Quarterly Abstract Update

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2 Antonelli P. J. & Baratelli R.; (2007); "Cochlear implant integrity after adenoidectomy with Coblation and monopolar electrosurgery"; Am J Otolaryngol. 28(1):9-12 9

3 Balmer R. & Fayle S. A.; (2007); "Enamel defects and ectopic eruption in a child with Usher syndrome and a cochlear implant"; Int J Paediatr Dent. 17(1):57-61 10

4 Basta D.; Dahme A.; Todt I.; & Ernst A.; (2007); "Relationship between intraoperative eCAP thresholds and postoperative psychoacoustic levels as a prognostic tool in evaluating the rehabilitation of cochlear implantees"; Audiol Neurootol. 12(2):113-118 10

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7 Bourgeois-Republique C.; Frachet B.; & Collet P.; (2006); "Interactive evolutionary algorithm. Application to automatic control of a cochlear implant"; Technique.et Science Informatiques. 25(8-9):1157-1178 12

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1. **"Cochlear implantation in the irradiated temporal bone".** Adunka, O. F. & Buchman, C. A.; (2007); J Laryngol Otol. 121(1):83-86

OBJECTIVE: To demonstrate the feasibility and complexities of cochlear implantation in the setting of bilateral temporal bone osteoradionecrosis. STUDY DESIGN: Case report. SETTING: Tertiary care referral centre. CASE DESCRIPTION: A 66-year-old woman with bilateral temporal bone osteoradionecrosis and profound hearing loss, following treatment for tonsillar cancer, underwent cochlear implantation. Prior canal wall down mastoidectomy and subsequent temporal bone resection with free flap reconstruction had been performed on the implanted ear. The contralateral ear received a canal wall down mastoidectomy. A completely dehiscent mastoid segment of the facial nerve and extensive fibrosis were evident in the implanted ear. Only minimal fibrous reaction was found within the cochlea, allowing for full electrode insertion. At three months, speech recognition testing documented a consonant-nucleus-consonant (CNC) word score of 54 per cent. CONCLUSIONS: This report demonstrates the feasibility of cochlear implantation after temporal bone surgery and free flap reconstruction in the setting of diffuse osteoradionecrosis. The patient's excellent open-set speech understanding using the cochlear implant implies that radiation did not severely damage the central auditory pathways. Thus, some patients with radiation-induced hearing loss may be appropriate cochlear implant candidates. Special attention should be paid to surgical planning, as complications related to wound healing, electrode insertion and facial nerve injury may be more likely.

2. **"Cochlear implant integrity after adenoidectomy with Coblation and monopolar electrosurgery".** Antonelli, P. J. & Baratelli, R.; (2007); Am J Otolaryngol. 28(1):9-12

PURPOSE: Conventional electrosurgical adenoidectomy has been deemed contraindicated in subjects with cochlear implants (CIs) because of risk to the CI and the auditory neurons. No published studies have evaluated the safety of electrosurgical adenoidectomy techniques with CIs. The goal of this study was to compare the impact of monopolar electrosurgery and Coblation radiofrequency bipolar electrosurgery on CI integrity. METHODS: Twelve fresh, cadaveric pigs received unilateral CIs, then the nasopharynx was treated for 15 to 30 minutes with continuous monopolar electrosurgery or Coblation. CIs were tested by the manufacturer for device integrity before and after treatment. RESULTS: Integrity was maintained in all CIs treated with either monopolar or Coblation electrosurgery. CONCLUSIONS: Although the safety of electrosurgical adenoidectomy after CI placement remains unproven, these observations suggest that judicious use of conventional monopolar and Coblation electrosurgery in adenoidectomy does not convey a serious risk to CI integrity. Theoretical considerations favor the use of Coblation over monopolar electrosurgery in CI recipients.

3. **"Enamel defects and ectopic eruption in a child with Usher syndrome and a cochlear implant".** Balmer, R. & Fayle, S. A.; (2007); Int J Paediatr Dent. 17(1):57-61

BACKGROUND: Usher syndrome is a genetic disorder consisting of progressive loss of vision and hearing. CASE REPORT: The paper describes an 8-year-old girl with Usher syndrome type I who presented with generalized defects of the permanent dentition and ectopic eruption of the right maxillary first permanent molar. A cochlear implant had been fitted for her hearing loss, and the report reviews the implications of this device for dental treatment. The impacted first permanent molar was encouraged to erupt into the correct position by shaving the distal surface of the second primary molar. CONCLUSION: This is the first report to describe in detail an association between Usher syndrome and enamel defects.

4. **"Relationship between intraoperative eCAP thresholds and postoperative psychoacoustic levels as a prognostic tool in evaluating the rehabilitation of cochlear implantees".** Basta, D.; Dahme, A.; Todt, I.; Ernst, A.; (2007); Audiol Neurootol. 12(2):113-118

A sufficient correlation between objective (e.g. eCAP of the auditory nerve) and psychoacoustic data has not yet been possible due to high interindividual variability in cochlear implantees. Therefore, the application of objective data in the evaluation of speech rehabilitation after cochlear implantation was investigated. eCaps of all electrodes were measured intraoperatively. The 'threshold' and 'comfort' levels, speech recognition and pure tone thresholds were determined at follow-up. The correlation coefficient was calculated between eCap thresholds and psychoacoustic levels. This correlation coefficient was ranked with other individual items in relation to their influence on the development of speech recognition. Only the duration of preimplant deafness, the pure tone hearing threshold and the correlation between eCAP and psychoacoustic levels have a significant influence on the rehabilitation within this selection of variables. Based on these results, an individualized mathematical modeling approach was introduced to predict the development of postoperative speech recognition by incorporating objective data.

5. **"Chronic suppurative otitis media following paediatric cochlear implantation".** Bibas, A.; Phillips, S.; Bailey, C. M.; Papsin, B. C.; (2007); Cochlear Implants International. 7(3):167-178

The objective of this study was to report and discuss the management of chronic suppurative otitis media (CSOM) following cochlear implantation in children. The study was a retrospective review of 650 patients receiving an implant at two paediatric tertiary referral centres for cochlear implantation. Nine patients were identified who developed CSOM following cochlear implantation (incidence 1.38%). The mean time interval between implantation and symptom development was 3.66 years (range 2-8 years) and the mean time interval between implantation and CSOM surgery was 5.02 years (range 2.2-8 years). All patients presented with otorrhoea and/or abscess formation over the implant site. Two patients underwent a modified radical mastoidectomy and seven underwent a combined approach tympanoplasty, three of whom required posterior canal wall reconstruction with cortical bone and one with cartilage. In four cases it was possible to remove the cholesteatoma without removing the implant. All but two patients were fitted with a contralateral implant. In the explanted ears the cochlear implant electrode was cut at the cochleostomy site, which was then covered with muscle. Chronic suppurative otitis media following cochlear implantation may occur either as a result of a posterior canal wall defect related to surgery or possibly de novo. Attempts should be made to save the implant, but explantation with reimplantation of the contralateral ear may be the only option. In these cases the intracochlear part of the electrode array should be left in situ to facilitate possible future reimplantation. Surgical options for management of CSOM should be individualized and may include both canal-wall up and canal-wall down techniques. To reduce the incidence of CSOM following implantation the authors recommend: (1) prompt treatment and careful follow-up of patients with a history of otitis media with effusion, (2) avoidance of excessive thinning of the posterior canal wall during mastoidectomy and (3) reconstruction of any accidental trauma to the annulus or posterior canal wall during posterior tympanotomy.

6. **"Threshold and channel interaction in cochlear implant users: evaluation of the tripolar electrode configuration".** Bierer, J. A.; (2007); J Acoust Soc Am. 121(3):1642-1653

The efficacy of cochlear implants is limited by spatial and temporal interactions among channels. This study explores the spatially restricted tripolar electrode configuration and compares it to bipolar and monopolar stimulation. Measures of threshold and channel interaction were obtained from nine subjects implanted with the Clarion HiFocus-I electrode array. Stimuli were biphasic pulses delivered at 1020 pulses/s. Threshold increased from monopolar to bipolar to tripolar stimulation and was most variable across channels with the tripolar configuration. Channel interaction, quantified by the shift in threshold between single- and two-channel stimulation, occurred for all three configurations but was largest for the monopolar and simultaneous conditions. The threshold shifts with simultaneous tripolar stimulation were slightly smaller than with bipolar and were not as strongly affected by the timing of the two channel stimulation as was monopolar. The subjects' performances on clinical speech tests were correlated with channel-to-channel variability in tripolar threshold, such that greater variability was related to poorer performance. The data suggest that tripolar channels with high thresholds may reveal cochlear regions of low neuron survival or poor electrode placement.

7. **"Interactive evolutionary algorithm. Application to automatic control of a cochlear implant".** Bourgeois-Republique, C.; Frachet, B.; Collet, P.; (2006); Technique.et Science Informatiques. 25(8-9):1157-1178

This paper describes an interactive evolutionary algorithm dedicated to cochlear implants fitting. The algorithm automatically suggests different fittings that are evaluated by the patient along predefined criteria: comfort and speech understanding. The evolutionary process is guided by the evaluation of the patient. The interaction with the patient is done through a PDA (personal data assistant). The main advantage to use this lightweight terminal for the evaluation is to give the patient a full autonomy, and lift all constraints (hospital, environmental, temporal...) allowing him to optimize his CI fitting in any noise environment. This work exposes the first medical application of such an algorithm for cochlear implant fitting. Obtained results on a patient are presented and discussed.

8. **"Numerical modeling and experimental measurements of the electric potential generated by cochlear implants in physiological tissues".** Burdo, S.; Di Rienzo, L.; Grandori, F.; Norgia, M.; Parazzini, M.; Pesatori, A.; Ravazzani, P.; Svelto, C.; Tognola, G.; (2007); IEEE Transactions on Instrumentation and Measurement. 56(1):187-193

The electric potential pattern generated by a cochlear implant was modeled using the finite-element method. The pattern, which is a response to bipolar current pulses from the implant electrode array, was investigated for different values of the electrical parameters of the human cochlea and of the array. Simulated data are compared with measurements in a water tank. Numerical simulations were carried out for different electrode configurations. Electrode configurations were found to affect the resulting potential, and the measurements confirmed our modeling approach. This study provides a better understanding of the relationship between the stimulation parameters and the delivered electric field, which is crucial to develop more efficient and spatially localized excitations of cochlear neural tissues.

9. **"Cochlear implant electrode array insertion monitoring with intra-operative 3D rotational X-ray".** Carelsen, B.; Grolman, W.; Tange, R.; Streekstra, G. J.; van Kemenade, P.; Jansen, R. J.; Freling, N. J.; White, M.; Maat, B.; Fokkens, W. J.; (2007); Clin Otolaryngol. 32(1):46-50

During cochlear implantation surgery, we use a mobile C-arm with 3D functionality to acquire per-operative 3D X-ray images. Scanning the multielectrode array is performed once before removal of the stylet and once after full insertion. When dissatisfied with the position of the multielectrode a repositioning is considered which happened occasionally. The major advantage is the extra certainty of the multielectrode array position in the cochlea with low-dose and little extra time. All cochlear implantations are now routinely scanned during surgery.

10. **"Concurrent sound segregation in electric and acoustic hearing".** Carlyon, R. P.; Long, C. J.; Deeks, J. M.; McKay, C. M.; (2007); J Assoc Res Otolaryngol. 8(1):119-133

We investigated potential cues to sound segregation by cochlear implant (CI) and normal-hearing (NH) listeners. In each presentation interval of experiment 1a, CI listeners heard a mixture of four pulse trains applied concurrently to separate electrodes, preceded by a "probe" applied to a single electrode. In one of these two intervals, which the subject had to identify, the probe electrode was the same as a "target" electrode in the mixture. The pulse train on the target electrode had a higher level than the others in the mixture. Additionally, it could be presented either with a 200-ms onset delay, at a lower rate, or with an asynchrony produced by delaying each pulse by about 5 ms re those on the nontarget electrodes. Neither the rate difference nor the asynchrony aided performance over and above the level difference alone, but the onset delay produced a modest improvement. Experiment 1b showed that two subjects could perform the task using the onset delay alone, with no level difference. Experiment 2 used a method similar to that of experiment 1, but investigated the onset cue using NH listeners. In one condition, the mixture consisted of harmonics 5 to 40 of a 100-Hz fundamental, with the onset of either harmonics 13 to 17 or 26 to 30 delayed re the rest. Performance was modest in this condition, but could be improved markedly by using stimuli containing a spectral gap between the target and nontarget harmonics. The results suggest that (a) CI users are unlikely to use temporal pitch differences between adjacent channels to separate concurrent sounds, and that (b) they can use onset differences between channels, but the usefulness of this cue will be compromised by the spread of excitation along the nerve-fiber array. This deleterious effect of spread-of-excitation can also impair the use of onset cues by NH listeners.

11. **"Advancement in post-meningitic lateral semicircular canal labyrinthitis ossificans".** Chan, C. C.; Saunders, D. E.; Chong, W. K.; Hartley, B. E.; Raglan, E.; Rajput, K.; (2007); J Laryngol Otol. 121(2):105-109

OBJECTIVE: To assess whether lateral semicircular canal (LSCC) ossification is more advanced than that in the cochlear basal turn, in order to judge the value of the former as a predictor. METHODS: Retrospective review of 33 paediatric patients from our cochlear implant programme, with profound sensorineural hearing loss after bacterial meningitis. Magnetic resonance imaging (MRI), computed tomography (CT) scans and operative findings were reviewed. RESULTS: On CT, LSCC ossification scores were more advanced than those for the cochlear basal turn in 69.9 per cent of implanted ears. Forty-five per cent (15/33) of children had ossification at surgery. In predicting this, the sensitivity of CT LSCC ossification was 90 per cent and that of MRI LSCC ossification was 83.3 per cent. CONCLUSIONS: The more advanced ossification found in the LSCC, compared with that in the cochlear basal turn, adds to previous findings of LSCC pathology predicting cochlear ossification. Surprisingly, CT of the LSCC appears

to be no less valuable than MRI in pre-operative cochlear implant assessment of post-meningitic children.

12. **"An integrate-and-fire-based auditory nerve model and its response to high-rate pulse train".** Chen, F. & Zhang, Y.-T.; (2007); Neurocomputing. 70(4-6):1051-1055

In this paper, a simple but efficient integrate-and-fire-based auditory nerve (AN) model is introduced. The model uses a Gaussian noise and a refractory function to describe the stochastic membrane potential fluctuation and the refractory effect during the neural firing, respectively. The proposed model is characterized by its computation ease and efficiency. Results of the model-based simulation showed that the neural firing produced an enhanced temporal representation of the stimulus waveform at the high-rate electrical stimulation. It was also found that there was an optimal pulse width to represent the temporal structure of the stimulus waveform. The proposed model would facilitate the further investigation of AN's response to different input stimulations, and help us to develop novel electrical stimulation strategies for cochlear implants in the future.

