

Performance Outcomes for Borderline Cochlear Implant Candidates

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Introduction

Initial CI candidacy criteria, 1985:

- Post-lingually deafened adults
- Bilateral profound sensory hearing loss (>100 dB)
- No benefit with hearing aids
- No additional handicapping conditions
- No medical or physical contraindications for surgery

Introduction

Changes in candidacy criteria:

- Include children as young as 12 months; elderly
- Pre-lingual deafness (adults & kids)
- More residual hearing
- Better pre-implant speech perception scores
- Abnormal cochleae
- Presence of additional handicapping conditions not a contraindication
- Auditory neuropathy OK

Introduction

Current criteria for adults:

- Pre- or post-lingually deafened adults
 - History of HA use
 - Auditory/oral skills
- Bilateral severe or profound sensory hearing loss (70 dB or worse)
- Limited benefit with hearing aids
 - 50% or less, open-set sentences, aided ear to be implanted
 - 60% or less, open-set sentences, best-aided (binaural)
 - Medicare/caid: <40% sentences
 - Presentation level, test material issues
- No medical or physical contraindications for surgery
- Realistic expectations and commitment to follow-up appointments
- Co-existing/multiple-handicapping conditions not a contraindication

Introduction

Current criteria for children:

- Pre or post-lingually deafened
- Bilateral profound SNHL (age 12-18 mos) or severe-profound SNHL (age 18 mos +)
- Limited benefit with appropriately fit HAs
 - Lack of progress in simple auditory skill development despite appropriately fit amplification and participation in intensive auditory-based rehabilitation (minimum 3-6 months)
 - 12% or less, open-set words OR 30% or less on open-set sentences
- No medical or physical contraindications for surgery
- Good family and educational support; realistic expectations
- Co-existing/multiple-handicapping conditions not a contraindication

Introduction

Common deviations from current candidacy criteria:

- 1.) Individuals with more residual hearing
 - Better thresholds
 - Better speech perception
 - Better "better" ear
- Why? Traditional candidates showing better performance with new technology.
- Risks:
 - Potential loss of residual hearing
 - Speech perception may not increase if good to begin with

Introduction

Common deviations from current candidacy criteria:

- 1.) Individuals with more residual hearing
 - 2.) Individuals with factors associated with poor outcomes
 - Long-deafened, never-aided ear
 - Little to no language
 - Poor compliance/follow-up/support, etc.
 - Neural etiologies
- Why? Experience shows that some benefit can be achieved.
 - Risks:
 - Benefit may not outweigh cost and risks of surgery

Introduction

THE QUESTION:

Will the patient be better off with the implant than without?



Methods

Challenges of retrospective studies:

- Inconsistent presentation level
- Different ear(s)/conditions tested
- Maturation effects (children)

Methods

Qualification for Category 1: Too Much Hearing

- "Good Speech Perception" -- Pre-implant sentence recognition scores better than 50% in the ear implanted or 60% best-aided condition, OR
- "Good Thresholds" -- Pre-implant hearing thresholds better than 70 dB HL at a minimum of two audiometric frequencies.

Methods

Qualification for Category 2: Poor Prognosis

- "Unaided Long-Deafened" -- Duration deafness >10 years and no HA use in CI ear
- "Language Delay" -- Chronological-language age gap >50% of chronological age (over age 2)
- "CI Profile Concerns" -- Three or more CI profile categories marked as "Great Concern"
- "Neural Pathology" -- Etiology consistent with neural pathology

Methods

SUBJECTS

Category 1 (Too Much Hearing)

- N = 12
- 3 children (age at implant 7.9 to 18.6 yrs; mean = 14.5 yrs)
- 9 adults (age at implant 34 to 86 yrs, mean = 58 yrs)

Category 2 (Poor Prognosis)

- N = 13
- 9 children (age at implant 2.3 to 9.9 yrs; mean = 5.3 yrs)
- 4 adults (age at implant 26 to 67 yrs, mean = 50 yrs)

Results: Category 1 (Too Much Hearing)

