigation of single-fiber responses to electric stimuli in acoustically sensitive ears. Responses to 250 pulse/s electric pulse trains were collected from 18 cats. Properties such as threshold, dynamic range, and jitter were found to differ from those of deaf ears. Other types of fiber activity observed in acoustically sensitive ears (i.e., spontaneous activity and electrophonic responses) were found to alter the temporal coding of electric stimuli. The electrophonic response, which was shown to greatly

change the information encoded by spike intervals, also exhibited fast adaptation relative to that observed in the "direct" response to electric stimuli. More complex responses, such as "buildup" (increased responsiveness to successive pulses) and "bursting" (alternating periods of responsiveness and unresponsiveness) were observed. Our findings suggest that bursting is a response unique to sustained electric stimulation in ears with functional hair cells.

64 **"Primary care physicians' knowledge, attitudes, and practices related to newborn hearing screening".** Moeller, M. P.; White, K. R.; Shisler, L.; (2006); Pediatrics. 118(4):1357-1370

OBJECTIVE. Universal newborn hearing screening focuses on providing the earliest possible diagnosis for infants with permanent hearing loss. The goal is to prevent or minimize the consequences of sensorineural hearing loss on speech and language development through timely and effective diagnosis and interventions. Pediatricians are in a key position to educate families about the importance of follow-up, if they are well informed. The objective of this study was to survey the attitudes, practices, and knowledge of primary care physicians in relation to newborn hearing screening and follow-up. METHODS. A survey was created on the basis of input from focus groups with primary care physicians. Surveys (n = 12211) were sent to primary care physicians in 21 states and 1 territory (Puerto Rico) regarding practices, knowledge, and attitudes related to universal newborn hearing screening. The response rate was 16.1% (n = 1968). RESULTS. Physicians reported a high level of support for universal newborn hearing screening; 81.6% judged it to be very important to screen all newborns for hearing loss at birth. Although physicians reported confidence in talking with parents about screening results, they indicated a lack of confidence in discussing follow-up procedures and intervention needs. Several important gaps in knowledge were identified, and these represent priorities for education, as based on their relevance to medical management and parent support. Physicians expressed a strong preference for action-oriented resources. CONCLUSION. Pediatricians and other primary care providers recognize the benefits of early detection and intervention for permanent hearing loss in infants. The current system of newborn hearing screening can be enhanced by strengthening the medical community's involvement in the process from screening to follow-up. Physician roles will be supported through the provision of action-oriented resources that educate parents about the importance of follow-up and that prepare professionals to incorporate appropriate surveillance procedures in daily practice.

65 **"Advances in Oto-Rhino-Laryngology".** Moller, A. R.; (2006); Advances in Oto-Rhino-Laryngology

This 228-page book is volume 64 in the series ''Advances in Oto-Rhino-Laryngology'', and this volume provides the latest scientific and clinical knowledge on cochlear and brainstem implants. This volume contains 12 individually-authored chapters. The first chapter overviews the history of cochlear implants and auditory brainstem implants. The remaining 11

chapters are divided among 3 thematic parts or sections. The first part focuses on cochlear implants Individual chapter topics in this first part include: surgical aspects of cochlear implantation , and mechanisms of insertional trauma; histopathology of the inner ear and its relevance to cochlear implantation ; factors influencing spoken language outcomes in children following early cochlear implantation ; central auditory development in children with cochlear implants in terms of clinical implications; brain plasticity under cochlear implant stimulation; and speech processing in vocoder-centric cochlear implants Auditory brainstem implants are the focus of the second part of the book. Individual chapter topics in this second part include: surgical aspects of auditory brainstem implants; a guide to the positioning of brainstem implants using intraoperative electrical auditory brainstem responses; and auditory outcomes in tumor vs. nontumor patients fitted with auditory brainstem implants. The theme of the final part of the book is the physiological basis for cochlear and auditory brainstem implants. There are 2 chapters in this final part, which discuss the basis of electrical stimulation of the cochlea and the cochlear nucleus, and the physiological basis for cochlear and auditory brainstem implants. Each chapter is independently referenced. The text is written in English, and each chapter is indexed by author and by subject. The book is illustrated with 84 figures, 9 of which are in color, and 4 tables. This book is highly recommended to audiologists, otolaryngologists, and neurosurgeons.

66 **"Routine use of the crystal device integrity testing system in pediatric patients".** Monin, D. L.; Kazahaya, K.; Franck, K. H.; (2006); J Am Acad Audiol. 17(10):722-732

Crystal Device Integrity Testing System (CITS), the first commercially available testing system of its type, allows rapid assessment of cochlear implant function by measuring averaged electrode voltages-the scalp-recorded fields generated by electrode currents. We describe our experience performing routine integrity tests on 44 pediatric cochlear implant patients using the CITS. We present our findings focusing on the monopolar and common ground scans to provide a framework from which CITS scans can be evaluated in the future. We also describe selected cases in which abnormal results using the CITS influenced clinical treatment, demonstrating the utility of performing routine integrity tests.

67 **"Absent semicircular canals in CHARGE syndrome: radiologic spectrum of findings".** Morimoto, A. K.; Wiggins, R. H., III; Hudgins, P. A.; Hedlund, G. L.; Hamilton, B.; Mukherji, S. K.; Telian, S. A.; Harnsberger, H. R.; (2006); American Journal of Neuroradiology. 27(8):1663-1671

BACKGROUND AND PURPOSE: This paper describes the CT findings that characterize the middle and inner ear anomalies in coloboma, heart defects, choanal atresia, mental retardation, genitourinary, and ear anomalies (CHARGE) syndrome. With this information, neuroradiologists will be better prepared to provide clinically relevant information to their referring physicians regarding this rare syndrome. MATERIALS AND METHODS: CT studies from 13 patients were reviewed by 2 neuroradiologists with Certificate of Additional

Qualification. Each ear was counted separately for a total of 26 ears. Middle and inner ear anomalies associated with CHARGE syndrome were categorized. Investigational review board approval was obtained. RESULTS: Twenty of 26 (77%) ears demonstrated cochlear aperture atresia. Four of these ears were evaluated with MR imaging and were found to lack a cochlear nerve. Twenty-one of 26 (81%) cochlea had some form of dysplasia. Six of 26 (23%) round windows were aplastic. Three of 26 (12%) round windows were hypoplastic. Twenty-one of 26 (81%) oval windows were atretic or aplastic. Fifteen of 26 (58%) vestibules were hypoplastic or dysplastic. There were 5 of 26 (19%) enlarged vestibular aqueducts. Twelve of 26 (46%) vestibular aqueducts had an anomalous course. All cases demonstrated absent semicircular canals. Twenty-three of 26 (88%) facial nerve canals had an anomalous course. Four of 26 (15%) tympanic segments were prolapsed. Three of 26 (12%) temporal bones had an anomalous emissary vein referred to as a petrosquamosal sinus. Twenty-one of 26 (81%) middle ear cavities were small. Twenty-three of 26 (93%) ossicles were dysplastic with ankylosis. Three of 26 (12%) internal auditory canals were small. CONCLUSION: The CT findings that correlate to the anomalies of CHARGE syndrome affect conductive as well as sensorineural hearing. Stenosis of the aperture for the cochlear nerve aperture on CT is suggestive of hypoplasia or absence of the cochlear nerve, which has been demonstrated in some cases by MR. Absence of the cochlear nerve would be a contraindication to cochlear implantation.

68 **"The role of educational experiences in the development of deaf identity".** Nikolaraizi, M. & Hadjikakou, K.; (2006); The Journal of Deaf Studies and Deaf Education. 11(4):477-492

In this study, the analytical educational experiences of 25 deaf adults are explored in relation to their identity. The qualitative analysis indicated that the most critical educational experiences for the participants' identity concerned their interactions with hearing or deaf peers and their language of communication with their peers at school. The participants with a hearing identity attended general schools, where they interacted with hearing peers in Greek, whereas the participants with a Deaf identity attended schools for the deaf, where they interacted with deaf peers in Greek Sign Language. The participants with a bicultural identity attended general schools, where they interacted with hearing peers in Greek, but they also had the chance to meet Deaf role models outside school, which played a critical role in the development of their identity.