13. **"Successful rehabilitation with cochlear implant in post-irradiation induced hearing loss in nasopharyngeal carcinoma patient".** Chua, D. Y. & Tan, H. K.; (2007); Ann Acad Med Singapore. 36(1):74-77

INTRODUCTION: We report a case of successful rehabilitation of hearing with a cochlear implant in a patient with nasopharyngeal carcinoma who developed post-irradiation hearing loss following treatment. CLINICAL PICTURE: A 55-year-old Chinese lady suffered from radiation-induced sensorineural hearing loss due to treatment for nasopharyngeal carcinoma. Audiological tests and imaging studies showed an intact retrocochlear pathway. TREATMENT: Cochlear implantation. OUTCOME: Cochlear implant was done with successful rehabilitation of hearing until the time of this report. CONCLUSIONS: If functionally active auditory fibres survive with no recurrent tumour, successful rehabilitation of post-irradiation induced sensorineural hearing loss is possible with a cochlear implant in a patient with nasopharyngeal carcinoma.

14. **"Does cochlear implantation and electrical stimulation affect residual hair cells and spiral ganglion neurons?".** Coco, A.; Epp, S. B.; Fallon, J. B.; Xu, J.; Millard, R. E.; Shepherd, R. K.; (2007); Hear Res. 225(1-2):60-70

Increasing numbers of cochlear implant subjects have some level of residual hearing at the time of implantation. The present study examined whether (i) hair cells that have survived one pathological insult (aminoglycoside deafening), can survive and function following long-term cochlear implantation and electrical stimulation (ES); and (ii) chronic ES in these cochleae results in greater trophic support of spiral ganglion neurons (SGNs) compared with cochleae devoid of hair cells. Eight cats, with either partial (n=4) or severe (n=4) sensorineural hearing loss, were bilaterally implanted with scala tympani electrode arrays 2 months after deafening, and received unilateral ES using charge balanced biphasic current pulses for periods of up to 235 days. Frequency-specific compound action potentials and click-evoked auditory brainstem responses (ABRs) were recorded periodically to monitor the residual acoustic hearing. Electrically evoked ABRs (EABRs) were recorded to confirm the stimulus levels were 3-6 dB above the EABR threshold. On completion of the ES program the cochleae were examined histologically. Partially deafened animals showed no significant increase in acoustic thresholds over the implantation period. Moreover, chronic ES of an electrode array located in the base of the cochlea did not adversely affect hair cells in the middle or apical turns. There was evidence of a small but statistically significant rescue of SGNs in the middle and apical turns of stimulated cochleae in animals with partial hearing. Chronic ES did not, however, prevent a reduction in SGN density for the severely deaf cohort, although SGNs adjacent to the stimulating electrodes did exhibit a significant increase in soma area ($p<0.01$). In sum, chronic ES in partial hearing animals does not adversely affect functioning residual hair cells apical to the electrode array. Moreover, while there is an increase in the soma area of SGNs close to the stimulating electrodes in severely deaf cochleae, this trophic effect does not result in increased SGN survival.

15. **"Auditory hair cell explant co-cultures promote the differentiation of stem cells into bipolar neurons".** Coleman, B.; Fallon, J. B.; Pettingill, L. N.; de Silva, M. G.; Shepherd, R. K.; (2007); Exp Cell Res. 313(2):232-243

Auditory neurons, the target neurons of the cochlear implant, degenerate following a sensorineural hearing loss. The goal of this research is to direct the differentiation of embryonic stem cells (SCs) into bipolar auditory neurons that can be used to replace degenerating neurons in the deafened mammalian cochlea. Successful replacement of auditory neurons is likely to result in improved clinical outcomes for cochlear implant recipients. We examined two post-natal auditory co-culture models with and without neurotrophic support, for their potential to direct the differentiation of mouse embryonic SCs into characteristic, bipolar, auditory neurons. The differentiation of SCs into neuron-like cells was facilitated by co-culture with auditory neurons or hair cell explants, isolated from post-natal day five rats. The most successful combination was the co-culture of hair cell explants with whole embryoid bodies, which resulted in significantly greater numbers of neurofilament-positive, neuron-like cells. While further characterization of these differentiated cells will be essential before transplantation studies commence, these data illustrate the effectiveness of post-natal hair cell explant co-culture, at providing valuable molecular cues for directed differentiation of SCs towards an auditory neuron lineage.

16. **"Auditory stream segregation of tone sequences in cochlear implant listeners".** Cooper, H. R. & Roberts, B.; (2007); Hear Res. 225(1-2):11-24

Previous claims that auditory stream segregation occurs in cochlear implant listeners are based on limited evidence. In experiment 1, eight listeners heard tones presented in a 30-s repeating ABA-sequence, with frequencies matching the centre frequencies of the implant's 22 electrodes. Tone A always stimulated electrode 11 (centre of the array); tone B stimulated one of the others. Tone repetition times (TRTs) from 50 to 200 ms were used. Listeners reported when they heard one or two streams. The proportion of time that each sequence was reported as segregated was consistently greater with increased electrode separation. However, TRT had no significant effect, and the perceptual reversals typical of normal-hearing listeners rarely occurred. The results may reflect channel discrimination rather than stream segregation. In experiment 2, six listeners performed a pitch-ranking task using tone pairs (reference=electrode 11). Listeners reported which tone was higher in pitch (or brighter in timbre) and their confidence in the pitch judgement. Similarities were observed in the individual pattern of results for reported segregation and pitch discrimination. Many implant listeners may show little or no sign of automatic stream segregation owing to the reduced perceptual space within which sounds can differ from one another.

17. **"How I do it/short communication: The middle temporal artery flap for coverage of an exposed cochlear implant cable in the mastoid cavity".** Craig, M. & Lavy, J.; (2006); Cochlear Implants International. 7(4):214-218

A patient who had previously undergone a modified radical mastoidectomy subsequently underwent cochlear implantation with good results. At surgery the mastoid cavity was partially obliterated to provide soft tissue cover for the implant cables. Following local infection the cable became exposed and we used a middle temporal artery local flap to provide cover for the cable. The anatomy of the flap and methods used are described here. The patient continues to have good hearing from the implant with a good coverage over the cable.

18. **"Evaluation of the Parental Perspective instrument for pediatric cochlear implantation to arrive at a short version".** Damen, G. W.; Krabbe, P. F.; Archbold, S. M.; Mylanus, E. A.; (2007); Int J Pediatr Otorhinolaryngol. 71(3):425-433

OBJECTIVE: Evaluation of the well-known and widely used Parental Perspectives questionnaire (PP) by means of statistical analysis and exploring the possibility to develop a short version, as the instrument is often regarded as being rather lengthy with 74 questions. METHODS: One hundred and thirty parents of children participated in this study. To assess internal consistency among the PP items of the domains, Cronbach's alpha coefficients were calculated. Corrected item-total correlations were carried out to investigate the strength of individual items' associations with the construct. Factor analysis was performed to identify the statistical factors of the original PP and in exploring a revised short form PP. RESULTS: Instead of the expected 8-factor structure (eight suggested domains), factor analyses found a 15-factor structure. Nevertheless, when the proposed eight domain structure is followed, some items can be disposed of, based upon the Cronbach's alpha analyses and consistent reasoning. After reducing the number of factors based on standard criteria, a three-domain structure was shown as main concept. The cumulative variance explained by this new model was 39.4% and the final number of items in this probable revised version is 23. Reliability analyses of the new domains of the proposed short version PP (sPP) showed good internal consistency (Cronbach's alpha 0.79). The corrected item-total correlations represent strong individual items' associations with the construct as R items-total varies between 0.34 and 0.64. CONCLUSIONS: The Parental Perspectives instrument (PP) is an important tool to assess the impact of cochlear implantation of a child for the quality of life for the family and the child itself. This statistical investigation showed a possible option for development of a short form usable in prospective follow-up studies.

19. **"Today's indications for cochlear implantation".** Deggouj, N.; Gersdorff, M.; Garin, P.; Castelein, S.; Gerard, J. M.; (2007); B-ENT. 3(1):9-14

Today's indications for cochlear implantation. During the last twenty years, the indications for cochlear implants (CIs) extended significantly due to positive experience with CIs, improved CI technology, and safer surgery. This paper reviews the classical and emerging indications for CIs anno 2007. Providing a postlingually deaf adult with a unilateral CI has been the earliest indication and remains the standard indication. However, CIs are also indicated for prelingually deaf adults, and for children younger than one year old. Recently, CIs are also indicated for adults with residual hearing: when best aided sentence recognition scores in quiet are lower than 70%. CIs for patients with residual hearing sometimes imply the use of a bimodal CI; a device that stimulates the cochlea both electrically and acoustically. Another promising evolution is bilateral implantation. Nowadays, it has also become possible to place a CI in the malformed cochlea. When an auditory nerve is absent or when implantation failed despite a functional device, auditory brainstem implants can restore some form of hearing to the deaf.

20. **"Residual hearing thresholds in cochlear implantation and reimplantation".** Di Nardo, W.; Cantore, I.; Cianfrone, F.; Melillo, P.; Rigante, M.; Paludetti, G.; (2007); Audiol Neurootol. 12(3):165-169

Implant and reimplantation surgery should be carried out with preservation of residual hearing. The aim of this study is to evaluate the effects of such a surgery on hearing threshold. We report the results on 40 patients, 20 males and 20 females, aged between 5 and 70 (mean 29) years, 16 pre-verbal and 24 post-verbal, with measurable pre-operative auditory thresholds. We used the following implants: Advanced Bionics, Med-El, Cochlear, and MXM Digisonic. Four of the patients underwent cochlear reimplantation owing to device failure. A complete insertion was obtained in all patients. Responses to pure-tone stimuli were evaluated in each ear in pre-implant conditions and 3 months after cochlear implant or reimplantation. The explantation was performed with minimal cochlear trauma and preservation of the explanted electrode integrity. 35% showed no change of the hearing threshold, 45% showed a slight worsening of the hearing threshold level in the implanted ear, and 20% had a total loss of residual hearing. Median increases of threshold levels were 10, 5, 10 and 3 dB HL respectively for 125, 250, 500 and 1 kHz. In the group of 4 patients who underwent cochlear reimplantation, 2 showed no variation of the hearing threshold, 1 preserved an appreciable hearing threshold, and 1 had a total loss of residual hearing. The data seem to suggest that hearing function is rather resistant to mechanical trauma during implant and reimplant surgery; the authors hypothesize a role for direct spiral ganglion activation under intense mechanical stimulation.

21. **"Implications of deep electrode insertion on cochlear implant fitting".** Gani, M.; Valentini, G.; Sigrist, A.; Kos, M. I.; Boex, C.; (2007); J Assoc Res Otolaryngol. 8(1):69-83

Using long Med-El Combi40+ electrode arrays, it is now possible to cover the whole range of the cochlea, up to about two turns. Such insertion depths have received little attention. To evaluate the contribution of deeply inserted electrodes, five Med-El cochlear implant users were tested on vowel and consonant identification tests with fittings with first one, two, and up to five apical electrodes being deactivated. In addition, subjects performed pitch-ranking experiments, using loudness-balanced stimuli, to identify electrodes creating pitch confusions. Radiographs were taken to measure each electrode insertion depth. All subjects used each modified fitting for two periods of about 3 weeks. During the experiment, the same stimulation rate and frequency range were maintained across all the fittings used for each individual subject. After each trial period the subject had to perform three consonant and three vowel identification tests. All subjects showed deep electrode insertions ranging from 605 degrees to 720 degrees. The two subjects with the deepest electrode insertions showed significantly increased vowel- and consonant-identification performances with fittings with the two or three most apical electrodes deactivated compared to their standard fitting with all available electrodes activated. The other three subjects did not show significant improvements in performance when one or two of their most apical electrodes were deactivated. Four out of five subjects preferred to continue use of a fitting with one or more apical electrodes deactivated. The two subjects with the deepest insertions also showed pitch confusions between their most apical electrodes. Two possible reasons for these results are discussed. One is to reduce neural interactions related to electrodes producing pitch confusions. Another is to improve the alignment of the frequency components of sounds coded by the electrical signals delivered to each electrode to the overall pitch of the auditory perception produced by the electrical stimulation of auditory nerve fibers.

22. **"A water-resistant speech processor".** Gibson, P.; Capcelea, E.; Darley, I.; Leavens, J.; Parker, J.; (2007); Cochlear Implants International. 7(3):159-166

Cochlear implant systems are used in diverse environments and should function during work, exercise and play as people go about their daily lives. This is a demanding requirement, with exposure to liquid and other contaminant ingress from many sources. For reliability, it is desirable that the speech processor withstands these exposures. This design challenge has been addressed in the Nucleus® Freedom™ speech processor. The Nucleus Freedom speech processor complies with International Standard IEC 60529, as independently certified. Tests include spraying the processor with water followed by immediate verification of functionality including microphone response, radio frequency link and processor controls. The processor has met level IP44 of the Standard.

23. **"The identification of musical instruments through nucleus cochlear implants".** Grasmeder, M. L. & Lutman, M. E.; (2007); Cochlear Implants International. 7(3):148-158

In this study, self-reported ability to recognize musical instruments was investigated by means of a questionnaire, which was sent to a group of adult Nucleus cochlear implant users and a group of normally hearing subjects. In addition, spectrograms and electrodograms were produced and analysed for samples of music played on 10 different musical instruments. Self-reported ability to recognize some instruments was poor in the group of implant users, particularly for the saxophone, tuba and clarinet. Electrodograms showed that these instruments could only be identified using distorted spectral information or reduced temporal information. Other instruments, such as the drum and piano, could be identified using temporal information. Limited spectral resolution makes the recognition of musical instruments difficult for Nucleus implant users.

24. **"Auditory brainstem implantation to rehabilitate profound hearing loss with totally ossified cochleae induced by pneumococcal meningitis".** Grayeli, A. B.; Kalamarides, M.; Bouccara, D.; Ben Gamra, L.; Ambert-Dahan, E.; Sterkers, O.; (2007); Audiol Neurootol. 12(1):27-30

Hearing rehabilitation by cochlear implantation is not always possible in case of total ossification after pneumococcal meningitis. We report 3 cases of postmeningitis profound hearing loss with total cochlear ossification in adults who underwent auditory brainstem implantation (Nucleus 22, Cochlear Inc., Lane Cove, Australia) between 1999 and 2004. The postoperative follow-up period ranged from 1 to 6 years. Eleven to 15 out of 22 electrodes were activated. All patients had significant speech discrimination in the sound-only mode and an enhanced lip-reading performance with the implant. Auditory brainstem implants are an efficient means of auditory rehabilitation and may be considered in selected cases of bilateral profound hearing loss with the impossibility of cochlear implantation.