Category 1: Too Much Hearing (N = 12)

- Good Speech Perception Group
 - N = 6 (4 adults, 2 teens)
- Good Thresholds Group
 - N = 5 (4 adults, 1 child)
 - N = 1 both audio & speech perception categories (adult)

Results: Category 1 (Too Much Hearing)

4 Case Examples, Good Speech Perception Group:

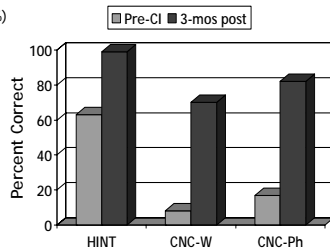
Results: Category 1 (Too Much Hearing)

Subject G1

- Age 34 at implant
- 2nd side CI (left)
- >50% ear to implant (63%)

- Pre-op:
 - Left only (HA)
 - 60 dB SPL

- Post-op:
 - Left CI only
 - 60 dB SPL



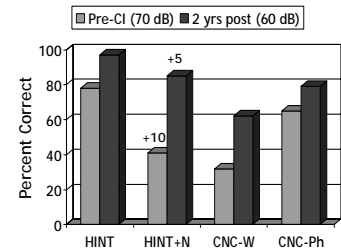
Results: Category 1 (Too Much Hearing)

Subject G3

- Age 55 at implant
- >60% best aided (78%)

- Pre-op:
 - Aided both ears
 - 70 dB SPL

- Post-op:
 - CI only
 - 60 dB SPL



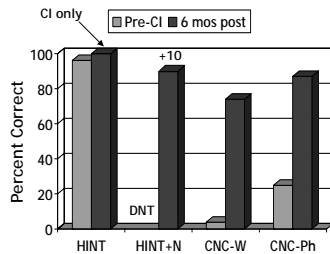
Results: Category 1 (Too Much Hearing)

Subject G4

- Age 86 at implant
- >60% best aided (96%)

- Pre-op:
 - Aided both ears
 - 60 dB SPL

- Post-op:
 - CI+HA (HINT CI only)
 - 60 dB SPL



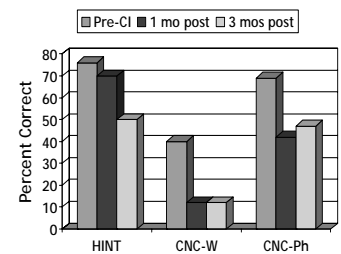
Results: Category 1 (Too Much Hearing)

Subject G6

- Age 18y 7m at implant
- >60% best aided (76%)

- Pre-op:
 - Aided both ears
 - 70 dB SPL

- Post-op:
 - CI+HA
 - 70 dB SPL



Results: Category 1 (Too Much Hearing)

Summary Results, Good Speech Perception Group:

- Mean pre-CI HINT score: 75% (Binaural condition for 5/6 subjects)
- Mean pre-CI CNC-W score: 24%
- Mean pre-CI CNC-Ph score: 47%
- 5/6 subjects performed better post-implant
- 1 subject performed worse post-implant

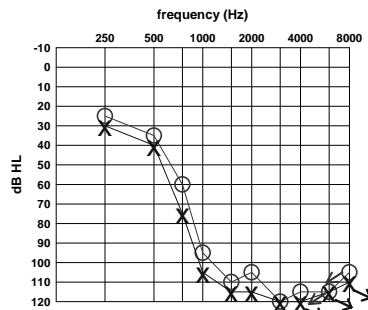
Results: Category 1 (Too Much Hearing)

3 Case Examples, Good Thresholds Group:

Results: Category 1 (Too Much Hearing)

Subject G10

- Age 56 at implant
- Audio < 70 dB
- Right CI

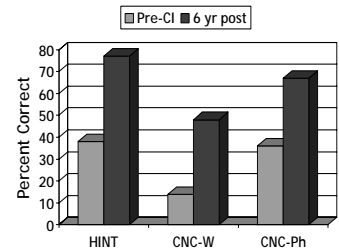


Results: Category 1 (Too Much Hearing)