69 **"Does cause of deafness influence outcome after cochlear implantation in children?".** Nikolopoulos, T. P.; Archbold, S. M.; O'Donoghue, G. M.; (2006); Pediatrics. 118(4):1350-1356

OBJECTIVES. The objective of this study was to evaluate long-term speech perception abilities of comparable groups of postmeningitic and congenitally deaf children after cochlear implantation. METHODS. This prospective longitudinal study comprised 46 postmeningitic deaf children and 83 congenitally deaf children with age at implantation of [≤]5.6 years. Both

groups were comparable with respect to educational setting and mode of communication and included children with additional disabilities. RESULTS. Both postmeningitic and congenitally deaf children showed significant progress after implantation. Most (73% and 77%, respectively) could understand conversation without lip-reading or use the telephone with a known speaker 5 years after implantation, whereas none could do so before implantation. At the same interval, the postmeningitic and congenitally deaf children scored a mean open-set speech perception score of 47 (range: 0-91) and 46 (range: 0-107) words per minute, respectively, on connected discourse tracking. The respective mean scores at the 3-year interval were 22 and 29 correct words per minute, respectively. None of these children could score a single correct word per minute before implantation. The progress in both groups was statistically significant. When the 2 groups were compared, there was no statistically significant difference. CONCLUSION. Postmeningitic and congenitally deaf children showed significant improvement in their auditory receptive abilities at the 3- and 5-year intervals after cochlear implantation. There was no statistically significant difference between the outcomes of the 2 groups, suggesting that, provided that children receive an implant early, cause of deafness has little influence on outcome. Although the prevalence of other disabilities was similar in both groups, for individual children, their presence may have profound impact. The study supports the concept of implantation early in life, irrespective of the cause of deafness.

70 **"Cell-gene delivery of brain-derived neurotrophic factor to the mouse inner ear".** Okano, T.; Nakagawa, T.; Kita, T.; Endo, T.; Ito, J.; (2006); Mol Ther. 14(6):866-871

Sensorineural hearing loss is a common disability, but treatment options are currently limited to cochlear implants and hearing aids. Studies are therefore being conducted to provide alternative means of biological therapy, including gene therapy. Safe and effective methods of gene delivery to the cochlea need to be developed to facilitate the clinical application of these therapeutic treatments for hearing loss. In this study, we examined the potential of cell-gene therapy with nonviral vectors for delivery of therapeutic molecules into the cochlea. NIH3T3 cells were transfected with the brain-derived neurotrophic factor (Bdnf) gene using lipofection and then transplanted into the mouse inner ear. Immunohistochemistry and Western blotting demonstrated the survival of grafted cells in the cochlea for up to 4 weeks after transplantation. No significant hearing loss was induced by the transplantation procedure. A Bdnf-specific enzyme-linked immunosorbent assay revealed a significant increase in Bdnf production in the inner ear following transplantation of engineered cells. These findings indicate that cell-gene delivery with nonviral vectors may be applicable for the local, sustained delivery of therapeutic molecules into the cochlea.

71 **"Hearing aids and cochlear implants under adverse conditions".** Oweiss, K. G. & Suhail, Y.; (2006); ICASSP IEEE Int Conf Acoust Speech Signal Process Proc

We conceptualize a new signal processing strategy to better represent the temporal and spectral cues in speech signals for Hearing Aid (HA) and Cochlear Implant (CI) applications under severe adverse conditions. The proposed approach rests on two well studied methods for signal separation and noise suppression, namely, the denoising and function approximation capabilities of the wavelet transform, blended with signal subspace decomposition through low rank approximation. The technique targets suppression of "competing voice" type noises. A cost function is defined to obtain a "best basis" representation of the desired speech signal for which an inherent invariance property of the signal subspace is observed. This allows better separation of the speech-like noise in contrast to classical bandpass filtering currently employed in CI and HA devices. We demonstrate the efficiency of the proposed method in capturing the rapid dynamics of speech signals, while minimizing the masking effects of noise, in addition to improved recognition rates in normal hearing listeners. The technique remains to be tested on actual patients.

72 **"[Subjetive benefits and limitations in relation with the cochlear implant reported by adolescent and adult patients].** Padilla Romero, M. J.; Sainz Quevedo, M.; Roldan Segura, C.; Garcia Negro, A. S.; Camacho Castro, A. C.; (2006); Acta Otorrinolaringol Esp. 57(10):455-461

OBJECTIVE: To identify the subjetive benefits and limitations of the pre and postlingually adolescent and adult patients of the cochlear implants program at Clinical Hospital San Cecilio (Granada). MATERIAL AND METHODS: Cross-sectional study of 60 pre and postlingually deaf patients who received cochlear implant with more than 12 years and at least a year of experience. A open-ended questionnaire was used to value their subjetive experience. A descriptive analysis was made and we applied the square Chi and Mann-Withney tests. RESULTS: The average implant usage per day was greater in the postlingually patients (14.6 hours) that in the prelingually (10.4 hours). Between the acoustic benefits, both more frequent were the perception of environmental sounds and the possibility of to converse easier, specially with one or two persons. The benefit more indicated by the patients was the improvement in its mood. The perception in noise situations was the difficulty more indicated by all patients. The problems, in relation with the device, more frequently indicated were the size and the weight. CONCLUSION: the cochlear implant provides subjetive benefits to the patients that complement their improvement in perception of the oral language and facilitate the re/integration of the deaf patients at his work and in his social life. Therefore, the speech perception tests must be complemented with another type of materials to value the result of the cochlear implant and then we will can to speak of success or failure.

73 **"The development of the Nucleus(R) FreedomTM cochlear implant system".** Patrick, J. F.; Busby, P. A.; Gibson, P. J.; (2006); Trends in Amplification. 10(4):175-200

Cochlear Limited (CochlearTM) released the fourth-generation cochlear implant system, Nucleus(R) FreedomTM, in 2005. Freedom is based on 25 years of experience in cochlear implant research and development and incorporates advances in medicine, implantable materials, electronic technology, and sound coding. This article presents the development of Cochlear's implant systems, with an overview of the first 3 generations, and details of the Freedom system: the CI24RE receiverstimulator, the Contour AdvanceTM electrode, the modular Freedom processor, the available speech coding strategies, the input processing options of Smart SoundTM to improve the signal before coding as electrical signals, and the programming software. Preliminary results from multicenter studies with the Freedom system are reported, demonstrating better levels of performance compared with the previous systems. The final section presents the most recent implant reliability data, with the early findings at 18 months showing improved reliability of the Freedom implant compared with the earlier Nucleus 3 System. Also reported are some of the findings of Cochlear's collaborative research programs to improve recipient outcomes. Included are studies showing the benefits from bilateral implants, electroacoustic stimulation using an ipsilateral and/or contralateral hearing aid, advanced speech coding, and streamlined speech processor programming.

74 **"Age-related changes in transient and oscillatory brain responses to auditory stimulation in healthy adults 19-45 years old".** Poulsen, C.; Picton, T. W.; Paus, T.; (2006); Cerebral Cortexbhl056

The capacity of the human cerebral cortex to track fast temporal changes in auditory stimuli is related to the development of language in children and to deficits in speech perception in the elderly. Although maturation of temporal processing in children and its deterioration in the elderly has been investigated previously, little is known about naturally occurring changes in auditory temporal processing between these limits. The present study examined age-related (19-45 years) changes in 3 electrophysiological measures of auditory processing: 1) the late transient auditory evoked potentials to tone onset, 2) the auditory steady-state response (ASSR) to a 40-Hz frequency-modulated tone, and 3) the envelope following response (EFR) to sweeps of amplitude-modulated white noise from 10 to 100 Hz. With increasing age, the latency of the auditory P1-N1 complex decreased, the oscillatory (ASSR) response became larger and more stable, and the resonant peak of the EFR increased from 38 Hz at 19 years to 46 Hz at 45 years. Source analysis localized these changes to the auditory regions of the temporal lobe. These results indicate persistent adaptation of cortical auditory processes into middle adulthood. We speculate that experience-driven myelination and/or refinement of inhibitory circuits may underlie these changes.

75 **"An analytical method to determine phoneme recognition abilities of South African cochlear implant users".** Pretorius, L. L.; Hanekom, J. J.; van Wieringen, A.; Wouters, J.; (2006); Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie. 25(4):195-208

This article describes analytical tests developed to investigate the extent to which Afrikaans- and English-speaking South African cochlear implant users recognize phonemes. Vowel stimuli (in a /pVOWELt/ context) and consonant stimuli (in an /aCONSONANTa/ context), uttered by male and female speakers, were recorded and acoustically analysed. Vowel and consonant recognition abilities of respectively nine and eleven local cochlear implant users were subsequently investigated. Typical confusions experienced by cochlear implant users were determined and explained in terms of the acoustic properties of the stimuli. General observations are that implant users find vowels that are identified by spectral characteristics difficult to recognise, while the recognition of temporal properties is better. During consonant recognition, place of articulation is particularly difficult to identify. Results support observations from similar studies conducted for other language groups. These analytical tests may be valuable for creating individualised speech processor settings and monitoring new implant users' progress in speech recognition ability.