25. **"Predictors of audiological outcome following cochlear implantation in adults".** Green, K. M.; Bhatt, Y. M.; Mawman, D. J.; O'Driscoll, M. P.; Saeed, S. R.; Ramsden, R. T.; Green, M. W.; (2007); Cochlear Implants Int. 8(1):1-11

The objective of this study was to examine variables that may predict open set speech discrimination following cochlear implantation. It consisted of a retrospective case review conducted in a tertiary referral centre with a cochlear implant programme. The patients were 117 postlingually deafened adult cochlear implant recipients. The main outcome measures were Bench, Kowal, Bamford (BKB) sentence scores recorded nine months following implant activation. The variables studied were age at the time of surgery, sex, duration of hearing loss, aetiology of hearing loss, residual hearing, implant type, speech processor strategy, number of active electrodes inserted. Variables found to have a significant effect on BKB following univariate analysis were entered into a multivariate analysis to determine independent predictors. Multivariate ordinal regression analysis gave an odds ration of 1.09 for each additional year of deafness prior to implantation (confidence interval 1.06-1.13; $p < 0.001$). Duration of deafness prior to implantation is an independent predictor of implant outcome. It accounted for 9% of the variability. Other factors must influence implant performance.

26. **"Vestibular symptoms in children with enlarged vestibular aqueduct anomaly".** Grimmer, J. F. & Hedlund, G.; (2007); Int J Pediatr Otorhinolaryngol. 71(2):275-282

OBJECTIVE: The objective of this study is to describe the vestibular symptoms in pediatric patients with enlarged vestibular aqueduct (EVA) anomaly. METHODS: Retrospective chart review of pediatric and adult patients with EVA anomaly who were treated at the University of Utah Hospital or Primary Children's Medical Center, between 1995 and 2005. Radiographs were reviewed to confirm the diagnosis. Comparisons were made between adult and pediatric patients. RESULTS: Thirty-two patients were included in the study, 17 females and 15 males. Twenty-one patients were under the age of 18 and 11 patients were age 18 or older. On initial audiometric evaluation at a tertiary hospital, the pure tone average in the right ear was 75.0 dB and the pure tone average in the left ear was 80.4 dB. The incidence of vestibular symptoms in adult patients was 45.5% and in pediatric patients was 48.0%. Fourteen patients underwent cochlear implantation. Four patients (28.6%) who previously denied vestibular symptoms experienced post-operative vertigo after cochlear implantation. CONCLUSIONS: About half of the patients with EVA in our series experienced vestibular symptoms. Pediatric patients in our series experienced vertigo and vestibular symptoms with equal frequency when compared to adult patients. Some patients with EVA undergoing cochlear implantation experienced vestibular symptoms in the post-operative period.

27. **"Effects of auditory pathway anatomy and deafness characteristics? (1): On electrically evoked auditory brainstem responses".** Guiraud, J.; Gallego, S.; Arnold, L.; Boyle, P.; Truy, E.; Collet, L.; (2007); Hear Res. 223(1-2):48-60

The purpose of this study was to distinguish the effects of different parameters on latencies of wave IIIe, wave Ve, and interpeak interval IIIe-Ve of electrical auditory brainstem responses (EABRs). EABRs were recorded from all the intra-cochlear electrodes in eight adult HiRes90K((R)) cochlear implant users. The relationship between latencies and stimulation sites in the cochlea was characterized to assess activity along the auditory pathway. Audiograms before implantation, psychophysics at first fitting and duration of deafness were used to describe the influence of deafness on latencies. A decreasing baso-apical latency gradient was found for waves IIIe and Ve, while the interpeak interval IIIe-Ve remained the same along the electrode array. Electrical stimulation enabling to stimulate various parts of the cochlea at the same time, this could indicate an anatomical way of compensating for the delay the acoustic wave takes to reach the cochlea apex in a non-implanted ear. However, psychophysical levels were also found to increase at the cochlear base showing that the latency gradient could result from an increasing gradient of neural degeneration toward the base. Correlations of EABR latencies with psychophysics, audiometric data and duration of deafness show that factors linked to deafness have indeed an influence on EABR latencies. The possible explanations for the latency shift observed, whether they are anatomical and/or pathological, are exposed.

28. **"Simulating auditory and visual sensorineural prostheses: a comparative review".** Hallum, L. E.; Dagnelie, G.; Suaning, G. J.; Lovell, N. H.; (2007); J Neural Eng. 4(1):S58-S71

Microelectronic vision prosthesis proposes to render luminous spots (so-called phosphenes) in the visual field of the otherwise blind subject by way of an implanted array of stimulating electrodes, and in doing so restore some spatial vision. There are now many research teams worldwide working towards a therapeutic device, analogous to the cochlear implant, for the profoundly blind. Despite the similarities between the cochlear implant and vision prostheses, there are few instances in the literature where the two approaches are compared and contrasted with a mind to informing the science and engineering of the latter. This is the focus of the present review; specifically, our interest is psychophysics and signal processing. Firstly, we examine the cochlear implant, and review a handful of psychophysical work: the acoustic simulation of cochlear implants and the method used. We focus on the use of normally hearing subjects (played coloured noise bands or sine waves) as a means of investigating cochlear-implant efficacy and speech processing algorithms. These results provide guidance to vision researchers, for they address the interpretation of simulation data, and flag key areas, such as 'artificial' perception in the presence of noise, that require experimental work in coming years. Secondly, we provide an up-to-date review of the body of analogous psychophysical work: the visual simulation, involving normal observers, of microelectronic vision prosthesis. These simulations allow predictions as to the likely clinical efficacy of the prosthesis; indeed, results to date suggest that a number on the order of 100 implanted electrodes will afford subjects mobility and recognition of faces (and other complex stimuli), while even fewer electrodes facilitate reading printed text and very simple visuomanual tasks. Further, the simulations allow investigations of image and signal processing strategies, plus they provide researchers in the field, and other interested persons, a perceptual experience that approximates what a prosthesis will likely afford implantees.

29. **"Cochlear implants in post-lingually deafened patients".** Hiraumi, H.; Tsuji, J.; Kanemaru, S.; Fujino, K.; Ito, J.; (2007); Acta Otolaryngol Suppl (557):17-21

CONCLUSION: Post-lingually deafened patients had good speech intelligibility scores with cochlear implantation. The age at the operation, duration of deafness, and the number of electrodes outside the cochlea showed only weak correlation with the postoperative performance, which warrants cochlear implantation in elderly patients and patients with a long history of deafness and leaving dummy electrodes outside the cochlea. Patients with cochlear obstruction showed comparable performance to patients with an open cochlea. OBJECTIVE: To evaluate the background and performance of post-lingually deafened cochlear implantation recipients. PATIENTS AND METHODS: Preoperative and intraoperative factors were collected for 109 cochlear implant subjects. Speech intelligibility scores were obtained and the effects of preoperative and intraoperative factors on postoperative performance were evaluated. RESULTS: The average speech intelligibility score was 85.1% for vowels, 41.1% for consonant-vowel (CV) syllables, and 80.4% for phrases. The correlation coefficient between the age at the operation, the duration of deafness, and the number of electrodes outside the cochlea and the postoperative performance was between 0.03 and -0.27. Patients with cochlear obstruction and patients with open cochlea did not show significant differences in speech intelligibility tests. The onset of deafness (progressive vs sudden) did not have an effect on the speech intelligibility test.

30. **"Indication for the need of flexible and frequency specific mapping functions in cochlear implant speech processors".** Hoth, S.; (2007); Eur Arch Otorhinolaryngol. 264(2):129-138

Categorical loudness scaling of electric and acoustic stimuli was performed in cochlear implant (CI) recipients equipped with Nucleustrade mark systems in order to achieve a normal loudness perception in the whole dynamic range of acoustic input. For each electrode, the lower and upper limits of electric stimulus were defined by the values corresponding to "very soft" and "too loud". Within this dynamic range, the stimulus strength intervals associated to the verbal categories "soft", "medium", "loud" and "very loud" were determined. The same loudness categories were used for the scaling of acoustic stimuli. From both scaling experiments, the transduction of the CI system can be assessed and the parameters of the individual mapping function yielding a normal loudness growth can be derived. Deviations from optimum mapping can be corrected at least partially by manipulating the parameters of the mapping function. In many cases, however, one mapping function is not sufficient for all channels. The results argue in favour of the development of flexible and channel-specific mapping function parameters in future CI systems.

31. **"Selectivity of neural stimulation in the auditory system: a comparison of optic and electric stimuli".** Izzo, A. D.; Suh, E.; Pathria, J.; Walsh, J. T.; Whitlon, D. S.; Richter, C. P.; (2007); J Biomed Opt. 12(2):021008

Pulsed, mid-infrared lasers were recently investigated as a method to stimulate neural activity. There are significant benefits of optically stimulating nerves over electrically stimulating, in particular the application of more spatially confined neural stimulation. We report results from experiments in which the gerbil auditory system was stimulated by optical radiation, acoustic tones, or electric current. Immunohistochemical staining for the protein c-FOS revealed the spread of excitation. We demonstrate a spatially selective activation of neurons using a laser; only neurons in the direct optical path are stimulated. This pattern of c-FOS labeling is in contrast to that after electrical stimulation. Electrical stimulation leads to a large, more spatially extended population of labeled, activated neurons. In the auditory system, optical stimulation of nerves could have a significant impact on the performance of cochlear implants, which can be limited by the electric current spread.

32. **"Electrically evoked auditory steady-state responses in guinea pigs".** Jeng, F. C.; Abbas, P. J.; Brown, C. J.; Miller, C. A.; Nourski, K. V.; Robinson, B. K.; (2007); Audiol Neurootol. 12(2):101-112

Most cochlear implant systems available today provide the user with information about the envelope of the speech signal. The goal of this study was to explore the feasibility of recording electrically evoked auditory steady-state response (ESSR) and in particular to evaluate the degree to which the response recorded using electrical stimulation could be separated from stimulus artifact. Sinusoidally amplitude-modulated electrical stimuli with alternating polarities were used to elicit the response in adult guinea pigs. Separation of the stimulus artifact from evoked neural responses was achieved by summing alternating polarity responses or by using spectral analysis techniques. The recorded response exhibited physiological response properties including a pattern of nonlinear growth and their abolishment following euthanasia or administration of tetrodotoxin. These findings demonstrate that the ESSR is a response generated by the auditory system and can be separated from electrical stimulus artifact. As it is evoked by a stimulus that shares important features of cochlear implant stimulation, this evoked potential may be useful in either clinical or basic research efforts.

33. **"Professional occupation after cochlear implantation".** Kos, M. I.; Degive, C.; Boex, C.; Guyot, J. P.; (2007); J Laryngol Otol. 121(3):215-218

The aims of this study were to verify whether cochlear implants helped profoundly deaf adults to maintain or even to develop their professional occupations, and to identify other elements that may contribute to or, on the contrary, impede such patients' professional success. All adult patients received a questionnaire concerning their professional activities before and after implantation. Demographic data, health information, hearing performance and degree of satisfaction with the implant were also considered. Sixty-seven adults had been implanted, with three different devices, since 1985. At the time of implantation, 34 had been professionally active. After implantation, 29 had remained professionally active, four of whom reported positive developments in their careers. Five patients had become professionally inactive. Those patients who had previously been professionally inactive remained so. There had been no difference in performance, either between different types of cochlear implants or between professionally active or inactive patients. The implanted patients had kept their jobs and many of them had developed their professional skills. In spite of this, cochlear implants may still be perceived as proving insufficiently satisfactory hearing to enable professionally inactive patients to reintegrate and to facilitate further learning or career developments.

34. **"[Cochlear implantation in children]".** Kronenberg, J.; Hildesheimer, M.; Taitelbaum-Swead, R.; Migirov, L.; (2007); Harefuah. 146(2):102-5, 166

The pediatric cochlear implant program was launched in our department in 1990. A year earlier, we began the cochlear implant program in our center. Cochlear implant surgery changed the life of implanted children by enabling integration into the regular education program. The experience of the Sheba Medical Center is presented in 286 children who were operated on between the years 1990-2005. Hearing results were examined using questionnaires and designated audiology tests. Improvement in the hearing ability of implanted children was noted, especially in those who underwent implantations in their first years of life and in those who had previous experience using hearing aids. Post-operative complications were scanty and similar to those reported in the literature. The incidence of device failure is decreasing over the years due to production improvement. The frequency of electronic failure was found to be similar to those described in the literature.

35. **"The suprameatal approach: An alternative surgical technique for cochlear implantation".** Kronenberg, J. & Migirov, L.; (2007); Cochlear Implants International. 7(3):142-147

The suprameatal approach (SMA) for cochlear implantation was developed in our department in 1999. This technique is based on retroauricular tympanotomy and does not include mastoidectomy. The SMA eliminates possible injury to the facial nerve and chorda tympani, shortens operative time, enables easier drilling of cochleostomy and better control of the electrode insertion, permits the preservation of residual hearing and improves the aesthetic results.

36. **"On the structure of phoneme categories in listeners with cochlear implants".** Lane, H.; Denny, M.; Guenther, F. H.; Hanson, H. M.; Marrone, N.; Matthies, M. L.; Perkell, J. S.; Stockmann, E.; Tiede, M.; Vick, J.; Zandipour, M.; (2007); Journal of Speech, Language, and Hearing Research. 50(1):2-14

Purpose To describe cochlear implant users' phoneme labeling, discrimination, and prototypes for a vowel and a sibilant contrast, and to assess the effects of 1 year's experience with prosthetic hearing. Method Based on naturally produced clear examples of "boot," "beet," "said," and "shed" by 1 male and 1 female speaker, continua with 13 stimuli were synthesized for each contrast. Seven hearing controls labeled those stimuli and assigned them goodness ratings, as did 7 implant users at 1-month postimplant. One year later, these measures were repeated, and within category discrimination, d', was assessed. Results Compared with controls, implant users' vowel and sibilant labeling slopes were substantially shallower but improved over 1 year of prosthesis use. Their sensitivity to phonetic differences within phoneme categories was about half that of controls. The slopes of their goodness rating functions were shallower and did not improve. Their prototypes for the sibilant contrast (but not the vowels) were closer to one another and did not improve by moving apart. Conclusions Implant users' phoneme labeling and within-category perceptual structure were anomalous at 1-month postimplant. After 1 year of prosthesis use, phoneme labeling categories had sharpened but within category discrimination was well below that of hearing controls.

37. **"Scalar localization of the electrode array after cochlear implantation: a cadaveric validation study comparing 64-slice multidetector computed tomography with microcomputed tomography".** Lane, J. I.; Driscoll, C. L.; Witte, R. J.; Primak, A.; Lindell, E. P.; (2007); Otol Neurotol. 28(2):191-194

HYPOTHESIS: Improved resolution available with 64-slice multidetector computed tomography (MDCT) could potentially be used clinically to localize the cochlear implant (CI) electrode array within the basal turn. BACKGROUND: In CI surgery, the electrode array should be inserted into and remain within the scala tympani to avoid injury to Reissner's membrane and the scala media. Correlating the position of the electrode in the basal turn with surgical technique and implant design could be helpful in improving outcomes. METHODS: After a standard left mastoid exposure of the round window niche through the facial recess performed on a cadaver head, an electrode array from a Nucleus Softip Contour CI was fully inserted through a cochleostomy. The head was then scanned axially on a 64-slice MDCT with 0.4-mm slice thickness and reconstructed into the oblique axial, oblique coronal, and oblique sagittal planes of the cochlea. The temporal bone was then harvested and imaged on a microcomputed tomographic scanner using

20-microm slice thickness. Identical reconstructions were made and compared with the 64-slice images to confirm exact location of the electrode array. RESULTS: The 64-slice MDCT accurately localized the electrode array to the scala tympani. This was best demonstrated in the oblique sagittal plane, identifying the electrode array in the posterior inferior portion of the basal turn, posterior to the spiral lamina. CONCLUSION: This ex vivo validation study suggests that 64-slice MDCT has the potential to allow accurate localization of the CI electrode array within the basal turn of the cochlea.