Subject G10

- Age 56 at implant
- Audio < 70 dB
- Right CI

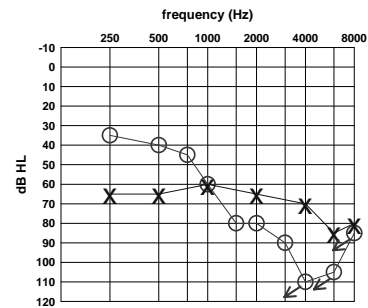
- Pre-op:
 - Right (HA)
 - 70 dB SPL
- Post-op:
 - Right (CI)
 - 70 dB SPL



Results: Category 1 (Too Much Hearing)

Subject G8

- Age 67 at implant
- Audio < 70 dB
- Left CI

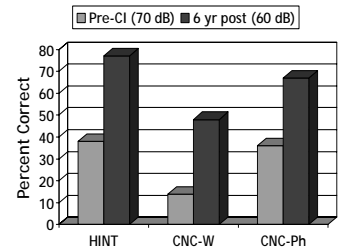


Results: Category 1 (Too Much Hearing)

Subject G8

- Age 67 at implant
- Audio < 70 dB
- Left CI

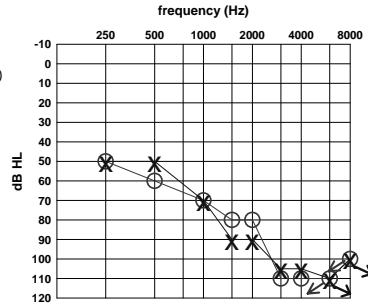
- Pre-op:
 - Aided both ears
 - 70 dB SPL
- Post-op:
 - CI only
 - 60 dB SPL



Results: Category 1 (Too Much Hearing)

Subject G7

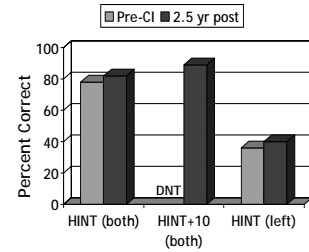
- Age 60 at implant
- Audio < 70 dB
- >60% best aided (78%)
- Left CI



Results: Category 1 (Too Much Hearing)

Subject G7

- Age 60 at implant; blind
- Audio < 70 dB
- >60% best aided (78%)
- Left CI

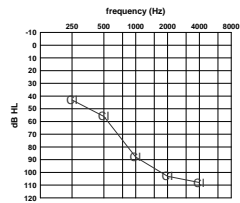


- Pre-op:
 - Both ears & left only
 - 60 dB SPL
- Post-op:
 - CI+HA & CI only
 - 60 dB SPL

Results: Category 1 (Too Much Hearing)

Summary Results, Good Thresholds Group:

- Mean threshold, 250 Hz: 43 dB HL
- Mean threshold, 500 Hz: 56 dB HL
- Mean threshold, 1000 Hz: 88 dB HL



- 5/6 subjects performed better post-implant
- 1 subject performed the same at 2y5m post-implant

Results: Category 1 (Too Much Hearing)

Summary Results for Category 1

- 10/12 subjects showed significant improvement with CI
 - One adult subject showed marginal improvement at 2 ½ years post-implant on HINT in quiet; however excellent performance in noise post-CI.
 - One child (18 y/o) showed significant drop in performance from pre to 3 months post-CI.

Results: Category 2 (Poor Prognosis)

Category 2: Poor Prognosis (N = 13)

- Unaided Long-Deafened Group
 - N = 4 (all adults)
- Language Delay Group
 - N = 7 (all children)
- CI Profile Concerns Group
 - N = 2 (children; one overlapped with language delay category)
- Neural Pathology Group
 - N = 1 (child)

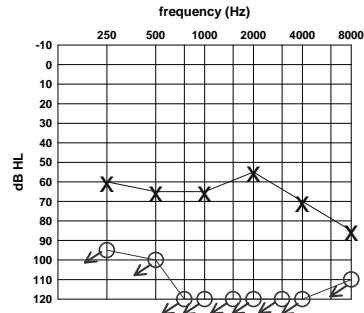
Results: Category 2 (Poor Prognosis)