76 **"Temporal bone imaging in GJB2 deafness".** Propst, E. J.; Blaser, S.; Stockley, T. L.; Harrison, R. V.; Gordon, K. A.; Papsin, B. C.; (2006); Laryngoscope. 116(12):2178-2186

OBJECTIVE: To describe temporal bone findings on computed tomography (CT) imaging in GJB2-related hearing loss (HL). We asked whether evaluation of the temporal bone is required in individuals with biallelic GJB2 mutations. STUDY DESIGN: Randomized, blinded, controlled, prospective measurement. METHODS: Blood from 264 pediatric cochlear implant users was analyzed for mutations in the GJB2 gene. Thirty-six aspects of the temporal bone on CT imaging were evaluated in 53 individuals (106 ears) with biallelic disease causing GJB2 mutations. A subset of patients was age matched and compared with normally hearing individuals. Subjects with biallelic GJB2 mutations were tested for mutations in the SLC26A4 gene to rule out Pendred syndrome as a confounding cause of large vestibular aqueduct syndrome. RESULTS: Approximately 53% of ears of subjects (72% of subjects) with biallelic GJB2 mutations had at least one temporal bone anomaly. The most common findings were 1) dilated endolymphatic fossa (28%); 2) hypoplastic modiolus (25%); 3) large vestibular aqueduct (8%); 4) hypoplastic horizontal semicircular canal (8%); 5) hypoplastic cochlea (4%). Compared with normally hearing individuals, the GJB2 group had hypoplasia of the cochlear nerve canal, lateral semicircular canal vestibule, internal auditory canal (t tests, $P < .001$), and were 11 times more likely to have a hypoplastic modiolus. Dilated endolymphatic fossae were 1.4 times more common in the GJB2 group, and large vestibular aqueducts were 3 times more common in the GJB2 group, as compared with normally hearing controls. CONCLUSIONS: Temporal bone anomalies are common in GJB2-

related HL, and imaging of the temporal bone should be included in routine evaluation of these individuals.

77 **"Transient infantile auditory neuropathy and its clinical implications".** Psarommatis, I.; Riga, M.; Douros, K.; Koltsidopoulos, P.; Douniadakis, D.; Kapetanakis, I.; Apostolopoulos, N.; (2006); Int J Pediatr Otorhinolaryngol. 70(9):1629-1637

OBJECTIVE: Auditory neuropathy (AN) has been a well-accepted clinical entity during the last years. Though we are able to diagnose AN reliably, little is known concerning its epidemiology, etiology and prognosis. This study is aimed at presenting a particular characteristic of the disease, namely its potential transient behaviour, observed in a group of high risk neonates suffering from AN. The ensuing clinical implications are underlined. METHOD: From 1995 to 2004, 1150 high risk (HR) neonates were subjected consecutively to audiological evaluation by auditory brain stem responses (ABR), participating in a targeted hearing screening program for HR neonates. All neonates with ABR threshold >40 dBnHL and middle ear free from disease underwent otoacoustic emissions (OAEs) testing as well. Children with elevated ABR thresholds were scheduled for re-examination after 4-6 months. Only infants demonstrating considerably elevated thresholds (>70 dBnHL), absent or atypical ABR in combination with normal OAEs were considered as suffering from AN. RESULTS: One hundred and seventy-seven neonates showed elevated ABR thresholds (15.4%). Seventy-nine of them demonstrated ABR thresholds >or=75 dBnHL, absent or strongly atypical waveforms at maximum test intensity and among them 25 displayed findings consistent with AN. Follow-up examination revealed a resolution of AN in 13 out of 20 infants retested, that is a restoration of ABR to normal and typical OAEs recordings. Using multiple logistic regression, we found that low birth weight may represent a reliable predictor for clinical recovery of AN infants. CONCLUSION: This article bring to light the temporary character that AN could show in HR neonates and especially in those with low birth weight. Based on the results of our study, the higher the birth weight, the less likely it is for neonates to recover from AN. From a practical point of view, these findings suggest that hearing screening protocols for HR neonates should be revised in both their methodology and time of application. Finally, the decision for amplification or cochlear implantation in HR infants with AN should be made very carefully and well after the 6th month of age, since the maturation process may still be in progress.

78 **"Speech recognition for unilateral and bilateral cochlear implant modes in the presence of uncorrelated noise sources".** Ricketts, T. A.; Grantham, D. W.; Ashmead, D. H.; Haynes, D. S.; Labadie, R. F.; (2006); Ear Hear. 27(6):763-773

OBJECTIVE: The purpose of the current investigation was to compare speech recognition in noise for bilateral and unilateral modes within postlingually deafened, adult bilateral cochlear implant recipients. In addition, it was of interest to evaluate the time course of the bilateral speech-recognition advantage and the effect of changing signal-to-noise ratio (SNR) on the

magnitude of the bilateral advantage. DESIGN: In the first experiment, 16 postlingually deafened adults who were bilaterally implanted with the MED-EL C40+ cochlear device were evaluated in unilateral left, unilateral right, and bilateral conditions 4 to 7 mo after activation. Speech recognition in the presence of five spatially separated, uncorrelated noise sources was evaluated using both a single fixed SNR of +10 dB and an adaptive-SNR method. In a follow-up study, a subset of 10 participants was re-evaluated using an identical fixed-SNR method 12 to 17 mo after activation to examine the time course of speech-recognition performance in both unilateral and bilateral modes at a single SNR. A third study was performed with a subset of six participants to examine performance over a range of SNRs. In this study, speech recognition was measured 12 to 17 mo after activation in quiet and at +5, +10, +15, and +20 dB SNRs using the same five uncorrelated noise sources. RESULTS: The speech-recognition data revealed a significant bilateral advantage of 3.3 dB using the adaptive-SNR method. A significant bilateral advantage of 9% was also measured using a fixed +10 dB SNR. Results from the second study revealed that experience resulted in a significant (11 to 20%) increase in speech-recognition-in-noise performance for both unilateral and bilateral modes; however, the magnitude of the bilateral advantage was not affected by experience. Results from the third study revealed the largest bilateral advantage at the poorest SNR evaluated. In addition, performance in quiet was significantly better than that measured in the presence of noise, even at the +20 dB SNR. CONCLUSIONS: The results of these experiments support a small but significant bilateral speech-recognition-in-noise advantage for cochlear implant recipients in an environment with multiple noise sources. This advantage is presumed to be attributable to the combined effects of binaural squelch and diotic summation. Although experience generally improved speech-recognition-in-noise performance in both unilateral and bilateral modes, a consistent bilateral advantage (approximately 10%) was measured at 4 to 7 mo and at 12 to 17 mo postactivation.

79 **"The growth of loudness functions measured in cochlear implant listeners using Absolute Magnitude Estimation and compared using Akaike's Information Criteria".** Sanpetrino, N. M. & Smith, R. L.; (2006); Annu Int Conf IEEE Eng Med Biol Proc

The input/output function for acoustic hearing can be characterized by the growth of loudness with sound pressure level and generally follows a compressive power law. In contrast, in electric hearing, loudness reportedly is an expansive function of applied electrical current but the specific shape of the function has not been fully determined. Loudness growth models have implications for the implementation of cochlear implant speech processors. Having an appropriate loudness growth model is important to cochlear implant users because they have a small dynamic range of hearing compared to normal hearing listeners. To compensate for this, appropriate models of loudness are necessary for the design of cochlear implant speech processors. It is also necessary to understand how loudness is encoded and may affect the relative performance in speech recognition. Currently, there is no consensus on the actual shape of the loudness growth function, with power or

exponential functions being suggested. In this study psychophysical loudness growth measures were obtained in twelve adult cochlear implant listeners, using the method of absolute magnitude estimation and production. Best-fit loudness growth functions as determined by Akaike's Information Criterion (AIC) method for finding the best-fit loudness model, seem to show a difference in the loudness growth functions across subjects and across electrode pairs within individual subjects. The range of functions observed is greater than previously reported and goes from linear to expansive, suggesting that individual variations in dynamic range should be incorporated in the design of cochlear implant sound processors.