38. **"Prosody and voice characteristics of children with cochlear implants".** Lenden, J. M. & Flipsen, P.; (2007); J Commun Disord. 40(1):66-81

This descriptive, longitudinal study involved the analysis of the prosody and voice characteristics of conversational speech produced by six young children with severe to profound hearing impairments who had been fitted with cochlear implants. A total of 40 samples were analyzed using the Prosody-Voice Screening Profile (PVSP; Shriberg, L. D., Kwiatkowski, J., & Rasmussen, C. (1990). Prosody-Voice Screening Profile (PVSP). Tuscon, AZ: Communication Skill Builders). Overall, the children presented with noticeable problems with stress and resonance quality. There were some difficulties noted with rate, loudness, and laryngeal quality, but there were no consistent difficulties with phrasing or pitch. This suggested that prosody and voice characteristics in this population are different from those typically observed in children with severe to profound hearing impairments though some problem areas remain. Some developmental trends were also observed. These findings suggest that cochlear implants offer some significant benefits to children with hearing impairment in terms of prosody and voice outcomes.

39. **"Perceptual adaptation to spectrally shifted vowels: training with nonlexical labels".** Li, T. & Fu, Q. J.; (2007); J Assoc Res Otolaryngol. 8(1):32-41

Although normal-hearing (NH) and cochlear implant (CI) listeners are able to adapt to spectrally shifted speech to some degree, auditory training has been shown to provide more complete and/or accelerated adaptation. However, it is unclear whether listeners use auditory and visual feedback to improve discrimination of speech stimuli, or to learn the identity of speech stimuli. The present study investigated the effects of training with lexical and nonlexical labels on NH listeners' perceptual adaptation to spectrally degraded and spectrally shifted vowels. An eight-channel sine wave vocoder was used to simulate CI speech processing. Two degrees of spectral shift (moderate and severe shift) were studied with three training paradigms, including training with lexical labels (i.e., "hayed," "had," "who'd," etc.), training with nonlexical labels (i.e., randomly assigned letters "f," "b," "g," etc.), and repeated testing with lexical labels (i.e., "test-only" paradigm without feedback). All training and testing was conducted over 5 consecutive days, with two to four training exercises per day. Results showed that with the test-only paradigm, lexically labeled vowel recognition significantly improved for moderately shifted vowels; however, there was no significant improvement for severely shifted vowels. Training with nonlexical labels significantly improved the recognition of nonlexically labeled vowels for both shift conditions; however, this improvement failed to generalize to lexically labeled vowel recognition with severely shifted vowels. Training with lexical labels significantly improved lexically labeled vowel recognition with severely shifted vowels. These results suggest that storage and retrieval of speech patterns in the central nervous system is somewhat robust to tonotopic distortion and spectral degradation. Although training with nonlexical labels may improve discrimination of spectrally distorted peripheral patterns, lexically meaningful feedback is needed to identify these peripheral patterns. The results also suggest that training with lexically meaningful feedback may be beneficial to CI users, especially patients with shallow electrode insertion depths.

40. **"Acoustic analysis of the speech of children with cochlear implants: a longitudinal study".** Liker, M.; Mildner, V.; Sindija, B.; (2007); Clin Linguist Phon. 21(1):1-11

The aim of the study was to analyse the speech of the children with cochlear implants, and compare it with the speech of hearing controls. We focused on three categories of Croatian sounds: vowels (F1 and F2 frequencies), fricatives (noise frequencies of /s/ and /S/), and affricates (total duration and the pattern of stop-fricative components in /ts/ and /tS/). Eighteen implanted children, aged between 9;5 and 15;2 years participated in the study. All had been profoundly hearing impaired before implantation. Three recordings per child were made over a 20-month period. The hearing controls were matched for age and sex. Implanted children had a smaller and fronted vowel space, their /s/ and /S/ noise frequencies overlapped, affricates were longer, with a high proportion of incorrect productions and substitutions. With time, there was a small but steady overall improvement in all categories. Early intervention (rehabilitation and implantation) are crucial for good speech acquisition.

41. **"Estimation of vowel recognition with cochlear implant simulations".** Liu, C. & Fu, Q. J.; (2007); IEEE Trans Biomed Eng. 54(1):74-81

Because there are many parameters in the cochlear implant (CI) device that can be optimized for individual patients, it is important to estimate a parameter's effect before patient evaluation. In this paper, Mel-frequency cepstrum coefficients (MFCCs) were used to estimate the acoustic vowel space for vowel stimuli processed by the CI simulations. The acoustic space was then compared to vowel recognition performance by normal-hearing subjects listening to the same processed speech. Five CI speech processor parameters were simulated to produce different degree of spectral resolution, spectral smearing, spectral warping, spectral shifting, and amplitude distortion. The acoustic vowel space was highly correlated with normal hearing subjects' vowel recognition performance for parameters that affected the spectral channels and spectral smearing. However, the acoustic vowel space was not significantly correlated with perceptual performance for parameters that affected the degree of spectral warping, spectral shifting, and amplitude distortion. In particular, while spectral warping and shifting did not significantly reshape the acoustic space, vowel recognition performance was significantly affected by these parameters. The results from the acoustic analysis suggest that the CI device can preserve phonetic distinctions under conditions of spectral warping and shifting. Auditory training may help CI patients better perceive these speech cues transmitted by their speech processors.

42. **"[Cochlear implantation in children with otitis media: third stage of a long-term prospective study]".** Luntz, M.; Khalaila, J.; Brodsky, A.; Shpak, T.; (2007); Harefuah. 146(2):106-10, 166

INTRODUCTION: The age at which cochlear implantation (CI) is performed in children generally corresponds to the age at which the prevalence of otitis media (OM) is highest. The risks of problematic middle ear infection and of potential spread of middle ear infection along the electrode array into the cochlea and the central nervous system are relatively high. Thus, it is necessary to establish a practicable protocol aimed at controlling OM prior to and after CI in young candidates. OBJECTIVE: To assess the risk for otitis media after cochlear implantation in otitis media (OM)-prone and non-OM-prone children who were treated according to a structured protocol designed to control OM prior to implantation. PATIENTS AND METHODS: Of 113 children referred for cochlear implantation during the study period, and were implanted under the age of 7 years, 70 were classified as OM-prone (Group A) and 43 as non-OM-prone (group B). Group A patients were managed according to a structured protocol aimed at pre-implantation control of OM. Postimplantation follow-up ranged from 6 to 75 months (average 35.5 months). RESULTS: In the OM-prone group of children, the mean age at referral and at implantation was significantly lower and the mean interval between referral and implantation significantly higher than in the healthy group. During the first month after implantation 18 children suffered from acute otitis media, the vast majority of them (16) belonged to the OM-prone children (22.8% of this group) and 2 subjects belonged to the non-OM-prone children (4.6% of this group). During the late post-operative period 28 of the OM-prone children (40%) and 4 of the non-OM-prone children (9.3%) developed acute OM in the implanted ear. Eleven (9.7 %) of these cases, (10 belonging to the OM-prone group B (14%), and one belonging to the non-OM-prone group A (2.3%)) proved to be recurrent and therapeutically challenging. Three subjects developed acute mastoiditis without intracranial complications. Each episode of mastoiditis or otitis media was controlled conservatively without any need of surgical drainage of the mastoid. This group of challenging cases did not differ from the OM-prone children who did not prove to be OM-challenging post-CI in regards to age at referral, age at CI and average number of ventilation tube (VT) operations prior to CI. Most pathogen isolations (65%) from OM or from VT drainage developed after CI were typical pathogens for acute otitis media (AOM). However, the percentage of non-typical AOM pathogen isolation increased with time after CI. CONCLUSIONS: Early referral led to early implantation, even in children susceptible to OM. The incidence of OM decreased after implantation in both groups, but was still significantly higher in the OM-prone group. Meanwhile, prior to CI it is not possible to predict the cases that become therapeutically challenging at a later stage.

43. **"A dual-process integrator-resonator model of the electrically stimulated human auditory nerve".** Macherey, O.; Carlyon, R. P.; van Wieringen, A.; Wouters, J.; (2007); J Assoc Res Otolaryngol. 8(1):84-104

A phenomenological dual-process model of the electrically stimulated human auditory nerve is presented and compared to threshold and loudness data from cochlear implant users. The auditory nerve is modeled as two parallel processes derived from linearized equations of conductance-based models. The first process is an integrator, which dominates stimulation for short-phase duration biphasic pulses and high-frequency sinusoidal stimuli. It has a relatively short time constant (0.094 ms) arising from the passive properties of the membrane. The second process is a resonator, which induces nonmonotonic functions of threshold vs frequency with minima around 80 Hz. The ion channel responsible for this trend has a relatively large relaxation time constant of about 1 ms. Membrane noise is modeled as a Gaussian noise, and loudness sensation is assumed to relate to the probability of firing of a neuron during a 20-ms rectangular window. Experimental psychophysical results obtained in seven previously published studies can be interpreted with this model. The model also provides a physiologically based account of the nonmonotonic threshold vs frequency functions observed in biphasic and sinusoidal stimulation, the large threshold decrease obtained with biphasic pulses having a relatively long inter-phase gap and the effects of asymmetric pulses.

44. **"Atraumatic surgical approach to the cochlea with a micromanipulator".** Manrique, M. J.; Savall, J.; Cervera-Paz, F. J.; Rey, J.; Der, C.; Echeverria, M.; Ares, M.; (2007); Acta Otolaryngol. 127(2):122-131

CONCLUSIONS. Our design and preliminary results show that the the micromanipulator could be a great help to the surgeon in the atraumatic surgical approach to the lateral wall of the cochlea at the promontory. OBJECTIVES. Hearing preservation in cochlear implant opens new frontiers in the treatment of sensorineural hearing loss. To preserve the membranous labyrinth intact, new surgical tools are needed, either for cochlear implantation or for other applications. The objectives of this study were to design and test a micromanipulator coupled to a drilling tool for the atraumatic exposure of the spiral ligament. The micromanipulator is designed to increase precision when drilling the otic capsule bone. MATERIALS AND METHODS. A group from the University of Navarra worked on the device design -- based on a compliant mechanism -- and in vitro test. The components and functioning of the micromanipulator are described. It was tested in 10 formalinized temporal bones after a mastoidectomy, a posterior tympanotomy, and a transcanal tympanotomy were performed. The micromanipulator was placed over the cranial surface, and used to expose the endostium, anteriorly to the round window niche. RESULTS. A combined approach through the external auditory canal was feasible, together with a posterior tympanotomy to visually control the work and make complementary manoeuvres. Drilling was easy, and visual control through the posterior tympanotomy was excellent. A high degree of drilling precision was achieved. A little disruption of the membranous labyrinth was found only in the first bone of the series.

45. **"Can the acoustic change complex be recorded in an individual with a cochlear implant? Separating neural responses from cochlear implant artifact".** Martin, B. A.; (2007); J Am Acad Audiol. 18(2):126-140

The purpose of this case study was to determine whether the P1-N1-P2 acoustic change complex (ACC) could be recorded in an individual with a cochlear implant. In a cochlear implant recipient, stimulus-related artifact from the implant can overlap the evoked potential of interest, making it difficult to determine whether the recorded response is neural or a simple reflection of the artifact. This is an even greater technical challenge for the ACC because stimuli having relatively long durations are used. The subject was a 24-year-old with a diagnosis of auditory neuropathy/auditory dys-synchrony and used a MED-EL Tempo+ cochlear implant in her left ear. The ACC was recorded to synthetic vowels containing a change of F2 at midpoint ranging from 0 (no change) to 1200 Hz (perceived as /ui/). The stimuli were presented randomly at 75 dB SPL via a loudspeaker. In one condition the subject ignored the stimuli and watched a captioned video. In the other, the subject pressed one button on a response pad if she perceived an acoustic change at stimulus midpoint and another if she did not. Cortical auditory evoked potentials were recorded from 32 scalp electrodes. Results indicated that the ACC was present and could be teased apart from the cochlear implant stimulus artifact. ACC thresholds showed good agreement with behavioral discrimination performance, and therefore, results are positive for the potential clinical application of the ACC technique to individuals with cochlear implants.

46. **"Effects of elicitation task variables on speech production by children with cochlear implants".** McCleary, E. A.; Ide-Helvie, D. L.; Lotto, A. J.; Carney, A. E.; Higgins, M. B.; (2007); Journal of Speech, Language, and Hearing Research. 50(1):83-96

Given the interest in comparing speech production development in children with normal hearing and hearing impairment, it is important to evaluate how variables within speech elicitation tasks can differentially affect the acoustics of speech production for these groups. In a first experiment, children (6-14 years old) with cochlear implants produced a set of monosyllabic words either in isolation or while simultaneously signing the word. Acoustical analyses indicated no change in word duration, voice onset time, intensity, or fundamental frequency between isolated and simultaneous signing conditions. In a second experiment, the same children verbally repeated words that were signed by a video model. The model either signed with inflection or without. Words repeated after inflected models were higher in fundamental frequency and intensity and were more intelligible. In addition, children with poorer speech perception skills sometimes produced the monosyllables as 2 syllables, but this only occurred for words that had multiple sign movements. The results have implications for the comparison of speech development between children with normal hearing and those with hearing impairment.

47. **"Surgical and medical complications in paediatric cochlear implantation: A review of 300 cases".** Migirov, L.; Muchnik, C.; Kaplan-Neeman, R.; Kronenberg, J.; (2006); Cochlear Implants International. 7(4):194-201

The aim of the study was to investigate an incidence of surgical and medical complications in different age groups of cochlear implant children. A retrospective study design was used. Patients' medical records were reviewed for age at the time of implantation, cause of deafness and complications. The incidence of complications was compared between the young (aged up to 2 years, n = 61) and older children (aged 216 years, n = 239). Some 300 paediatric cochlear implantations were performed in our department between January 1993 and March 2005. Major complications, such as facial nerve paralysis, electrode misplacement, foreign body reaction, flap breakdown, protrusion of the positioner and cholesteatoma were rare (3%). Disequilibrium was found to be the most common complication, followed by wound problems and mastoiditis without significant differences between the two groups. However, magnet or receiver-stimulator displacement were more common in the young children ($p = 0.028$). Most surgical and medical complications could be treated successfully, and only 2% required explantation of the device. Generally, operating on a child aged under 2 years was not particularly different from operating on an older child.