3 Case Examples, Unaided Long-Deafened Group:

Results: Category 2 (Poor Prognosis)

Subject P1

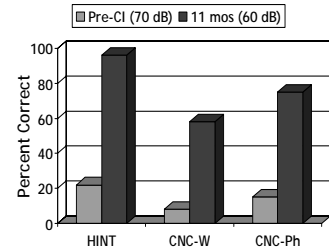
- Age 57 at implant
- >10 yrs duration
- Right CI (anacusic)
- Meniere's



Results: Category 2 (Poor Prognosis)

Subject P1

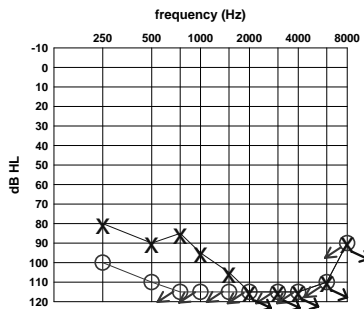
- Age 57 at implant
- >10 yrs duration
- Right CI (anacusic)
- Meniere's
- Pre-op
 - Left (aided)
 - 70 dB SPL
- Post-op
 - Right (CI-only)
 - 60 dB SPL



Results: Category 2 (Poor Prognosis)

Subject P2

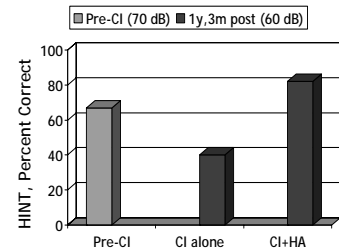
- Age 51 at implant
- >10 yrs duration
- Right CI
- Unknown etiology



Results: Category 2 (Poor Prognosis)

Subject P2

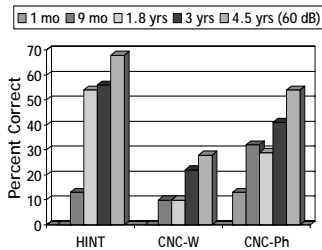
- Age 51 at implant
- >10 yrs duration
- Right CI
- Unknown etiology
- Pre-op
 - HINT
 - Left (aided)
 - 70 dB SPL
- Post-op
 - HINT
 - CI+HA, CI only
 - 60 dB SPL



Results: Category 2 (Poor Prognosis)

Subject P3

- Age 67 at implant
- >10 yrs duration
- Right CI
- Progressive HL @ 20 yrs
- Pre-op
 - CNT; NR audio
 - Unaided 15 yrs both ears
- Post-op
 - CI only
 - 70 dB SPL up to 3 yrs



Results: Category 2 (Poor Prognosis)

Summary Results, Unaided Long-Deafened Group:

- 3/4 subjects achieve benefit with CI
 - 2 subjects aided in non-CI ear → 1 slow improvement, 1 fast
 - 1 subject unaided binaurally → slow improvement
- 1 subject has not returned since I.S.
 - ASL primary mode of communication

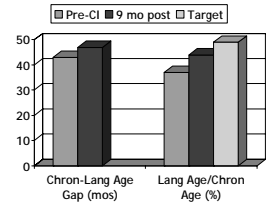
Results: Category 2 (Poor Prognosis)

3 Case Examples, Language Delay Group:

Results: Category 2 (Poor Prognosis)

Subject P5

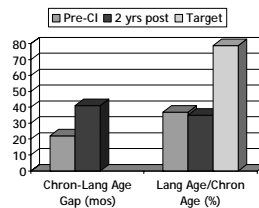
- Age 6y 2m at implant
- Chron-lang age gap >50%
- Pre-op (age 5y 8m)
 - Avg lang age 25m
 - Chron-lang gap 43m
 - Gap = 63% of chron age
- 9 Months Post-IS (age 7y 0m)
 - Avg lang age 37m
 - Chron-lang gap 47m
 - Gap = 56% of chron age
 - 12 mos progress in 16 mos time