80 **"Speech recognition in noise in children with cochlear implants while listening in bilateral, bimodal, and FM-system arrangements".** Schafer, E. C. & Thibodeau, L. M.; (2006); American Journal of Audiology. 15(2):114-126

PURPOSE: Speech recognition performance in noise was examined in children with cochlear implants (CIs) when using (a) a second CI (bilateral group), (b) a hearing aid (HA) on the nonimplant ear (bimodal group), and (c) a frequency modulation (FM) system on 1 or both sides. METHOD: While always maintaining use of the first CI, 2 groups participated in 6 conditions each using various listening arrangements with the second CI, HA, or FM system. Speech-in-noise thresholds were determined using simple phrases, classroom noise, and a method-of-limits approach. RESULTS: No group differences were detected across any conditions. In the no-FM-system conditions, no significant benefit of bilateral or bimodal input was found relative to a single CI. In the FM-system conditions, thresholds were significantly lower (up to 20 dB) relative to all other conditions when FM-system input was provided to the first-implanted side or to both sides simultaneously. CONCLUSIONS: Children's speech-in-noise thresholds did not improve when providing input to the second side with a CI or an HA relative to a single CI. However, children with CIs had better speech recognition in noise with the use of an FM system on one or both sides relative to the conditions with no FM system. Binaural conditions with a single FM receiver on the second CI or HA yielded significantly poorer performance than any other FM condition.

81 **"The economic costs of congenital bilateral permanent childhood hearing impairment".** Schroeder, L.; Petrou, S.; Kennedy, C.; McCann, D.; Law, C.; Watkin, P. M.; Worsfold, S.; Yuen, H. M.; (2006); Pediatrics. 117(4):1101-1112

OBJECTIVE. The objective of this study was to estimate the economic costs of bilateral permanent childhood hearing impairment (PCHI) in the preceding year of life for children aged 7 to 9 years. METHODS. A cost analysis was conducted by using a birth cohort of children born between 1992 and 1997 in 8 districts of Southern England, of which half had been born into populations exposed to universal newborn screening (UNS). Unit costs were applied to estimates of health, social, and broader resource use made by 120 hearing-impaired children and 63 children in a normally hearing comparison group.

Associations between societal costs per child and severity of hearing impairment, language ability score, exposure to UNS, and age of confirmation were analyzed, including adjustment for potential confounders in a linear regression model. RESULTS. The mean societal cost in the preceding year of life at 7 to 9 years of age was {pound}14092.5 for children with PCHI, compared with {pound}4206.8 for the normally hearing children, a cost difference of {pound}9885.7. After adjusting for severity and other potential confounders in a linear regression model, mean societal costs among children with PCHI were reduced by {pound}2553 for each unit increase in the z score for receptive language. Using similar regression models, exposure to a program of UNS was associated with a smaller cost reduction of {pound}2213.2, whereas costs were similar between children whose PCHI was confirmed at <9 or >9 months. CONCLUSIONS. The study provides rigorous evidence of the annual health, social, and broader societal cost of bilateral PCHI in the preceding year of life at 7 to 9 years of age and shows that it is related to its severity and has an inverse relationship with language abilities after adjustment for severity.

82 **"Otosclerosis: a review of aetiology, management and outcomes".** Siddiq, M. A.; (2006); Br J Hosp Med (Lond). 67(9):470, 472-470, 476

Otosdcerosis is an autosomal dominant condition affecting the temporal bone. It presents predominantly with deafness in a young population. This review looks at the aetiological theories, present treatment strategies and surgical outcomes of this condition.

83 **"Detection of mutations in genes associated with hearing loss using a microarray-based approach".** Siemering, K.; Manji, S. S. M.; Hutchison, W. M.; Du Sart, D.; Phelan, D.; Dahl, H. H.; (2006); Molecular Diagnostics. 8(4):483-489

Knowing the etiology of hearing loss in a person has implications for counseling and management of the condition. More than 50% of cases of early onset, nonsyndromic sensorineural hearing loss are attributable to genetic factors. However, deafness is a genetically heterogeneous condition and it is therefore currently not economically and practically feasible to screen for mutations in all known deafness genes. We have developed a microarray-based hybridization biochip assay for the detection of known mutations. The current version of the hearing loss biochip detects nine common mutations in the connexin 26 gene, four mutations in the pendrin gene, one mutation in the usherin gene, and one mutation in mitochondrial DNA. The biochip was validated using DNA from 250 people with apparent nonsyndromic, moderate to profound sensorineural hearing loss. The hearing loss biochip detected with 100% accuracy the mutations it was designed for. No false-positives or false-negative results were seen. The biochip can easily be expanded to test for additional mutations in genes associated with hearing impairment or other genetic conditions.

84 **"Responses to short-term auditory stimulation through contralateral hearing aid use in pediatric cochlear implant users".** Skubisz, K. C.; (2006); Dissertation

Binaural hearing is necessary for localization of sounds and understanding speech in the presence of background noise. Unilateral implantation is the current standard for deaf children and adults who are candidates for a cochlear implant. There is debate as to whether a listener can process sound through bimodal amplification, that is, an electrical signal from a cochlear implant in the presence of an acoustical signal from an amplification device in the contralateral ear. The present investigation focused on short-term auditory stimulation with a hearing aid in the nonimplanted ear and its effect on localization and speech discrimination in noise in pediatric cochlear implant users. Six children with prelingual, bilateral severe-to-profound sensorineural hearing loss, who were consistent cochlear implant users for at least 6 continuous months, and who had not consistently worn a hearing aid in the nonimplanted ear since their implant surgeries participated in this study. Speech recognition and localization testing were conducted in two aided conditions, with the cochlear implant alone and with the CI and contralateral hearing aid. Testing in the bimodal condition was preceded by at least 30 minutes of intense listening, often through auditory training or speech therapy. All testing was carried out twice with no less than 2 weeks between testing sessions, in order to investigate possible fatigue and learning effects. There were negligible fatigue and learning effects on speech perception within each subject's performance, although there was much variability across individual results. Results suggest that localization with an implant or with an implant and hearing aid may be a learning process. Even after short-term contralateral hearing aid use, the children in this study performed similarly to children in other studies who had more experience in the bimodal condition. Important considerations for listening situations where background noise may be an issue were discussed. Short-term bimodal amplification may be useful for speech therapy or auditory training sessions or in classroom settings where background noise is present. Binaural benefit on the localization test did not reach statistical significance when considering both trials. This apparent lack of binaural benefit may be due to critical periods of auditory development.

85 **"Perceptual adaptation by normally hearing listeners to a simulated "hole" in hearing".** Smith, M. W. & Faulkner, A.; (2006); J Acoust Soc Am. 120(6):4019-4030

Simulations of cochlear implants have demonstrated that the deleterious effects of a frequency misalignment between analysis bands and characteristic frequencies at basally shifted simulated electrode locations are significantly reduced with training. However, a distortion of frequency-to-place mapping may also arise due to a region of dysfunctional neurons that creates a "hole" in the tonotopic representation. This study simulated a 10 mm hole in the mid-frequency region. Noise-band processors were created with six output bands (three apical and three basal to the hole). The spectral information that would have been represented in the hole was either dropped or reassigned to

bands on either side. Such reassignment preserves information but warps the place code, which may in itself impair performance. Normally hearing subjects received three hours of training in two reassignment conditions. Speech recognition improved considerably with training. Scores were much lower in a baseline (untrained) condition where information from the hole region was dropped. A second group of subjects trained in this dropped condition did show some improvement; however, scores after training were significantly lower than in the reassignment conditions. These results are consistent with the view that speech processors should present the most informative frequency range irrespective of frequency misalignment.

86 **"Estimated cost-effectiveness of active middle-ear implantation in hearing-impaired patients with severe external otitis".** Snik, A. F. M.; van Duijnhoven, N. T. L.; Mylanus, E. A. M.; Cremers, C. W. R. J.; (2006); Archives of Otolaryngology - Head and Neck Surgery. 132(11):1210-1215

Objective To determine the cost-effectiveness of middle-ear implantations in hearing-impaired patients with severe external otitis in the Netherlands. Design Cost-effectiveness analysis, using single-subject repeated measures of quality of life and total cost determinations. Setting Hospital based. Patients Moderately to severely sensorineurally hearing-impaired patients (n = 21) with severe chronic external otitis, eligible to receive a middle-ear implant. Main Outcome Measure Cost per quality-adjusted life-year (QALY), based on scores of the Medical Outcomes Study Short-Form HealthSurvey (SF-36) generic quality of life questionnaire. Only direct costs were included in cost calculation of middle-ear implantation. Results Mean health utility gain was 0.046 (0.012-0.079) (P = .01) measured at the mental component of the SF-36. With a mean profitable time of 19.4 years and an overall cost of {euro}14 354, minimal cost-effectiveness of middle-ear implantation was {euro}16 085/QALY. Conclusion Based on the cost per QALY, middle-ear implantation proved to be a cost-effective and justified health care intervention in the Netherlands.