48. **"Revision surgeries in cochlear implant patients: a review of 45 cases".** Migirov, L.; Taitelbaum-Swead, R.; Hildesheimer, M.; Kronenberg, J.; (2007); Eur Arch Otorhinolaryngol. 264(1):3-7

The aim of this study was to analyze the causes for revision procedures, surgical findings and audiological outcome in reoperated cochlear implant patients. The medical records of 45 patients were reviewed retrospectively for age at the time of implantation, the implant was used for initial and revision surgeries, the duration of implant use before revision, surgical findings, and postoperative audiological results. Generally, children were reoperated more often than adults (12.5 vs. 6.9%) and, with one exception of improper electrode insertion, there were no major post-revision complications. Device failure (DF) was the main cause for revision surgery (23/45) followed by wound/flap problems, magnet/receiver-stimulator displacement, foreign body/allergic reaction, subperiosteal abscess, misplaced electrode, intractable vertigo, cholesteatoma and extrusion of the positioner. No significant difference was found in the rate of DF between children and adults for each implant separately (P = 0.289 for Nucleus 22, P = 0.355 for Nucleus 24, P = 0.683 for Clarion and P = 1.0 for Med-El). The failure rates of different implants did not differed significantly among adults. DF in the Clarion group was significantly higher compared to the Nucleus and Med-El combined for pediatric patients (P = 0.0218) and all CI recipients (adults + children; P = 0.0055). The post-revision audiological benefit was unchanged or improved compared to the initial implantation values in all reimplanted patients and was not influenced by minor surgical procedures (wound revision, drainage of any collection, magnet replacement, or relocation of receiver-stimulator). Since DF was found to be the most common cause for reoperation, improving device technology could prevent the vast majority of revision procedures.

49. **"Implication of central asymmetry in speech processing on selecting the ear for cochlear implantation".** Morris, L. G.; Mallur, P. S.; Roland, J. T.; Waltzman, S. B.; Lalwani, A. K.; (2007); Otol Neurotol. 28(1):25-30

OBJECTIVE: Emerging evidence in auditory neuroscience suggests that central auditory pathways process speech asymmetrically. In concert with left cortical specialization for speech, a "right-ear advantage" in speech perception has been identified. The purpose of this study is to determine if this central asymmetry in speech processing has implications for selecting the ear for cochlear implantation. STUDY DESIGN: Retrospective cohort study. SETTING: Academic university medical center PATIENTS: One hundred one adults with bilateral severe-to-profound sensorineural hearing loss INTERVENTION: Cochlear implantation with the Nucleus 24 Contour device. MAIN OUTCOME MEASUREMENTS: Patients were divided into two groups according to the ear implanted. Results were compared between left-ear- and right-ear-implanted patients. Further subgroup analysis was undertaken, limited to right-handed patients. Postoperative improvement on audiograms and scores on speech perception tests (Hearing in Noise test, City University of New York in quiet and in noise test, Consonant-Vowel Nucleus- Consonant words, and phonemes) at 1 year was compared between groups. Analysis of covariance was used to control for any intergroup differences in preoperative characteristics. RESULTS: The groups were matched in age, duration of hearing loss, duration of hearing aid use, percentage implanted in the better hearing ear, and preoperative audiologic testing. Postoperatively, there were no differences between left-ear- and right-ear-implanted patients in improvement on speech recognition tests. CONCLUSION: Despite central asymmetry in speech processing, our data do not support a right-ear advantage in speech perception outcomes with cochlear implantation. Therefore, among the many factors in choosing the ear for cochlear implantation, central asymmetry in speech processing does not seem to be a contributor to postoperative speech recognition outcomes.

50. **"The effect of Gaussian noise on the threshold, dynamic range, and loudness of analogue cochlear implant stimuli".** Morse, R. P.; Morse, P. F.; Nunn, T. B.; Archer, K. A.; Boyle, P.; (2007); J Assoc Res Otolaryngol. 8(1):42-53

The deliberate addition of Gaussian noise to cochlear implant signals has previously been proposed to enhance the time coding of signals by the cochlear nerve. Potentially, the addition of an inaudible level of noise could also have secondary benefits: it could lower the threshold to the information-bearing signal, and by desynchronization of nerve discharges, it could increase the level at which the information-bearing signal becomes uncomfortable. Both these effects would lead to an increased dynamic range, which might be expected to enhance speech comprehension and make the choice of cochlear implant compression parameters less critical (as with a wider dynamic range, small changes in the parameters would have less effect on loudness). The hypothesized secondary effects were investigated with eight users of the Clarion cochlear implant; the stimulation was analogue and monopolar. For presentations in noise, noise at 95% of the threshold level was applied simultaneously and independently to all the electrodes. The noise was found in two-alternative forced-choice (2AFC) experiments to decrease the threshold to sinusoidal stimuli (100 Hz, 1 kHz, 5 kHz) by about 2.0 dB and increase the dynamic range by 0.7 dB. Furthermore, in 2AFC loudness balance experiments, noise was found to decrease the loudness of moderate to intense stimuli. This suggests that loudness is partially coded by the degree of phase-locking of cochlear nerve fibers. The overall gain in dynamic range was modest, and more complex noise strategies, for example, using inhibition between the noise sources, may be required to get a clinically useful benefit.

51. **"Cochlear implantation and far-advanced otosclerosis".** Mosnier, I.; Bouccara, D.; Ambert-Dahan, E.; Ferrary, E.; Sterkers, O.; (2007); Adv Otorhinolaryngol. 65(323-327

OBJECTIVE: To evaluate results of cochlear implantation in patients with far-advanced otosclerosis. METHODS: Sixteen patients with far-advanced otosclerosis had undergone unilateral (n = 13) or bilateral (n = 3) cochlear implantation. Surgical difficulties, incidence of complications and postoperative benefit were analyzed. RESULTS: A full electrode insertion was achieved in all patients without surgical difficulties. All patients demonstrated excellent benefit of cochlear implantation. Binaural implantation still improves speech performances, compared to unilateral implantation. In case of residual cochlear function of one nonoperated side, a stapes surgery, performed during the same surgical time as cochlear implantation, can improve speech scores and restore bilateral hearing. Facial nerve stimulation occurred only in 1 patient. CONCLUSION: Cochlear implantation is the method of choice for rehabilitation of patients with otosclerosis, presenting profound or total hearing loss. Patients obtain excellent benefit with a low rate of complications.

52. **"Educational performance of pediatric cochlear implant recipients in mainstream classes".** Mukari, S. Z.; Ling, L. N.; Ghani, H. A.; (2007); Int J Pediatr Otorhinolaryngol. 71(2):231-240

OBJECTIVES: The present study documents the school performance of 20 pediatric cochlear implant recipients who attended mainstream classes and compares their educational performance with their normally hearing peers. METHODOLOGY: All 20 school-aged children who underwent cochlear implantation at the Universiti Kebangsaan Malaysia cochlear implant programme participated in this study. Three measures were employed to assess the school performance. First, using the SIFTER teacher-rating scale, the second measure was the child's examination results, and the third was the child's standing compared to his/her peers in language subject, mathematics, and the overall academic performance during the end of semester examinations. RESULTS: The SIFTER rating scale indicated that only 11.8% of the children were identified as not educationally at risk, 17.6% passed four of the SIFTER subtests, whereas the other 71.6% failed in at least two of the subtests on SIFTER. The highest pass rate was obtained in behavior subtest (76.5%), followed by classroom participation (70.6%), attention (58.8%), academic (47.1%), and communication (11.8%). On the educational performance, the cochlear implant recipients performed significantly better in mathematics (mean scores 62.67%; S.D. 22.24) than in language (mean scores 49.96%, S.D. 25.88) ($p<0.01$). In the overall examination performance, 25.00% had above average performance (>75th percentile), 18.75% had average performance (25-75th percentile), and another 56.25% performed at below average (<25th percentile). CONCLUSION: Children with cochlear implant were rated poorly in the SIFTER communication subtest. It is possible that language deficit presents an educational challenge in these children. The educational performance of children with cochlear implants in mainstream classes varies. Although 43.75% of them thrive well in a full-time mainstream setting, a significant percentage of them (56.25%) performed at below the average level. These findings reemphasize that although a cochlear implant has successfully provided deaf children with a good hearing potential, the majority of its recipients still require additional educational supports in order to function well in the mainstream educational setting.

53. **"Sound-direction identification with bilateral cochlear implants".** Neuman, A. C.; Haravon, A.; Sislian, N.; Waltzman, S. B.; (2007); Ear Hear. 28(1):73-82

OBJECTIVE: The purpose of this study was to compare the accuracy of sound-direction identification in the horizontal plane by bilateral cochlear implant users when localization was measured with pink noise and with speech stimuli. DESIGN: Eight adults who were bilateral users of Nucleus 24 Contour devices participated in the study. All had received implants in both ears in a single surgery. Sound-direction identification was measured in a large classroom by using a nine-loudspeaker array. Localization was tested in three listening conditions (bilateral cochlear implants, left cochlear implant, and right cochlear implant), using two different stimuli (a speech stimulus and pink noise bursts) in a repeated-measures design. RESULTS: Sound-direction identification accuracy was significantly better when using two implants than when using a single implant. The mean root-mean-square error was 29 degrees for the bilateral condition, 54 degrees for the left cochlear implant, and 46.5 degrees for the right cochlear implant condition. Unilateral accuracy was similar for right cochlear implant and left cochlear implant performance. Sound-direction identification performance was similar for speech and pink noise stimuli. CONCLUSIONS: The data obtained in this study add to the growing body of evidence that sound-direction identification with bilateral cochlear implants is better than with a single implant. The similarity in localization performance obtained with the speech and pink noise supports the use of either stimulus for measuring sound-direction identification.

54. **"A case of cochlear implant with internal mechanical failure".** Ohno, T.; Iki, T.; Taniguchi, A.; Fujiki, N.; Ohta, K.; Ito, J.; (2007); Acta Otolaryngol Suppl557):15-16

Cochlear implantation has been performed since the 1970s and has been proven to be an effective treatment for profoundly deaf people. In some cases re-implantation has also been reported due to trauma causing implant damage, mechanical failure, extrusion, and wound infections, or device upgrade. We present a case of a 9-year-old boy with a cochlear implant in which mechanical failure occurred after a blow to his temporal region. The clinical presentation and radiographic imaging findings suggested that the cause of mechanical failure was internal failure. We performed cochlear re-implantation to the same ear and it worked well. The explanted device analysis by the manufacturer concluded that the device had failed due to a cracked hybrid integrated circuit.

55. **"Evaluation of companding-based spectral enhancement using simulated cochlear-implant processing".** Oxenham, A. J.; Simonson, A. M.; Turicchia, L.; Sarpeshkar, R.; (2007); J Acoust Soc Am. 121(3):1709-1716

This study tested a time-domain spectral enhancement algorithm that was recently proposed by Turicchia and Sarpeshkar [IEEE Trans. Speech Audio Proc. 13, 243-253 (2005)]. The algorithm uses a filter bank, with each filter channel comprising broadly tuned amplitude compression, followed by more narrowly tuned expansion (companding). Normal-hearing listeners were tested in their ability to recognize sentences processed through a noise-excited envelope vocoder that simulates aspects of cochlear-implant processing. The sentences were presented in a steady background noise at signal-to-noise ratios of 0, 3, and 6 dB and were either passed directly through an envelope vocoder, or were first processed by the companding algorithm. Using an eight-channel envelope vocoder, companding produced small but significant improvements in speech reception. Parametric variations of the companding algorithm showed that the improvement in intelligibility was robust to changes in filter tuning, whereas decreases in the time constants resulted in a decrease in intelligibility. Companding continued to provide a benefit when the number of vocoder frequency channels was increased to sixteen. When integrated within a sixteen-channel cochlear-implant simulator, companding also led to significant improvements in sentence recognition. Thus, companding may represent a readily implementable way to provide some speech recognition benefits to current cochlear-implant users.

56. **"Hearing loss diagnosis followed by meningitis in Danish children, 1995-2004".** Parner, E. T.; Reefhuis, J.; Schendel, D.; Thomsen, J. L.; Ovesen, T.; Thorsen, P.; (2007); Otolaryngol Head Neck Surg. 136(3):428-433

OBJECTIVE: A higher risk of meningitis associated with cochlear implants may be explained in part by a generally higher risk of meningitis in children with severe to profound hearing loss. We investigated whether children with hearing loss have an increased risk of meningitis. STUDY DESIGN AND SETTING: A historical cohort study of all children born in Denmark between January 1, 1995, and December 31, 2004, was conducted. The cohort was selected through the Danish Medical Birth Registry, and information on hearing loss and meningitis was obtained from the National Hospital Registry. RESULTS: We identified 39 children with both hearing loss and meningitis. Of these children, five were diagnosed first with hearing loss and later with meningitis. The relative risk of meningitis in the group of children with a hearing loss diagnosis, as compared with the non-hearing loss group, was 5.0 (95% CI, 2.0 to 12.0). CONCLUSIONS: The study provides evidence for an association between hearing loss and the development of meningitis. Parents and health care providers of children with hearing loss should be more alert for possible signs and symptoms of meningitis, and vaccination should be considered.

57. **"Cochlear implantations in children with Waardenburg syndrome: An electrophysiological and psychophysical review".** Pau, H.; Gibson, W. P. R.; Gardner-Berry, K.; Sanli, H.; (2006); Cochlear Implants International. 7(4):202-206

Waardenburg syndrome presents with dystopia canthorum, pigmentary abnormalities of hair, iris and skin (often a white forelock and heterochromia iridis) and sensorineural deafness. The authors review the electrophysiological and psychophysical findings of implanted children with Waardenburg syndrome at the Sydney Cochlear Implant Centre. Twenty children with Waardenburg syndrome received cochlear implants between 1985 and 2001. Electrical auditory brainstem response (EABR) was performed in all of these patients intra-operatively as part of the routine investigations. Only 13 of these patients were assessed one year or more post-operatively by means of the Melbourne Categories (0-7). Four patients (20%) were found to have abnormal EABR recordings. The mode of Melbourne Categories in this group (n = 3) was 1 at one year post-operation. The other 16 patients were found to have normal EABR and the mode of Melbourne Categories in this group (n = 10) was 7. A poor outcome after cochlear implantation was associated with abnormal EABR recordings (a 'true' auditory neuropathy) and was found in a significant proportion of patients with Waardenburg syndrome.

58. **"Trans-tympanic electric auditory brainstem response (TT-EABR): The importance of the positioning of the stimulating electrode".** Pau, H.; Gibson, W. P. R.; Sanli, H.; (2006); Cochlear Implants International. 7(4):183-187

Trans-tympanic electric auditory brainstem response (TT-EABR) is an established pre-operative investigation in cochlear implantation surgery. Various techniques have been employed to obtain electrical responses but there has been no universal agreement on the exact positioning of the stimulating electrode on the medial wall of the mesotympanum. The authors investigate the relationship of the positioning of the electrode and the brainstem response.