Results: Category 2 (Poor Prognosis)

Subject P6

- Age 3y, 1m at implant
- Chron-lang age gap >50%
- Pre-op (age 2y 11m)
 - Avg lang age 13m
 - Chron-lang gap 22m
 - Gap = 63% of chron age
 - Bilingual environment
- Post-op (5y 3m)
 - 2 years post-IS
 - Avg lang age 22m
 - Chron-lang gap 41m
 - Gap = 65% of chron age
 - 9 mos progress in 28 mos time



Results: Category 2 (Poor Prognosis)

Subject P8

- Age 5y, 3m at implant
- Chron-lang age gap >50%
- Pre-op (age 4y 11m)
 - Avg lang age 23m
 - Chron-lang gap 36m
 - Gap = 61% of chron age
 - Severe behavior problems
- Post-op (age 6y 2m)
 - 83% sentences (Common Phrases Test)
 - 88% words (GASP)
 - "...currently putting 3-5 words together and beginning to use grammatical markers such as present progressive '-ing' and possessive '-s'."
 - Improved behavior

Results: Category 2 (Poor Prognosis)

Summary Results, Language Delay Group:

- Age range at implant: 2y 4m - 8y 0m
- Pre-CI language gap ranged from 50-78% of chronological age
- Only 2/7 subjects with SLE post-CI
 - Subject P5 language gap 63% → 56% over 16 months
 - Subject P6 language gap 63% → 65% over 28 months
- Overall,
 - 5 subjects appear to be making progress (most slowly)
 - 2 subjects not progressing well; very little benefit

Results: Category 2 (Poor Prognosis)

1 Case Example, CI Profile Concerns Group:

Results: Category 2 (Poor Prognosis)

BTNRH Cochlear Implant Profile

- Modified from ChIP (1989, Manhattan Eye, Ear, & Throat Hospital)
- 13 categories:
 - Chronological age
 - Duration of deafness
 - Medical
 - Multiple handicaps (cognitive, sensory, fine/gross motor)
 - Hearing (amplification, HA use, auditory skills)
 - Vision
 - Speech (oral motor/feeding, vocalizations, articulation)
 - Language (early communication abilities, receptive, expressive)
 - Behavior
 - Intervention (previous, current)
 - Educational/support services
 - Family (support, communication modality, cultural community)
 - Expectations

Results: Category 2 (Poor Prognosis)

Subject P11

- Age 9y, 11m at implant
- CI Profile concerns
- Pre-op concerns:
 - Auditory skills, inconsistent HA use
 - Speech (vocalizations, artic)
 - Family (communication modality → 10 sibs, only mom signs; expectations)
 - Language delay (5y 8m age equivalent scores; age 9y 5m at test)
- Post-op
 - 58% ESP pattern perception (auditory only) at 2 months post-IS
 - 80% correct, environmental vs. speech sounds
 - 90% correct, loud vs. soft, prolonged vs. interrupted

Results: Category 2 (Poor Prognosis)

1 Case Example, Neural Pathology Group:

Results: Category 2 (Poor Prognosis)

Subject P13

- Age 2y, 5m at implant
- Infantile Refsum's
- Pre-op:
 - Consistent HA user, early aided, progressive, TC
 - Vision loss
 - Global developmental delays; motor delays
 - Good early intervention, family support
- 1 Year Post-op:
 - Increased frequency of vocalizations
 - Expanded phoneme repertoire
 - Babble-like sequences (bababa, ninini)
 - Can repeat patterns

Results: Category 2 (Poor Prognosis)

Summary Results for Category 2:

- 12/13 showed some improvement with CI
 - 8/13 showed good/steady improvement with CI
 - 4/13 showed marginal improvement with CI → Definition of benefit?
- 1 suspected non-user

Conclusions

- In general, subjects with significant pre-operative hearing benefit well with a CI
- Unaided, long-term deafened do benefit, but course is slower
- Significant language delays do benefit, but is minimal and slow
- Not a clear definition of "benefit"

Acknowledgements

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