87 **"New perspectives on assessing amplification effects".** Souza, P. E. & Tremblay, K. L.; (2006); Trends in Amplification. 10(3):119-143

Clinicians have long been aware of the range of performance variability with hearing aids. Despite improvements in technology, there remain many instances of well-selected and appropriately fitted hearing aids whereby the user reports minimal improvement in speech understanding. This review presents a multistage framework for understanding how a hearing aid affects performance. Six stages are considered: (1) acoustic content of the signal, (2) modification of the signal by the hearing aid, (3) interaction between sound at the output of the hearing aid and the listener's ear, (4) integrity of the auditory system, (5) coding of available acoustic cues by the listener's auditory system, and (6) correct identification of the speech sound. Within this framework, this review describes methodology and research on 2 new assessment techniques: acoustic analysis of speech measured at the output of the hearing aid and auditory evoked potentials recorded while the listener wears hearing aids. Acoustic analysis topics include the relationship between conventional

probe microphone tests and probe microphone measurements using speech, appropriate procedures for such tests, and assessment of signal-processing effects on speech acoustics and recognition. Auditory evoked potential topics include an overview of physiologic measures of speech processing and the effect of hearing loss and hearing aids on cortical auditory evoked potential measurements in response to speech. Finally, the clinical utility of these procedures is discussed.

88 **"Intraoperative computed tomography in otorhinolaryngology".**
Stieve, M.; Schwab, B.; Haupt, C.; Bisdas, S.; Heermann, R.; Lenarz, T.; (2006); Acta Otolaryngol. 126(1):82-87

CONCLUSIONS: Intraoperative CT surgery provides the surgeon with additional information about the altered surgical site in difficult anatomical situations. The skull base and lamina papyracea may be revealed by means of intraoperative CT, which may be beneficial in endonasal sinus surgery involving difficult surgical sites, although individual ethmoid cells cannot be assessed owing to blood artefacts. This provides the surgeon with valuable information that may facilitate the procedure considerably. In soft-tissue surgery it is advisable to apply a contrast agent in order to achieve good soft-tissue contrast, thus allowing the tumour to be adequately distinguished from benign tissue. The intraoperative application of CT is a fairly time-consuming procedure, partly owing to the preparation time (set-up of the appliance; 10-min warming-up phase) and partly due to the length of time required to calculate each image (15 s). OBJECTIVE: CT is a well-established imaging method for the assessment of osseous and soft-tissue structures in the head and neck region. Saving information and transferring it to the intraoperative site may, however, be problematic. Computer-assisted navigation systems are now able to assist difficult surgical procedures in the field of otolaryngology. To investigate the indications for intraoperative CT, we used it in various surgical procedures in the head and neck region. MATERIAL AND METHODS: Intraoperative CT was applied using the Tomoscan M in 46 cases in order to demonstrate the surgical benefit of the following procedures: endonasal surgical procedures on the paranasal sinuses (maxillary and ethmoidal sinusitis, anterior fracture of the sphenoidal sinus); tumour removal by means of laser surgery (carcinomas of the hypopharynx and larynx); and cochlear implantation (to verify the electrode position). After positioning the patient on the CT table, the workstation was set up in the operating theatre. If necessary, the gantry could be moved over the patient's head without repositioning the patient. RESULTS: Intraoperative CT was used to assist in the exposure of the skull base and lamina papyracea in endonasal surgery of the paranasal sinuses. Individual ethmoidal sinuses could not be evaluated owing to blood artefacts. Intraoperative imaging proved particularly helpful in revision surgery for chronic sinusitis in cases with missing anatomical landmarks owing to previous surgeries, where there is an increased risk of inflicting damage to the skull base or orbita. The resection margins can be determined in craniofacial resections. In soft-tissue procedures, such as tumour removal by means of laser surgery, it proved possible to visualize the resection borders of malignant tumours. Assessment of the electrode position

in cochlear implantation is particularly useful in revision cases and in cases of cochlear obliteration.

89 **"On the optimal extraction of neural correlates of binaural interaction for bilateral cochlear implant adjustments".** Strauss, D. J. & Delb, W.; (2006); IEEE Trans Biomed.EngCD-ROM

Accessible neural correlates of binaural interaction might be useful for the objective adjustment of cochlear implants in a bilateral implantation. A possible candidate could be the beta -wave of binaural interaction components in auditory brainstem responses which has been shown to be an objective measure of binaural interaction. However a reliable and automated detection of this component capable of clinical use still remains a challenge and, moreover, it is mainly applied as discrete decision measure which does not allow for a quantitative assessment of binaural interaction. In this correspondence, we suggest a continuous timescale feature of binaurally evoked brainstem responses for the quantitative assessment of binaural interaction in bilateral cochlear implant users. The extraction of such a feature by morphological local discriminant bases has recently been introduced in the objective diagnosis of the central auditory processing disorder. We show that this feature could be optimal for the adjustment of cochlear implants in the sense that it is continuous and allows for a machine based analysis. It is concluded that morphological local discriminant bases allow for the extraction of a continuous time-scale correlate of binaural interaction which seems to be applicable to objective bilateral cochlear implant adjustments

90 **"Aminoglycoside-induced degeneration of adult spiral ganglion neurons involves differential modulation of tyrosine kinase B and p75 neurotrophin receptor signaling".** Tan, J. & Shepherd, R. K.; (2006); American Journal of Pathology. 169(2):528-543

Aminoglycoside antibiotics induce sensorineural hearing loss by destroying hair cells of the organ of Corti, causing progressive secondary degeneration of primary auditory or spiral ganglion neurons (SGNs). Recent studies show that the p75 neurotrophin receptor (NTR) is aberrantly up-regulated under pathological conditions when the neurotrophin receptor tyrosine kinases (Trks) are presumptively down-regulated. We provide in vivo evidence demonstrating that degenerating SGNs induced an augmented p75NTR expression and a coincident reduction of TrkB expression in their peripheral processes. Nuclear transcription factors c-Jun and cyclic AMP response element-binding protein phosphorylated by p75NTR- and TrkB-activated signal pathways, respectively, also showed a corresponding differential modulation, suggesting an activation of apoptotic pathways, coupled to a loss of pro-survival neurotrophic support. Our findings identified brain-derived neurotrophic factor (BDNF) expression in hair and supporting cells of the adult cochlea, and its loss, specifically the mature form, would impair TrkB-induced signaling. The precursor of BDNF (pro-BDNF) is differentially cleaved in aminoglycoside-deafened cochleae, resulting in a predominant up-regulation of a truncated form of pro-BDNF, which colocalized with p75NTR-expressing SGN fibers. Together, these data suggest that an antagonistic interplay of

p75NTR and TrkB receptor signaling, possibly modulated by selective BDNF processing, mediates SGN death in vivo.

91 **"Cochlear implants: informing commissioning decisions, based on need".** Taylor, F. & Hine, C.; (2006); J Laryngol Otol. 120(12):1008-1013

Cochlear implantation is a high cost, low volume intervention which is provided to adults and children with profound hearing impairment. Demand is increasing in the UK as a result of improved technology, changes in intervention criteria and the national newborn hearing screening programme. In order to inform commissioning policy for cochlear implantation in five English primary care trusts, we reviewed the evidence and assessed the complexities of developing needs and of service provision assessment and planning. Our results indicated that the current level of provision was well below what would be expected if the majority of people meeting current criteria were given a cochlear implant. Gaps between the clinical intervention thresholds and the level of service commissioned have widened. Long-term cost effectiveness and incidence studies are needed to assess cochlear implantation in the light of these lower clinical intervention thresholds.