59. **"Noise exposure of the inner ear during drilling a cochleostomy for cochlear implantation".** Pau, H. W.; Just, T.; Bornitz, M.; Lasurashvilli, N.; Zahnert, T.; (2007); Laryngoscope. 117(3):535-540

OBJECTIVES: Inserting an electrode array into the cochlea may cause inner ear trauma, which has to be minimized, particularly in cochlear implant patients with substantial residual hearing. Another potential inner ear trauma has, to a large extent, been neglected so far: the acoustic trauma that can occur during cochleostomy using different techniques. In this study, the noise exposure of the inner ear during the drilling procedure was re-evaluated. In experiments on temporal bones, quantitative measurements of sound pressure level (SPL) were carried out while a cochleostomy for cochlear implantation was drilled. STUDY DESIGN: Experimental study. MATERIALS AND METHODS: Acoustic measurements during different drilling procedures were carried out on four human temporal bone preparations equipped with microphones attached to the round window. Special calibrations were carried out, which allowed determination of SPLs affecting the cochlea during the drilling procedure. RESULTS: The highest SPLs measured on the cochlea were recorded when a still-intact endosteal membrane was touched by the burr. The SPL exceeded 130 dB and reached a level almost comparable with the situation when the ossicular chain is touched by a running burr. CONCLUSIONS: In the drilling procedure for a cochleostomy, the inner ear may be affected by very high SPLs, particularly if the endosteal membrane is left intact and comes into contact with the running burr. Of course, the resulting SPLs depend on the drilling speed and the size and characteristics of the burr (larger burrs cause higher SPLs); however, we are of the opinion that the cochlear function is at risk, anyway, if special precaution is not exercised. Even when working with reduced drilling speed, the surgeon should be aware of the high risk in the form of an acoustic trauma, which may endanger residual hearing. Recommendations in terms of "soft surgery" are given in the paper (e.g., the use of microhooks instead of a drill to remove the very last shell of bone covering the cochlea).

60. **"Effects of masking noise on vowel and sibilant contrasts in normal-hearing speakers and postlingually deafened cochlear implant users".** Perkell, J. S.; Denny, M.; Lane, H.; Guenther, F.; Matthies, M. L.; Tiede, M.; Vick, J.; Zandipour, M.; Burton, E.; (2007); J Acoust Soc Am. 121(1):505-518

The role of auditory feedback in speech production was investigated by examining speakers' phonemic contrasts produced under increases in the noise to signal ratio (N/S). Seven cochlear implant users and seven normal-hearing controls pronounced utterances containing the vowels /i/, /u/, /e/ and /ae/ and the sibilants /s/ and /I/ while hearing their speech mixed with noise at seven equally spaced levels between their thresholds of detection and discomfort. Speakers' average vowel duration and SPL generally rose with increasing N/S. Average vowel contrast was initially flat or rising; at higher N/S levels, it fell. A contrast increase is interpreted as reflecting speakers' attempts to maintain clarity under degraded acoustic transmission conditions. As N/S increased, speakers could detect the extent of their phonemic contrasts less effectively, and the competing influence of economy of effort led to contrast decrements. The sibilant contrast was more vulnerable to noise; it decreased over the entire range of increasing N/S for controls and was variable for implant users. The results are interpreted as reflecting the combined influences of a clarity constraint, economy of effort and the effect of masking on achieving auditory phonemic goals-with implant users less able to increase contrasts in noise than controls.

61. **"Objective methods in postlingually and prelingually deafened adults for programming cochlear implants: EST and NRT".** Polak, M.; Hodges, A. V.; King, J. E.; Payne, S. L.; Balkany, T. J.; (2007); Cochlear Implants International. 7(3):125-141

This study compared responses of prelingually and postlingually deafened adult Nucleus 24 cochlear implant users on two objective measures employed to predict programming levels: neural response telemetry (NRT) and electrically evoked stapedial reflexes (eSR). Thirty experienced postlingually and prelingually deafened adult implant users underwent standard behavioural judgements of maximum comfortable loudness levels (C levels) and thresholds (Ts) followed by eSR and NRT measurements. Two different programs were created based on both the subjective judgement and the objective estimates of C levels (eSR thresholds) and these were compared. Relationships between the subjective and the objective measures were statistically analysed. Maximum stimulation levels estimated by both eSR and NRT were highly correlated with C levels. Variability of NRT results was higher than for eSR results. Mean NRT thresholds for postlingually deafened patients were higher than for prelingually deafened patients. A number of prelingually deafened users could distinguish no difference between programs; however, the majority of postlingually deafened users were sensitive to the difference and many reported preference for the program with eSR-estimated C levels. Neural response telemetry thresholds and eSRTs obtained in Nucleus 24 patients are highly correlated with C levels and Ts. Results suggest that estimation of C levels and Ts using NRT or eSR requires different correction factors for prelingually versus postlingually deafened adult subjects.

62. **"Bilateral cochlear implantation in a patient with long-term deafness".** Portmann, D.; Felix, F.; Negrevergne, M.; Bourdin, M.; Lagourgue, P.; Coulomb-Faye, F.; Polanski, F. J.; (2007); Rev Laryngol Otol Rhinol (Bord). 128(1-2):65-68

PURPOSE OF THE STUDY: 1) To report the case of a 70-year-old patient with a history of auditory deprivation for 80% of his life and who received bilateral cochlear implants and 2) to discuss different aspects of the case, including duration of auditory deprivation, the decision for bilateral implantation, age at implantation, and the use of this treatment modality for tinnitus. CASE REPORT: A two-stages bilateral cochlear implantation was performed in a 70-year-old patient with long-term deafness without operative or post-operative problems with excellent functional result. DISCUSSION: Various studies have reported that in patients with long-term auditory deprivation, the results of cochlear implants are delayed and sometimes unsatisfactory when compared to patients with more recent post-lingual deafness. However they did not contraindicate the surgery. The positive results with the first implant (both for the tinnitus and the hearing loss) motivated the patient and medical team to proceed to bilateral implantation. CONCLUSION: Patients with longstanding auditory deprivation can achieve good functional results even though at a slower rate. The use of bilateral cochlear implants accelerates and optimizes the final outcome.

63. **"Polyarteritis nodosa and cochlear implantation".** Psillas, G.; Kyriafinis, G.; Daniilidis, J.; (2007); J Laryngol Otol. 121(2):196-199

Polyarteritis nodosa is a systemic disease which affects the small to medium-sized muscular arteries. Sudden or progressive, bilateral hearing loss is a presenting otologic manifestation. To date, no case of cochlear implantation in patients with polyarteritis nodosa has been reported. The authors present a case of polyarteritis nodosa (confirmed by biopsy) in a 71-year-old man with progressive, bilateral sensorineural hearing loss who underwent cochlear implantation. A successful full insertion of the Nucleus 3G electrode array was achieved without surgical or post-operative complications. The patient immediately showed a positive subjective response and, at three month post-operative evaluation, had gained useful open-set speech perception. A review of five temporal bone cases with hearing loss and polyarteritis nodosa revealed the possibility of fibrosis and ossification in the basal turn of the cochlea, of which the surgeon should be aware prior to cochlear implantation.

64. **"Cochlear implantation in otosclerotic deafness".** Ramsden, R.; Rotteveel, L.; Proops, D.; Saeed, S.; van Olphen, A.; Mylanus, E.; (2007); Adv Otorhinolaryngol. 65(328-334

The otosclerotic process commonly involves the otic capsule and may cause quite widespread demineralisation which leads to a progressive and often profound bilateral sensorineural hearing loss. In this situation cochlear implantation may be the only effective treatment. This chapter considers the pathology of this hearing loss, the effects of cochlear obliteration on implantation, and the effects of demineralisation of the otic capsule on placement of the electrode and nonauditory stimulation. A study is reported from 4 cochlear implant centres in the UK and the Netherlands of 53 patients with cochlear otosclerosis who received cochlear implantation. The CT features of their petrous bones are presented and a classification of the radiological features suggested. 38% of patients experienced facial nerve stimulation presumably due to spread of current through an otic capsule with lower than usual electrical impedance. The most common rogue electrodes were in the proximity of the geniculate ganglion. These could usually be successfully programmed out of the MAP.

65. **"The effect of polypyrrole with incorporated neurotrophin-3 on the promotion of neurite outgrowth from auditory neurons".** Richardson, R. T.; Thompson, B.; Moulton, S.; Newbold, C.; Lum, M. G.; Cameron, A.; Wallace, G.; Kapsa, R.; Clark, G.; O'Leary, S.; (2007); Biomaterials. 28(3):513-523

This research aims to improve the nerve-electrode interface of the cochlear implant using polymer technology to encourage neuron survival, elongation and adhesion to the electrodes. Polypyrrole (Ppy) doped with p-toluene sulphonate (pTS) is an electroactive polymer into which neurotrophin-3 (NT3) can be incorporated. Ppy/pTS+/-NT3 was synthesised over gold electrodes and used as a surface for auditory neuron explant culture. Neurite outgrowth from explants grown on Ppy/pTS was equivalent to tissue culture plastic but improved with the incorporation of NT3 (Ppy/pTS/NT3). Electrical stimulation of Ppy/pTS/NT3 with a biphasic current pulse, as used in cochlear implants, significantly improved neurite outgrowth from explants. Using (125)I-NT3, it was shown that low levels of NT3 passively diffused from Ppy/pTS/NT3 during normal incubation and that electrical stimulation enhanced the release of biologically active NT3 in quantities adequate for neuron survival. Furthermore, Ppy/pTS/NT3 and its constituents were not toxic to auditory neurons and the Ppy/pTS/NT3 coating on gold electrodes did not alter impedance. If applied to the cochlear implant, Ppy/pTS/NT3 will provide a biocompatible, low-impedance substrate for storage and release of NT3 to help protect auditory neurons from degradation after sensorineural hearing loss and encourage neurite outgrowth towards the electrodes.

66. **"Modifications of standard cochlear implantation techniques for children under 18 months of age".** Roberson, J. B.; Kunda, L. D.; Stidham, K. R.; Inserra, M. M.; Choe, W.; Tonokawa, L.; (2006); Cochlear Implants International. 7(4):207-213

Cochlear implantation is being performed in increasingly younger children. We present a retrospective cohort of 19 patients with 23 ears implanted under 18 months of age. The mean age at implantation was 11.9 months, with the youngest being 6.8 months.* The facial recess was narrow in nine ears (39%), including all premature infants. An inferiorly located stapedius tendon was sectioned in seven ears (30%) to facilitate round window access. Countersinking of the receiver-stimulator required dural exposure in 22 ears (96%). The receiver-stimulator was secured with sutures in 15 ears (65%) and within a tight pocket in eight ears (35%). Tympanostomy tubes were placed in 10 ears (43%). Cochlear implantation in very young children frequently necessitates modified surgical techniques.

**NOTE: Implantation under 12 months of age is off-label use in the United States.*

67. **"Interpreting parental proxy reports of (health-related) quality of life for children with unilateral cochlear implants".** Sach, T. H. & Barton, G. R.; (2007); Int J Pediatr Otorhinolaryngol. 71(3):435-445

OBJECTIVE: To examine what factors are associated with EuroQol EQ-5D scores in children after unilateral cochlear implantation and to explore parental conceptualisations of health-related quality of life (HRQL) and quality of life (QoL). METHODS: Face to face interviews were conducted with the parents of 222 implanted children, in an attempt to elicit information on their child's HRQL and QoL. Post-implant, the child's HRQL was measured using the EQ-5D, completed by parental proxy. Regression analysis was undertaken in order to estimate the association between the child EQ-5D score and child characteristics, child performance, and parental characteristics, in order to assess the construct validity of the EQ-5D. HRQL was also measured using the EuroQol visual analogue scale (VAS), where the endpoints were the best and worst imaginable health state, and a VAS was also used to measure QoL (endpoints: best/worst imaginable QoL). Parents were asked to estimate scores on both these VAS measures both post-implantation and (retrospectively) pre-implantation. Throughout the HRQL and QoL elicitation process, subjects' comments, and observations were noted. RESULTS: Children who had an additional disability ($p<0.001$), were male ($p<0.05$) or had a lower level of auditory perception ($p<0.001$) were estimated to have lower EQ-5D scores, as were children whose parents who left school before age 18 years ($p<0.05$). According to the EuroQol VAS the mean difference between pre- and post-implantation score was 0.14, compared to 0.35 for the QoL VAS, demonstrating that parents tended not to see HRQL and QoL as equivalent. As 67% of parents deemed there to be no difference between the pre- and post-implant EuroQol VAS scores we also infer that the majority of parents rejected the notion of deafness being a HRQL issue. CONCLUSION: The evidence relating to the construct validity of the EQ-5D is variable-though it was able to discriminate between children with certain levels of auditory performance, it could not discriminate between children who differed in other ways. By limiting outcome from cochlear implantation to HRQL, as opposed to QoL, the benefits of cochlear implants are likely to be underestimated.

68. **"Auditory midbrain implant: a combined approach for vestibular schwannoma surgery and device implantation".** Samii, A.; Lenarz, M.; Majdani, O.; Lim, H. H.; Samii, M.; Lenarz, T.; (2007); Otol Neurotol. 28(1):31-38

HYPOTHESIS: The lateral suboccipital approach is a well-established route for safe removal of vestibular schwannomas in neurofibromatosis Type 2 (NF2) patients. The goal of this study was to assess if this approach can be extended to a lateral supracerebellar infratentorial approach to enable insertion of an auditory midbrain implant (AMI) penetrating array along the tonotopic gradient of the inferior colliculus central nucleus (ICC). BACKGROUND: The AMI is a new auditory prosthesis designed for penetrating stimulation of the ICC in patients with neural deafness. The initial candidates are NF2 patients who, because of the growth and/or surgical removal of bilateral acoustic neuromas, develop neural deafness and are unable to benefit from cochlear implants. The ideal surgical approach in NF2 patients must first enable safe removal of vestibular schwannomas and then provide sufficient exposure of the midbrain for AMI implantation. METHODS: This study was performed on formalin-fixed and fresh cadaver specimens. Computed tomography scan and magnetic resonance imaging were used to study the heads of the specimens and for surgical navigation. RESULTS: The lateral suboccipital craniotomy enabled sufficient exposure of the cerebellopontine angle and internal auditory canal for tumor removal. It could then be extended to a lateral supracerebellar infratentorial approach that provided good exposure of the dorsolateral aspect of the tentorial hiatus and mesencephalon for implantation of the AMI along the tonotopic gradient of the ICC. This approach did not endanger the trochlear nerve or any major midline venous structures in the quadrigeminal cistern. CONCLUSION: This modified lateral suboccipital approach ensures safe removal of large vestibular schwannomas and provides sufficient exposure of the inferior colliculus for ideal AMI implantation.