92 **"Direct and indirect activation of cortical neurons by electrical microstimulation".** Tehovnik, E. J.; Tolias, A. S.; Sultan, F.; Slocum, W. M.; Logothetis, N. K.; (2006); Journal of Neurophysiology. 96(2):512-521

Electrical microstimulation has been used to elucidate cortical function. This review discusses neuronal excitability and effective current spread estimated by using three different methods: 1) single-cell recording, 2) behavioral methods, and 3) functional magnetic resonance imaging (fMRI). The excitability properties of the stimulated elements in neocortex obtained using these methods were found to be comparable. These properties suggested that microstimulation activates the most excitable elements in cortex, that is, by and large the fibers of the pyramidal cells. Effective current spread within neocortex was found to be greater when measured with fMRI compared with measures based on single-cell recording or behavioral methods. The spread of activity based on behavioral methods is in close agreement with the spread based on the direct activation of neurons (as opposed to those activated synaptically). We argue that the greater activation with imaging is attributed to transynaptic spread, which includes subthreshold activation of sites connected to the site of stimulation. The definition of effective current spread therefore depends on the neural event being measured.

93 **"The effect of organ of corti loss on ganglion cell survival in humans".** Teufert, K. B.; Linthicum, F. H.; Connell, S. S.; (2006); Otol Neurotol. 27(8):1146-1151

HYPOTHESIS: Severe spiral ganglion cell loss does not necessarily follow loss of hair cells or supporting cells in humans. BACKGROUND: Despite some publications to the contrary, statements that loss of hair cells and/or supporting cells of the organ of Corti results in a severe loss of spiral ganglion cells in humans still appear in the literature, especially in respect to cochlear

implants. This assumption is apparently based on studies in animals or cell culture and not from studies of human temporal bones. METHODS: Morphological analysis of archival temporal bones with microscopic and statistical analysis of ganglion cell, hair cell, and supporting cell populations was performed in 33 ears with total hearing losses of varying causes and durations of deafness. None of the ears had remaining hair cells. Six ears had had cochlear implants. RESULTS: Ganglion cell counts ranging from 2,889 to 34,299 and the corresponding percentage of remaining ganglion cells based on age-normative data were not significantly related to the duration of hearing loss ($r = -0.13$ and 0.02, respectively, $p > 0.05$) or to remaining supporting cell populations (r's from 0.15 to 0.27, $p > 0.05$). More than half of ears (51.5%) had ganglion cell counts within two standard deviations of age-normative means. Mean ganglion cell counts and percentage of remaining ganglion cells of ears with surviving peripheral processes (dendrites) did not differ significantly from those of ears with no peripheral processes. CONCLUSION: The loss of hair and supporting cells in the organ of Corti in humans does not necessarily result in as significant a loss of spiral ganglion cells as has been reported animals. In fact, our results suggest that ganglion cell loss may be a primary concomitant loss due to the disease process.

94 **"Auditory performance of cochlear implant children aged 2-5 years".** Thawin, C.; Kanchanalarp, C.; Lertsukprasert, K.; Cheewaruangroj, W.; Khantapasuantara, K.; Ruencharoen, S.; (2006); J Med Assoc Thai. 89(11):1923-1927

OBJECTIVE: To assess the categories of auditory performance in prelingual deaf children after implantation. STUDY DESIGN: Prospective study MATERIAL AND METHOD: The present study consisted of one boy and four girls aged between 2 and 5 years old at the time of implantation. All subjects had bilateral profound sensorineural hearing loss and received no substantial benefit from amplification. Three subjects were implanted with Med-El combi 40+ with CIS strategy and two subjects received multichanal monopolar Nucleus 24 cochlear implant with ACE strategy. After implantation, all subjects undertook a program ofhabilitation at the Speech and Hearing Clinic Ramathibodi Hospital. The Categories of Auditory Performance (CAP) score was determined at regular intervals prior to implantation, immediately at the initial mapping (0) and 3, 6, 12 and 18 months after the implantation. RESULTS: The results showed that before implantation, only three children showed awareness of environment sounds, CAP score level 1, and that immediately after mapping, all of the children demonstrated awareness of the environmental sounds. Moreover, two of these children showed awareness of speech sounds, CAP score level 2. The CAP scores were gradually increased over a 12-month period. At the 12-month assessment interval, four children could discriminate two speech sounds, CAP score level 4 and one child understood phrases without lip reading, CAP score level 5. 18 months after of implantation, the CAP score for four children increased to level 5. One child understood conversation without lip reading with a familiar talker, CAP score level 6. Furthermore, children with congenital hearing loss who underwent implantation at a younger age received more benefit from the implantation. CONCLUSION: The CAP score was found to be a useful and sensitive tool to

evaluate the outcome of auditory receptive abilities in young congenital deaf children who underwent cochlear implantation. The accessible outcome measurement will provide information for parents and professionals to obtain a hierarchical scale on which the children's auditory ability with other more formal measures may be inappropriate.

95 **"[The measurement of pneumatized mastoid and facial recess in cochlear implant recipients younger than three years old]".** Tian, H. & Zhang, D.; (2006); Lin.Chuang.Er Bi Yan Hou Ke Za Zhi. 20(10):441-443

OBJECTIVE: To evaluate the postnatal growth of mastoid air cells and facial recess and the implications for cochlear implantation in very young children. METHOD: Thirty-two pediatric cochlear implant recipients younger than three years were enrolled in this study. Before implantation, pneumatized mastoid and facial recess were measured by high resolution computed tomography (HRCT) and compared with direct anatomical measurement in implantation. RESULT: We found the similar result in two measurements. All recipients had facial recess and there was no significant difference of the volume between the recipients in this study and the children in another group who were older than seven years old (P >0.05). The size of pneumatized mastoid was significantly different between recipients younger than 16 months and those older (P <0.05). CONCLUSION: (1) HRCT is very clinically valuable in making accurate diagnosis and surgical plan. (2) The facial recess is already adult size in children younger than three years old. (3) The size of pneumatized mastoid may affect mastoidotomy in cochlear implantation in very young children.

96 **"Quantitative and qualitative evaluation of linguistic input support to a prelingually deaf child with cued speech: a case study".** Torres, S.; Moreno-Torres, I.; Santana, R.; (2006); The Journal of Deaf Studies and Deaf Education. 11(4):438-448

This paper studies the linguistic input attended by a deaf child exposed to cued speech (CS) in the final part of her prelinguistic period (18-24 months). Subjects are the child, her mother, and her therapist. Analyses have provided data about the quantity of input directed to the child (oral input, more than 1,000 words per half-an-hour session; cued ratio, more than 60% of oral input; and attended ratio, more than 55% of oral input), its linguistic quality (lexical variety, grammatical complexity, etc.), and other properties of interaction (child attention and use of spontaneous gestures). Results show that both adults provided a rich linguistic input to the child and that the child attended most of the input that the adults cued. These results might explain the positive linguistic development of children exposed early to CS.

97 **"The effect of intensity on pitch in electric hearing and its relationship to the speech perception performance of cochlear implantees".** Umat, C.; McDermott, H. J.; McKay, C. M.; (2006); J Am Acad Audiol. 17(10):733-746

This study investigated the effect of intensity on pitch in electric hearing and its relationship to the speech perception ability of cochlear implantees. Subjects were 13 adult users of the Nucleus 22 cochlear implant system, using either the Spectra22 or ESPrit22 speech processor and the SPEAK speech processing strategy. A multidimensional scaling technique was employed. Speech perception was measured using sentences and vowels. All measurements were performed in a soundfield condition, and subjects wore their own speech processors with their normally used settings. Results showed a significant correlation between the degree of deviation of the subjects' stimulus spaces from the "ideal" space and subjects' performance with the sentences, but not with the vowels. A significant correlation was found between subjects' response variability in performing the multidimensional scaling task and their speech perception measures, suggesting that spectral smearing or underlying cognitive abilities might affect implantees' speech perception performance.

98 **"A comparison of intra- versus post-operatively acquired electrically evoked compound action potentials".** van Wermeskerken, G. K.; van Olphen, A. F.; van Zanten, G. A.; (2006); Int J Audiol. 45(10):589-594

The objective of this study was to compare the electrically evoked compound action potentials, intra- versus post-operatively, in cochlear implant patients. In a prospective study twenty-five consecutively implanted adult patients received a multichannel cochlear implant. In all patients, electrically evoked compound action potentials were recorded immediately after cochlear implantation and in a post-operative setting nine months later. The threshold of the electrically evoked compound action potential was determined in both settings. A high success rate (97.4%) was found in the intra-operative setting when recording the electrically evoked compound action potential threshold per patient. The success rate per patient was significantly lower (53.4%) in the post-operative setting. Correlations between the intra- versus the post-operative ECAP thresholds were statistically significant for all electrodes tested. The ECAP thresholds were not significantly different for the two settings. The intra-operative setting is preferable for acquisition of the ECAP threshold.

99 **"Virtual channels in Nucleus(R) 24 cochlear implants".** Vondrasek, M.; Sovka, P.; Tichy, T.; (2006); Analysis of Biomedical Signals and Imagesxvi+385

This paper describes a method of implementing virtual channels in Nucleus(R) 24 cochlear implants by sequential stimulation of adjacent electrodes. It was shown that virtual electrodes can be created the Nucleus(R) Contour Advance TM implant. The applicability of "fixed stimulating rate" stimulation method is limited due to the poor possibility of setting the pitch of

the hearing percept. This method is also more difficult to implement. On the other hand, the "fixed amplitudes" stimulating method allows easy setting of pitch and it can be easily implemented. The reliability of recognition depends on the patient and also on the place of stimulation. Virtual electrodes enable better pitch discrimination with currently used speech coding. Virtual electrodes could be used for the substitution of damaged electrode by stimulating in the neighbouring electrode pair.

100 **"Song recognition by children and adolescents with cochlear implants".** Vongpaisal, T.; Trehub, S. E.; Schellenberg, E. G.; (2006); Journal of Speech, Language, and Hearing Research. 49(5):1091-1103

PURPOSE: To assess song recognition and pitch perception in prelingually deaf individuals with cochlear implants (CIs). METHOD: Fifteen hearing children (5-8 years) and 15 adults heard different versions of familiar popular songs--original (vocal + instrumental), original instrumental, and synthesized melody versions--and identified the song in a closed-set task (Experiment 1). Ten CI users (8-18 years) and age-matched hearing listeners performed the same task (Experiment 2). Ten CI users (8-19 years) and 10 hearing 8-years-olds were required to detect pitch changes in repeating-tone contexts (Experiment 3). Finally, 8 CI users (6-19 years) and 13 hearing 5-year-olds were required to detect subtle pitch changes in a more challenging melodic context (Experiment 4). RESULTS: CI users performed more poorly than hearing listeners in all conditions. They succeeded in identifying the original and instrumental versions of familiar recorded songs, and they evaluated them favorably, but they could not identify the melody versions. Although CI users could detect a 0.5-semitone change in the simple context, they failed to detect a 1-semitone change in the more difficult melodic context. CONCLUSION: Current implant processors provide insufficient spectral detail for some aspects of music perception, but they do not preclude young implant users' enjoyment of music.

101 **"A new cochlear implant device of Advanced Bionics - experience and short term results of the use of the HiRes 90K implant".** Watanabe, N.; Takahashi, M.; Miyamoto, N.; Murakami, S.; Inoue, H.; (2006); Oto-Rhino-Laryngology TokyoThe HiRes 90K Bionic Ear implant is a new device manufactured by Advanced Bionics in the United States ; it has received approval from the Food and Drug Administration (FDA), USA, and has been widely adopted around the world, except in Japan, for several years. Some of the advantageous features of this device are the shape with a soft, flexible and low profile, 16 electrode channels, and a new sound processing program. We implanted the HiRes 90K device in four postlingual deaf adults (three men and a woman ; age at implantation, 64-74 years) ; no major postoperative complications were observed in any of the subjects. One patient had a transient floating sensation after the surgery, however, this symptom gradually resolved on its own within a few weeks. Two patients answered the Meaningful auditory integration scale (MAIS), and we estimated the MAIS value of CIS (continuous interleaved sampler), PPS (paiired pulsatile sampler), HiRes-S and HiRes-P each other. In both, the values of HiRes-S and HiRes-P were higher than those of CIS and PPS. As a result, all the

patients prefered the HiRes sound processing to the conventional proceedings. Although these are only short-term results, we consider that the HiRes 90K Bionic Ear implant and sound processig system may exhibit better efficacy and greater safety than the CI implant and conventional sound processing system used in Japan.

102 **"Pneumococcal meningitis threshold model: A potential tool to assess infectious risk of new or existing inner ear surgical interventions".** Wei, B. P.; Shepherd, R. K.; Robins-Browne, R. M.; Clark, G. M.; O'Leary, S. J.; (2006); Otol Neurotol. 27(8):1152-1161

HYPOTHESIS: A minimal threshold of Streptococcus pneumoniae is required to induce meningitis in healthy animals for intraperitoneal (hematogenous), middle ear, and inner ear inoculations, and this threshold may be altered via recent inner ear surgery. BACKGROUND: There has been an increase in the number of reported cases of cochlear implant-related pneumococcal meningitis since 2002. The pathogenesis of pneumococcal meningitis is complex and not completely understood. The bacteria can reach the central nervous system (CNS) from the upper respiratory tract mucosa via either hematogenous route or via the inner ear. The establishment of a threshold model for all potential routes of infection to the CNS in animals without cochlear implantation is an important first step to help us understand the pathogenesis of the disease in animals with cochlear implantation. METHODS: Fifty-four otologically normal adult Hooded Wistar rats (27 receiving cochleostomy and 27 controls) were inoculated with different amounts of bacterial counts via three different routes (intraperitoneal, middle ear, and inner ear). Rats were monitored during 5 days for signs of meningitis. Blood, cerebrospinal fluid, and middle ear swabs were taken for bacterial culture, and brains and cochleae were examined for signs of infection. RESULTS: The threshold of bacterial counts required to induce meningitis is lowest in rats receiving direct inner ear inoculation compared with both intraperitoneal and middle ear inoculation. There is no change in threshold between the group of rats with cochleostomy and the control (Fisher's exact test, $p < 0.05$). CONCLUSION: A minimal threshold of bacteria is required to induce meningitis in healthy animals and is different for three different routes of infection (intraperitoneal, middle ear, and inner ear). Cochleostomy performed 4 weeks before the inoculation did not reduce the threshold of bacteria required for meningitis in all three infectious routes. This threshold model will also serve as a valuable tool, assisting clinicians to quantitatively analyze if the presence of a cochlear implant or other CNS prostheses alter the risk of meningitis.

103 **"Protective effects of local administration of ciprofloxacin on the risk of pneumococcal meningitis after cochlear implantation".** Wei, B. P.; Robins-Browne, R. M.; Shepherd, R. K.; Azzopardi, K.; Clark, G. M.; O'Leary, S. J.; (2006); Laryngoscope. 116(12):2138-2144

OBJECTIVES: To determine whether ciprofloxacin retains its antimicrobial activity after storage with Healon at ambient temperature and at 37 degrees C over 5 weeks and then to establish whether the application of

ciprofloxacin/Healon onto scala tympani electrode arrays reduces the risk of meningitis in implanted rats inoculated with S. pneumoniae. STUDY DESIGN: In vitro laboratory and in vivo animal studies METHODS: The antibacterial activity of three concentrations of ciprofloxacin/Healon (7.5, 75, and 750 microg/mL) was examined over 5 weeks at both ambient temperature (23 degrees C) and body temperature (37 degrees C). Thirty-six rats (18 implanted with ciprofloxacin [750 mg/mL]/Healon-coated electrode array and 18 without the coating) were infected with S. pneumoniae 4 weeks after implantation by way of three different routes of infection (hematogenous, middle ear, and inner ear) and observed for the development of meningitis. RESULTS: The antibacterial activity of ciprofloxacin/Healon was maintained over 5 weeks at both 23 degrees C and 37 degrees C. The implanted rats with the ciprofloxacin/Healon-coated electrode array were protected from meningitis when the bacteria were given by way of the hematogenous route (Fisher's exact test, P = .008) but not when the bacteria were inoculated directly into the middle or inner ear. However, the time to develop meningitis was significantly longer in rats implanted with a coated array, irrespective of the route of inoculation (P < .05, log rank test). CONCLUSION: Our animal model demonstrated that a ciprofloxacin-coated electrode array can protect healthy implanted rats from meningitis when the route of infection is hematogenous and can delay the onset of meningitis when bacteria are inoculated directly into the middle or inner ear.