69. **"[Clinical and audiological findings in children with auditory neuropathy]".** Shehata-Dieler, W.; Volter, C.; Hildmann, A.; Hildmann, H.; Helms, J.; (2007); Laryngorhinootologie. 86(1):15-21

BACKGROUND: Auditory neuropathy is a disorder characterised by preservation of outer hair cells function with normal otoacoustic emissions (OAEs), but with absent auditory brainstem responses (ABR). Perisynaptic synchronisation disorder is one of the possible pathogenesis underlying auditory neuropathy. In this paper we describe the clinical presentation and audiological findings in pediatric auditory neuropathy and its management. PATIENTS AND METHODS: 9 children with auditory neuropathy could be included in the study. An audiological evaluation was performed in all children including behavioural audiometry, measurement of the

OAEs as well as electrocochleography (ECoG) and ABR recordings. Children who failed to get any benefit from conventional amplification received a cochlear implant. Prior to implantation the responses to electrical stimuli were examined with the promontory test and with the electrically evoked ABR. RESULTS: One child showed auditory neuropathy only on one side with normal hearing thresholds on the contralateral ear. Another child had normal hearing thresholds after the follow up period. Four children received a hearing aid. But variable hearing reactions were observed. Thus in three cases a CI is planned. In three children cochlea implantation was done. Following implantation a remarkable improvement in hearing/speech capabilities with the CI compared to conventional hearing aids were observed in all three cases. Beside, these three children developed open set speech discrimination and are using now oral language for communication. CONCLUSIONS: Auditory neuropathy is a disorder which presents with different clinical and audiological findings. Thus the management of this disorder must be an individual one. In light of our findings we support the use of cochlear implants as an option for children with auditory neuropathy in cases where conventional amplification does not work sufficiently.

70. **"A low-power asynchronous interleaved sampling algorithm for cochlear implants that encodes envelope and phase information".** Sit, J. J.; Simonson, A. M.; Oxenham, A. J.; Faltys, M. A.; Sarpeshkar, R.; (2007); IEEE Trans Biomed Eng. 54(1):138-149

Cochlear implants currently fail to convey phase information, which is important for perceiving music, tonal languages, and for hearing in noisy environments. We propose a bio-inspired asynchronous interleaved sampling (AIS) algorithm that encodes both envelope and phase information, in a manner that may be suitable for delivery to cochlear implant users. Like standard continuous interleaved sampling (CIS) strategies, AIS naturally meets the interleaved-firing requirement, which is to stimulate only one electrode at a time, minimizing electrode interactions. The majority of interspike intervals are distributed over 1-4 ms, thus staying within the absolute refractory limit of neurons, and form a more natural, pseudostochastic pattern of firing due to complex channel interactions. Stronger channels are selected to fire more often but the strategy ensures that weaker channels are selected to fire in proportion to their signal strength as well. The resulting stimulation rates are considerably lower than those of most modern implants, saving power yet delivering higher potential performance. Correlations with original sounds were found to be significantly higher in AIS reconstructions than in signal reconstructions using only envelope information. Two perceptual tests on normal-hearing listeners verified that the reconstructed signals enabled better melody and speech recognition in noise than those processed using tone-excited envelope-vocoder simulations of cochlear implant processing. Thus, our strategy could potentially save power and improve hearing performance in cochlear implant users.

71. **"Preservation of low frequency hearing in partial deafness cochlear implantation (PDCI) using the round window surgical approach".** Skarzynski, H.; Lorens, A.; Piotrowska, A.; Anderson, I.; (2007); Acta Otolaryngol. 127(1):41-48

CONCLUSION: Successful hearing preservation is possible in individuals with excellent low frequency hearing. This is possible due to the partial insertion of an atraumatic electrode using an atraumatic round window surgical technique. OBJECTIVES: This paper describes the round window surgical technique used to preserve excellent low frequency hearing in patients receiving partially inserted MED-EL cochlear implant electrodes. Results of preserved low frequency hearing in partial deafness cochlear implantation (PDCI) are reported. PATIENTS AND METHODS: The surgical approach is described in detail. Ten subjects received a partial insertion of a standard electrode, using the round window approach. Pure tone audiometry was conducted in the implanted and non-implanted ear preoperatively, at implant fitting and then at 1, 3, 6 and 12 months after initial device fitting. RESULTS: Results show hearing preservation in 9 of the 10 subjects. One subject lost all hearing 2 weeks after cochlear implantation. Hearing has remained essentially stable up to the 1 year postoperative period. Eight of the nine subjects use the cochlear implant together with their natural low frequency hearing; one subject uses a hearing aid in the implanted ear to amplify the low frequencies.

72. **"Induction of localized cochlear hypothermia".** Smith, L. P.; Eshraghi, A. A.; Whitley, D. E.; Van de Water, T. R.; Balkany, T. J.; (2007); Acta Otolaryngol. 127(3):228-233

CONCLUSIONS: Localized cochlear hypothermia was induced in a rat model, demonstrating the feasibility of modulating cochlear temperature without affecting core body temperature. OBJECTIVES: Systemic hypothermia has been demonstrated to protect the rat cochlea against electrode insertion trauma-induced hearing loss. Due to potential adverse effects of systemic hypothermia, we set out to demonstrate the feasibility of inducing localized cochlear hypothermia and compared the efficacy of three cooling techniques. MATERIALS AND METHODS: Twenty-four ears were prepared by sealing a temperature micro-probe into the basal turn of the cochlea. Cochleae were then cooled by cold saline irrigation of the external auditory canal (EAC) or bulla or by direct application of ice over the bulla. Cochlear temperature measurements were recorded every 30 s during the cooling period until stable. Rectal temperature was monitored continuously and maintained at 36 degrees C. RESULTS: All techniques resulted in cochlear hypothermia without a concomitant change in rectal temperature. EAC irrigation (14 degrees C and 11 degrees C) decreased cochlear temperature on average by 1.1 degrees C and 1.6 degrees C, respectively. Bulla irrigation (14 degrees C and 11 degrees C) decreased cochlear temperature on average by 3.3 degrees C and 4.1 degrees C, respectively. The ice produced an average cochlear temperature decrease of 4.1 degrees C. In all cases, a cochlear temperature nadir was reached in 5-6 min with no significant differences between groups with respect to time.

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

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

74. **"Speech understanding in background noise with the two-microphone adaptive beamformer BEAM in the Nucleus Freedom Cochlear Implant System".** Spriet, A.; Van Deun, L.; Eftaxiadis, K.; Laneau, J.; Moonen, M.; van Dijk, B.; van Wieringen, A.; Wouters, J.; (2007); Ear Hear. 28(1):62-72

OBJECTIVE: This paper evaluates the benefit of the two-microphone adaptive beamformer BEAM in the Nucleus Freedom cochlear implant (CI) system for speech understanding in background noise by CI users. DESIGN: A double-blind evaluation of the two-microphone adaptive beamformer BEAM and a hardware directional microphone was carried out with five adult Nucleus CI users. The test procedure consisted of a pre- and post-test in the lab and a 2-wk trial period at home. In the pre- and post-test, the speech reception threshold (SRT) with sentences and the percentage correct phoneme scores for CVC words were measured in quiet and background noise at different signal-to-noise ratios. Performance was assessed for two different noise configurations (with a single noise source and with three noise sources) and two different noise materials (stationary speech-weighted noise and multitalker babble). During the 2-wk trial period at home, the CI users evaluated the noise reduction performance in different listening conditions by means of the SSQ questionnaire. In addition to the perceptual evaluation, the noise reduction performance of the beamformer was measured physically as a function of the direction of the noise source. RESULTS: Significant improvements of both the SRT in noise (average improvement of 5-16 dB) and the percentage correct phoneme scores (average improvement of 10-41%) were observed with BEAM compared to the standard hardware directional microphone. In addition, the SSQ questionnaire and subjective evaluation in controlled and real-life scenarios suggested a possible preference for the beamformer in noisy environments. CONCLUSIONS: The evaluation demonstrates that the adaptive noise reduction algorithm BEAM in the Nucleus Freedom CI-system may significantly increase the speech perception by cochlear implantees in noisy listening conditions. This is the first monolateral (adaptive) noise reduction strategy actually implemented in a mainstream commercial CI.

75. **"Cochlear implantation in a patient with bilateral deep brain stimulators".** St Martin, M. B. & Hirsch, B. E.; (2007); Laryngoscope. 117(1):183-185

OBJECTIVE: We report the case of a patient successfully implanted with a Nucleus Contour cochlear implant after placement of a deep brain stimulator for Parkinson disease. METHODS: The authors conducted a case report and literature review. RESULTS: Successful hookup and mapping of the device was performed 1 month after implantation without evidence of aberrant activity of the deep brain stimulators. CONCLUSIONS: To our knowledge, this is the first reported case of successful implantation of both a cochlear implant and a deep brain stimulator in the same patient. We have outlined one approach to avoiding detrimental interactions between cochlear implant and deep brain stimulator devices.

76. **"Development of a drug delivery device: using the femtosecond laser to modify cochlear implant electrodes".** Stover, T.; Paasche, G.; Lenarz, T.; Ripken, T.; Breitenfeld, P.; Lubatschowski, H.; Fabian, T.; (2007); Cochlear Implants Int. 8(1):38-52

Animal experiments suggest that pharmacological intervention could possibly enhance cochlear implant performance. One of the key aspects is therefore a drug delivery device for the human inner ear. The objective of this study was to investigate the possibility of using the femtosecond laser for modifying a cochlear implant electrode for the purpose of drug delivery to the cochlea. Using silicone sheets, the best parameters for creating defined channels at calculated diameters were investigated using a femtosecond laser. The results were transferred to a cochlear implant electrode array (Nucleus Contour). The capability of delivering substances through the drilled openings was tested in vitro. By variation of the output of the laser, spot distance, repetition rate, number of cycles and introducing several focus planes, it was possible to drill holes with nearly vertical walls in the silicone sheets. Transferring these data to the cochlear implant electrode resulted in prototypes for drug delivery with various openings along the array. The use of the femtosecond laser allows rapid modification and adaptation of designs to experimental prototypes of cochlear implant electrodes for the purpose of drug delivery to the inner ear.

77. **"Migration of the ball electrode after cochlear implantation".** Tange, R. A.; Grolman, W.; Carelsen, B.; (2007); Otol Neurotol. 28(2):195-198

OBJECTIVE: To review the postoperative radiographic investigations of patients implanted with a cochlear implant. STUDY DESIGN: Retrospective case series. PATIENTS: Thirty-nine patients (22-77 yrs old) implanted for sensorineural deafness in the cochlear implants program of the Academic Medical Center of Amsterdam. INTERVENTION: Cochlear implantation with Cochlear Nucleus 24 Contour and Cochlear Nucleus Freedom (Cochlear Corp., Lane Cove, New South Wales, Australia) implant. RESULTS: This retrospective analysis of the postoperative computed tomographic scans showed that, in a large number of the implantations, the external ball electrode of the cochlear implant migrated from the insertion place toward the magnet of the receiver/stimulator unit of the implant. It seems that this migration of the external ball electrode does not influence the function of the cochlear implant and the result of the hearing rehabilitation in the short term. CONCLUSION: Because of the magnetic field of the receiver/stimulator unit of the cochlear implant and the magnet of the external transmitting coil of the speech processor, it seems to be possible that the extracochlear ball electrode can migrate in the space between the temporal bone and the temporal muscle during the postoperative healing phase. The importance of our observation is still not clear.

78. **"The pattern of auditory brainstem response wave V maturation in cochlear-implanted children".** Thai-Van, H.; Cozma, S.; Boutitie, F.; Disant, F.; Truy, E.; Collet, L.; (2007); Clin Neurophysiol. 118(3):676-689

OBJECTIVE: Maturation of acoustically evoked brainstem responses (ABR) in hearing children is not complete at birth but rather continues over the first two years of life. In particular, it has been established that the decrease in ABR wave V latency can be modeled as the sum of two decaying exponential functions with respective time-constants of 4 and 50 weeks [Eggermont, J.J., Salamy, A., 1988a. Maturational time-course for the ABR in preterm and full term infants. Hear Res 33, 35-47; Eggermont, J.J., Salamy, A., 1988b. Development of ABR parameters in a preterm and a term born population. Ear Hear 9, 283-9]. Here, we investigated the maturation of electrically evoked auditory brainstem responses (EABR) in 55 deaf children who recovered hearing after cochlear implantation, and proposed a predictive model of EABR maturation depending on the onset of deafness. The pattern of EABR maturation over the first 2 years of cochlear implant use was compared with the normal pattern of ABR maturation in hearing children. METHODS: Changes in EABR wave V latency over the 2 years following cochlear implant connection were analyzed in two groups of children. The first group (n=41) consisted of children with early-onset of deafness (mostly congenital), and the second (n=14) of children who had become profoundly deaf after 1 year of age. The modeling of changes in EABR wave V latency with time was based on the mean values from each of the two groups, allowing comparison of the rates of EABR maturation between groups. Differences between EABRs elicited at the basal and apical ends of the implant electrode array were also tested. RESULTS: There was no influence of age at implantation on the rate of wave V latency change. The main factor for EABR changes was the time in sound. Indeed, significant maturation was observed over the first 2 years of implant use only in the group with early-onset deafness. In this group maturation of wave V progressed as in the ABR model of [Eggermont, J.J., Salamy, A., 1988a. Maturational time-course for the ABR in preterm and full term infants. Hear Res 33, 35-47; Eggermont, J.J., Salamy, A., 1988b. Development of ABR parameters in a preterm and a term born population. Ear Hear 9, 283-9] of normal hearing children: a sum of two decaying exponential functions, one showing an early rapid decrease in latency and the other a slower decrease. Remarkably, the time-constants fell well within the ranges described by Eggermont and Salamy (i.e., 3.9 and 68 weeks), consistent with the time-course of the neurophysiological mechanisms presumably involved in auditory pathway maturation during the first 2 years of life: i.e., myelination and increased synaptic efficacy. In contrast, relatively little change in wave V was evident in children with late-onset deafness. In agreement with the notion that EABR maturation follows an apex-to-base gradient as described for ABR, we observed that wave V latencies were longer for the basal than the apical end of the implant electrode array and remained so throughout the study period, whatever the time of onset of deafness. CONCLUSIONS: The findings in the early-onset of deafness group support the theory that auditory pathways remain "frozen" during the period of sensory deprivation until cochlear implant rehabilitation restores the normal chronology of maturational processes. In children with late-onset deafness, however, some maturational processes may occur before the onset of deafness, and thus less additional maturation is required during the first two years of implant use resulting in no significant EABR latency changes being observed in this period. The results suggest that the rehabilitation-induced plasticity of the auditory pathways is, in case of late auditory deprivation, unlikely to result in neurophysiological outcomes similar to those observed in children with early auditory deprivation. SIGNIFICANCE: Changes in EABR wave V latency over the first 2 years of cochlear implant use were found to be well fitted by the sum of two decaying exponential functions in children with early-onset deafness. This is in line with the maturation of ABR wave V latency in normal-hearing children over the first two years of life. Further studies are needed to assess whether the differences observed in terms of auditory pathways maturation are associated with consistent differences in terms of language development.

79. **"Validity of the MacArthur-Bates Communicative Development Inventories for measuring language abilities in children with cochlear implants".** Thal, D.; DesJardin, J. L.; Eisenberg, L. S.; (2007); American Journal of Speech-Language Pathology. 16(1):54-64

Purpose To examine the validity of the MacArthur-Bates Communicative Development Inventories (CDI) for measuring language abilities in children with profound hearing loss who are using cochlear implants. Method Twenty-four children with cochlear implants and their mothers participated in this study. Children ranged in age from 32 months to 86 months (the majority were 32 to 66 months old). The number of months postimplantation ranged from 3 to 60 (the majority were around 24 months). Mothers completed the CDI before behavioral testing. Behavioral measures included the Reynell Developmental Language Scales and measures of vocabulary and grammar from a spontaneous language sample. Results Both the Words and Gestures and the Words and Sentences forms of the CDI were shown to have excellent validity for this sample of children, if they had language that was in the range measured by the instrument. Correlations with behavioral measures ranged from .41 to .93 and were comparable to those reported for children with typical development. Conclusions The CDI forms are valid tools to use with children who are using cochlear implants and who are in the early stages of language development, even if they are older than the norming sample. Age-equivalence may be obtained if children score below the median for the oldest age norms. They may also be used to describe the language of children who are not at ceiling. Specific recommendations for interventionists are provided.

80. **"Cochlear implantation via the middle fossa: surgical and electrode array considerations".** Todd, N. W.; (2007); Cochlear Implants Int. 8(1):12-28

Cochlear implantation via the middle cranial fossa may access the entire length of the cochlea without opening the middle ear. Concerns include safety and electrode array design. The objectives of this study were to determine the depth to the superior portion of the basal turn (SPBT) and distances from the facial and greater petrosal nerves, and to describe some ideas about electrode arrays. The study involved operative dissection of 41 bequeathed otitis-free adult crania (82 temporal bones). Mastoid size was assessed by x-ray. Commercially available MED-EL split arrays were inserted. The depth from the floor of the middle cranial fossa to SPBT of the cochlea ranged from 0.5 mm to 4.2 mm. Small mastoid size correlated with shallow depth. Distances from the centre of the SPBT to the labyrinthine portion of the facial nerve, to the geniculate ganglion, and to the greater petrosal nerve ranged from 1.0 mm to 3.0 mm, 2.0 mm to 3.2 mm, and 1.8 mm to 2.8 mm, respectively. More than 75% of electrodes inserted toward the round window extended into the vestibule. Insertions toward the cochlear apex had a median insertion depth of 12 mm (range 6 mm to 18 mm). The middle cranial fossa approach appears safe and allows electrode access to nearly the full length of the cochlea. Electrode arrays specific for this route of implantation are

needed, together with a rigorous study comparing outcomes of this route of implantation with traditional implantation through the facial recess.

81. **"Bimodal benefits of cochlear implant and hearing aid (on the non-implanted ear): a pilot study to develop a protocol and a test battery".** Ullauri, A.; Crofts, H.; Wilson, K.; Titley, S.; (2007); Cochlear Implants Int. 8(1):29-37

ABSTRACT This is a pilot study that aims (1) to help design a protocol for fitting and optimizing cochlear implants and hearing aids, (2) to help design a test battery that can help monitor children's progress and (3) to assess the benefit of using a cochlear implant with a contralateral hearing aid. Seven children between the ages of seven and 15 years completed the study. None of them had worn a contralateral hearing aid (HA) since cochlear implantation (five to seven years after implantation). The Listening Inventory for Education (LIFE), Life Situation Questionnaire (LSQ), and Client Orientated Scale of Improvement for Children (COSI-C) questionnaires together with subject's feedback were used as subjective measures, and speech perception tests - the City of New York (sentences list) (CUNY) and Bamford-Kowal-Bench (sentences list) (BKB) depending on child's speech perception skills - in quiet and in noise were used as objective measures. The results showed mixed subjective feedback, even though objectively all children improved their speech perception scores when wearing cochlear implants and hearing aids. The COSI-C proved to be the most successful tool to collect feedback from parents.

82. **"Evaluation of the benefit for cochlear implantees of two assistive directional microphone systems in an artificial diffuse noise situation".** van der Beek, F. B.; Soede, W.; Frijns, J. H.; (2007); Ear Hear. 28(1):99-110

OBJECTIVE: People with cochlear implants have severe problems with speech understanding in noisy surroundings. This study evaluates and quantifies the effect of two assistive directional microphone systems compared to the standard headpiece microphone on speech perception in quiet surroundings and in background noise, in a laboratory setting developed to reflect a situation whereby the listener is disturbed by a noise with a mainly diffuse character due to many sources in a reverberant room. DESIGN: Thirteen postlingually deafened patients, implanted in the Leiden University Medical Centre with the Clarion CII device, participated in the study. An experimental set-up with 8 uncorrelated steady-state noise sources was used to test speech perception on monosyllabic words. Each subject was tested with a standard headpiece microphone, and the two assistive directional microphones, TX3 Handymic by Phonak and the Linkit array microphone by Etymotic Research. Testing was done in quiet at a level of 65 dB SPL and with decreasing signal-to-noise ratios (SNR) down to -15 dB. RESULTS: Using the assistive directional microphones, speech recognition in background noise improved substantially and was not affected in quiet. At an SNR of 0 dB, the average CVC scores improved from 45% for the headpiece microphone to 67% and 62% for the TX3 Handymic and the Linkit respectively. Compared to the headpiece, the Speech Reception Threshold (SRT) improved by 8.2 dB SNR and 5.9 dB SNR for the TX3 Handymic and the Linkit respectively. The gain in SRT for TX3 Handymic and Linkit was neither correlated to the SRT score with headpiece nor the duration of CI-use. CONCLUSION: The speech recognition test in background noise showed a clear benefit from the assistive directional microphones for cochlear implantees compared to the standard microphone. In a noisy environment, the significant benefit from these assistive device microphones may allow understanding of speech with greater ease.

83. **"Audiological performance after cochlear implantation: a 2-year follow-up in children with inner ear malformations".** Van Wermeskerken, G. K.; Dunnebier, E. A.; Van Olphen, A. F.; Van Zanten, B. A.; Albers, F. W.; (2007); Acta Otolaryngol. 127(3):252-257

CONCLUSIONS: Open-set speech perception in children with an inner ear malformation is equal to that of other congenitally deaf children after an average of 2 years follow-up. OBJECTIVE: To analyze audiological performance after cochlear implantation in a sample of children with radiographically detectable malformations of the inner ear compared to performance in prelingually deafened children at large. MATERIALS AND METHODS: Nine children with osseous inner ear malformations were compared to 22 congenitally deaf children, all of whom underwent cochlear implantation. All subjects were tested on their electrical evoked compound action potential. Speech perception tests were performed using the monosyllabic trochee polysyllabic test without visual support and the open-set monosyllabic wordlist. RESULTS: In all, 20% of the congenitally deaf children in our center study have inner ear abnormalities. Inner ear malformations were limited to incomplete partition of the cochlea; none of the subjects had common cavity malformations. Electrical compound action potentials were successfully recorded in both groups intraoperatively. Speech perception tests on open-set speech yielded an average of 48.8% (SD 21.2%) in the group of children with inner ear malformations vs 54.5% (SD 21.1%) in congenitally deaf children. In four of nine cases with an inner ear malformation we encountered a minor CSF leak.

84. **"Evaluation of a non-linear spectral subtraction noise suppression scheme in cochlear implant users".** Verschuur, C.; Lutman, M.; Abdul, W. N.; (2006); Cochlear Implants International. 7(4):188-193

The aim of the study was to determine benefit to speech recognition in noise by adult cochlear implant users with the non-linear spectral subtraction (NSS) noise suppression strategy. Users of the Nucleus 22 or Nucleus 24 cochlear implant systems were tested with sentence materials combined with stationary noise at +5 and +10dB signal to noise ratio (SNR), with and without NSS processing applied offline. Sentence scores were significantly higher with NSS processing, for both SNRs. The effect was greater at +5 dB SNR (12% improvement with NSS) than at +10dB SNR (5% improvement with NSS). These results are promising and suggest that online implementation of NSS as part of cochlear implant processors has the potential to yield benefits for speech recognition in noise.

85. **"[The conventional hearing aid]".** Vincent, C.; Vaneecloo, F. M.; Delattre, A.; Decroix, D.; Lebreton, J. P.; Ruzza, I.; (2007); Ann Otolaryngol Chir Cervicofac. 124(1):33-40

The conventional hearing aid has benefited from the progress made in electronic miniaturization and digital signal processing. The prescriber should be familiar with these improvements, the anatomic and acoustic limitations related to hearing aids, the possibilities of surgical rehabilitation, as well as the indications for other auditive rehabilitation techniques (bone conduction hearing, middle ear implant, and cochlear implant). A hearing aid should be prescribed within a precise context taking into account patient history, clinical examination, audiometric testing, and choice of the device. Optimal management of a hearing device for a child should be conducted within an adapted network including a specialized ENT physician, audiophonology, a qualified hearing prosthetist, a speech therapist, etc.).

86. **"Auditory sensory memory and working memory processes in children with normal hearing and cochlear implants".** Watson, D. R.; Titterington, J.; Henry, A.; Toner, J. G.; (2007); Audiol Neurootol. 12(2):65-76

There can be wide variation in the level of oral/aural language ability that prelingually hearing-impaired children develop after cochlear implantation. Automatic perceptual processing mechanisms have come under increasing scrutiny in attempts to explain this variation. Using mismatch negativity methods, this study explored associations between auditory sensory memory mechanisms and verbal working memory function in children with cochlear implants and a group of hearing controls of similar age. Whilst clear relationships were observed in the hearing children between mismatch activation and working memory measures, this association appeared to be disrupted in the implant children. These findings would fit with the proposal that early auditory deprivation and a degraded auditory signal can cause changes in the processes underpinning the development of oral/aural language skills in prelingually hearing-impaired children with cochlear implants and thus alter their developmental trajectory.

87. **"Effects of inner ear trauma on the risk of pneumococcal meningitis".** Wei, B. P. C.; Shepherd, R. K.; Robins-Browne, R. M.; Clark, G. M.; O'Leary, S. J.; (2007); Archives of Otolaryngology - Head and Neck Surgery. 133(3):250-259

Objective To examine the risk of pneumococcal meningitis in healthy rats that received a severe surgical trauma to the modiolus and osseous spiral lamina or the standard insertion technique for acute cochlear implantation. Design Interventional animal studies. Subjects Fifty-four otologically normal adult Hooded-Wistar rats. Interventions Fifty-four rats (18 of which received a cochleostomy alone; 18, a cochleostomy and acute cochlear implantation using standard surgical techniques; and 18, a cochleostomy followed by severe inner ear trauma) were infected 4 weeks after surgery with Streptococcus pneumoniae via 3 different routes (hematogenous, middle ear, and inner ear) to represent all potential routes of bacterial infection from the upper respiratory tract to the meninges in cochlear implant recipients with meningitis. Results Severe trauma to the osseous spiral lamina and modiolus increased the risk of pneumococcal meningitis when the bacteria were given via the middle or inner ear (Fisher exact test, P<.05). However, the risk of meningitis did not change when the bacteria were given via the hematogenous route. Acute electrode insertion did not alter the risk of subsequent pneumococcal meningitis for any route of infection. Conclusions Severe inner ear surgical trauma to the osseous spiral lamina and modiolus can increase the risk of pneumococcal meningitis. Therefore, every effort should be made to ensure that cochlear implant design and insertion technique cause minimal trauma to the bony structures of the inner ear to reduce the risk of pneumococcal meningitis.

88. **"Mothers' stress and expectations as a function of time since child's cochlear implantation".** Weisel, A.; Most, T.; Michael, R.; (2007); The Journal of Deaf Studies and Deaf Education. 12(1):55-64

This study examined stress, attitudes, and expectations among mothers of deaf children who underwent cochlear implantation (CI), as related to time elapsed since surgery. Participants were 64 mothers of such children at different points in the implantation process: candidates, 0-3 years postimplantation, and more than 3 years later. Expectations in communication and academic domains decreased as time since implantation passed. No differences emerged in stress levels between the 3 groups. Higher levels of mothers' and fathers' education correlated with lower stress levels. Older mothers expressed lower levels on the cohesion dimension of family functioning. Findings suggested the need to consider mothers' expectations in the rehabilitation process and to encourage mothers' realistic expectations with regard to the effects of CI.

89. **"Effect of age at cochlear implantation on open-set word recognition in Mandarin speaking deaf children".** Wu, J. L.; Lin, C. Y.; Yang, H. M.; Lin, Y. H.; (2006); Int J Pediatr Otorhinolaryngol. 70(2):207-211

OBJECTIVE: The purpose of this study was to determine whether age at cochlear implantation influences open-set speech perception in children after long-term use of the implant device. METHOD: Twenty-eight congenitally deafened children, receiving implants of Nucleus CI24M devices, were divided into two groups: (1) CI < 3: those who received implants before 3 years of age and (2) CI > 3: those who received implants after 3 years of age. We compared open-set speech perception in CI < 3 and CI > 3 after 4-5 years of device use. Speech perception tests were conducted using the Mandarin Lexical Neighborhood Test (M-LNT). Unpaired t-test was applied for statistical analysis, and $p < 0.05$ was considered significant. RESULTS: In CI < 3, the average of percent correct was 80.0 +/- 8.8 and 70.5 +/-

9.2% on, respectively, the easy and hard versions of the M-LNT. By contrast, in CI > 3, the average percent correct was 62.5 +/- 19.9 and 59.1 +/- 15.2%, respectively. Regardless of the M-LNT version used, CI < 3 performed significantly better than CI > 3 (easy, p = 0.005 versus hard, p = 0.022). CONCLUSION: The present investigation demonstrated that age at implantation influences open-set speech perception of cochlear implanted children 4-5 years after device connection. Implantation before 3 years of age promotes the development of open-set speech perception abilities in congenitally deafened children.

90. **"A fundamental frequency estimator for the real-time processing of musical sounds for cochlear implants".** Zakis, J. A.; McDermott, H. J.; Vandali, A. E.; (2007); Speech Communication. 49(2):113-122

A real-time fundamental frequency (F/sub 0/) estimator that operates in the frequency domain was developed for the processing of musical sounds in cochlear-implant (CI) sound processors. Its performance was evaluated with male and female sung-vowel stimuli in quiet, and in white noise and babble noise. The error rates of the developed F/sub 0/ estimator were much lower than those of a temporal F/sub 0/ estimator that was previously used in CI sound processors, and were comparable to the published error rates of F/sub 0/ estimators that were designed for other applications and evaluated with speech or musical instrument stimuli. It is envisaged that the experimental F/sub 0/ estimator will be used in advanced CI coding strategies to improve the perception of pitch by CI users, which may result in improved perception of musical sounds, as well as improved speech perception for tonal languages.