104 **"Comparing cochlear implant users' speech performance with processor fittings based on conventionally determined T and C levels or on compound action potential thresholds and live-voice speech in a prospective balanced crossover study".** Willeboer, C. & Smoorenburg, G. F.; (2006); Ear Hear. 27(6):789-798

OBJECTIVE: The objective of the present study is to improve the efficiency of the fitting procedure of cochlear implant processors by making use of measurements of the electrically evoked compound actio potential (ECAP) and live-voice speech. DESIGN: In a randomised prospective cross-over design we compare speech performance of eighteen adult subjects when following the conventional fitting procedure to a procedure in which we use the profile of the ECAP threshold levels across the full electrode array measured intra-operatively. The overall level of the profile is shifted (by an equal amount of current units per electrode) until we find the threshold for live speech (new T levels) and the loudness comfort level (new C levels). Each fitting procedure is tested for 6 wk. Speech performance is measured in quiet and in noise every other week. RESULTS: The results show little difference between the scores (Dutch CVC words) for the conventional fitting procedure and the ECAP based fitting, although the T and C levels may differ markedly. CONCLUSION: The new fitting procedure is much faster and easier in the initial phase. Further improvement of performance may be obtained in a later stage of the fitting procedure by changing some individual electrodes on the basis of subjective responses.

105 **"Management of cerebrospinal fluid leakage from cochleostomy during cochlear implant surgery".** Wootten, C. T.; Backous, D. D.; Haynes, D. S.; (2006); Laryngoscope. 116(11):2055-2059

OBJECTIVES: The objectives of this retrospective review were to determine the incidence of cerebrospinal fluid (CSF) otorrhea from the cochleostomy during cochlear implant surgery, to recognize patients at risk, and to determine the appropriate preoperative, postoperative and intraoperative management. METHODS: A chart review from two cochlear implant centers was performed to determine the incidence of CSF otorrhea, patients at risk, and appropriate management. RESULTS: The incidence of CSF gusher is low, encountered in approximately 1% of patients undergoing cochlear implant surgery, and is seen in equal incidence in children and adults in our series. Preoperative imaging was predictive in only 50% of cases. Mechanisms for otorrhea in specific cochlear malformations and in those in which no apparent malformation exists are discussed. Successful implantation is expected in most cases. Intraoperative management may require complete packing of the middle ear space in addition to the cochleostomy to control CSF leak. Lumbar drain is rarely necessary. Outpatient management is possible in the majority of cases. Vaccination and antibiotic prophylaxis is essential. CONCLUSIONS: CSF otorrhea can be encountered in cochlear malformations and in cochleas without apparent malformation. Successful implantation without short-term or long-term complications is expected.

106 **"[Pre-operative electrophysiological evaluation for pediatric cochlear implant recipients with auditory neuropathy or auditory dys-synchrony]".** Xi, X.; Han, D. Y.; Li, X. Q.; (2006); Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 41(12):956-959

Abstract unavailable

107 **"[Cochlear implantation in patients with otitis media-related diseases]".** Yang, H.; Cao, K. L.; Chen, X. W.; Wang, Y.; Wei, C. G.; Jin, X.; Wei, B. J.; (2006); Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 41(12):908-912

OBJECTIVE: To evaluate the indications, surgical techniques and complications of cochlear implantation in patients with otitis media-related diseases. METHODS: Retrospective study of the data collected from patients receiving cochlear implantation. Totally 866 cases of cochlear implantation were performed in Peking Union Medical College Hospital from May 1995 to February 2006. Among which, 41 patients with otitis media-related diseases were grouped into 5 types: chronic secretory otitis media (13 cases), silent (subclinical) otitis media (18 cases), dry eardrum perforation (1 case), bilateral cholesteatoma of middle ear (2 cases) and middle ear granuloma (7 cases). Seven cases were accompanied with deformities of middle ear and (or) inner ear. Pedicled aponeurosis of occipitofrontalis muscle was transplanted to cover and protect the inserted electrodes and facial nerve in a patient with bilateral cholesteatoma after radical mastoidectomy. RESULTS: All the 41 patients with otitis media-related diseases were successfully implanted in one

stage or staged operations and followed up uneventfully for 5 months to 6 years and 11 months. All implant devices had worked normally and all patients had performed well. CONCLUSIONS: Patients with chronic secretory otitis media, silent (subclinical) otitis media, middle ear granuloma or dry ear-drum perforation could be operated in one stage or staged procedures safely and effectively. Patients with bilateral cholesteatoma could be implanted after radical removal of related lesions. Pedicled aponeurosis of occipitofrontalis muscle could be transplanted in cases of mastoid bowl to cover and protect the inserted electrodes and the exposed facial nerve and with easy access to observe the mastoid cavity. Active suppurative otitis media was contraindicated for cochlear implantation. Long-term following-up was essential for better evaluation of the outcomes of cochlear implantation in patients with otitis media-related diseases.

108 **"Stability of low-frequency residual hearing in patients who are candidates for combined acoustic plus electric hearing".** Yao, W. N.; Turner, C. W.; Gantz, B. J.; (2006); Journal of Speech, Language, and Hearing Research. 49(5):1085-1090

The purpose of this study was to investigate the stability over time of low-frequency auditory thresholds to better determine if the new technique of using a short-electrode cochlear implant that preserves residual low-frequency acoustic hearing can be a long-term solution for those with severe-to-profound hearing loss at high frequencies. The present study determined the long-term rate of decline in acoustic hearing in patients who have a preexisting hearing loss yet have not been implanted with a cochlear implant. A retrospective analysis of patients' audiograms that fit into the range for candidacy for the short-electrode device was performed to calculate the rate of change of threshold over time. The analysis of adult patients' data indicated that there was an average of only 1.05 dB hearing deterioration per year in the low frequencies and that presbycusis accounted for approximately one third to one half of this decline. The average deterioration of hearing threshold for pediatric patients was 1.2 dB per year; however, the rates of change in pediatric patients were considerably more variable (across individuals and across frequencies) than in adults. These data provide support for the idea that the short-electrode cochlear implant may be a practical solution for most adults in the long run, but this may not be the case for all pediatric patients.

109 **"Can cochlear implants decrease tinnitus?".** Yonehara, E.; Mezzalira, R.; Porto, P. R.; Bianchini, W. A.; Calonga, L.; Curi, S. B.; Stoler, G.; (2006); Int Tinnitus.J. 12(2):172-174

Suppression of tinnitus by electrical stimulation via a cochlear implant has been studied in recent years. Some individuals who undergo cochlear implant surgery report total or partial relief of the symptoms even in the contralateral ear. The mechanisms involved in this suppression are not clear. The results obtained in our study demonstrated an improvement of 71% in 29 implant cases, confirming data found in the literature. Our aim was to study tinnitus in individuals before surgery and after cochlear implant activation and to observe improvement in the perception of tinnitus, comparing these results with data in

the literature. We conducted a retrospective study of 29 postlingual adults who had profound sensorineural hearing loss and underwent cochlear implant surgery at the cochlear implant sector of the Otorhinolaryngology, Head and Neck Surgery Department, University of Campinas, Sao Paulo, Brazil, between May 2003 and June 2005. The device employed in this procedure was the Nucleus 24K multichannel device (Cochlear Ltd, Lane Cove, Australia). After the internal component was activated, patients completed a questionnaire. Before surgery, 21 of the 29 patients (72%) who later underwent cochlear implant surgery presented with tinnitus, which was bilateral in 14 cases (67%). After the cochlear implant was activated, seven patients (33%) presented with total suppression, and eight patients (39%) reported partial relief. In the 14 cases with bilateral symptoms, tinnitus was totally suppressed or decreased in both ears in 12 cases (86%). Individuals who underwent multichannel cochlear implant surgery presented with reduced tinnitus even in the contralateral ear.

110 **"A pilot study of robot-assisted cochlear implant surgery using steerable electrode arrays".** Zhang, J.; Xu, K.; Simaan, N.; Manolidis, S.; (2006); Med Image Comput Comput Assist Interv Int Conf Med Image Comput Comput Assist Interv. 9(Pt 1):33-40

This paper presents results of a pilot study evaluating the efficacy of robotic assistance using novel steerable electrode arrays for cochlear implant surgery. The current surgical setup of cochlear implant surgery is briefly reviewed and its limitations are highlighted. In an effort to reduce trauma to the structure of the cochlea, the kinematics and path planning for novel cochlear steerable electrodes are developed to minimize the interaction forces between the electrode and the cochlea. An experimental robotic system is used to compare the electrode insertion forces of steerable implants with those of nonsteerable electrodes. The results of these experiments show about 70% reduction in the insertion forces when steerable electrodes are used with our proposed path planning and control. A distance metric explaining this reduction in the insertion force is defined and experimentally validated. Although this is only a preliminary study, we believe that these results provide a strong indication to the potential of robot-assisted cochlear implant surgery to provide a significant reduction in trauma rates during cochlear implant surgery.