Bilateral Cochlear Implant Guidelines

Gavin Morrison
St Thomas’ Hearing Implant Centre
London, UK
Overview

- Audiometric Candidacy
- UK (NICE) & World Practices
- Auditory Implant Neurophysiology
- Results and Evidence
- Recommendations
Audiometric Candidacy

- UK – NICE
- USA
- Continental Europe
UK: What is NICE?
(Nat. Inst. for Health & Care excellence)

- NICE guidance is developed using the expertise of the NHS and the wider healthcare community.

- The aim of NICE guidance is to promote equalities in health care provision in the UK.

- The focus is to consider cost effectiveness of the treatment.

- Local NHS services have to follow through on the NICE guidance.
Appraisal Committee's recommendations

1. Unilateral cochlear implantation is recommended as an option for children and adults with severe to profound deafness who do not receive adequate benefit from acoustic hearing aids.
Appraisal Committee's preliminary recommendations cont..

2. Simultaneous bilateral cochlear implantation is recommended as an option for the following groups with severe to profound deafness who do not receive adequate benefit from acoustic hearing aids as defined previously:

- prelingual children
- children and adults who are registered as blind
- children and adults who are at risk of ossification of the cochlea (for example after meningitis).
Definitions by NICE

- For the purposes of this guidance, severe to profound deafness is defined as hearing only sounds that are louder than **90 dB at frequencies of 2 and 4 kHz without acoustic hearing aids**.

Adequate benefit from acoustic hearing aids is defined for this guidance as:

- for adults, a score of 50% or greater on Bamford-Kowal-Bench (BKB) sentence testing at a sound intensity of 70 dB

- for children, speech, language and listening skills appropriate to age, developmental stage and cognitive ability.

- Cochlear implantation should be considered for children and adults only after an assessment by a multidisciplinary team..... As part of the assessment children and adults should also have had a valid trial of a hearing aid for at least 3 months usually.
One Implant or Two?

• In the UK: Implant funding was reviewed by NICE in 2006

• Recommendations were released in 2009

  • Children under assessment should be offered 2 implants simultaneously (in the same operation) if clinically appropriate & parents want this

  • Children under 19 years of age, with one implant should be offered the opportunity to have a second implant in their other ear

• Recommendations reviewed - only very minor edits since then.
Appraisal Committee's preliminary recommendations ctd..

3. Bilateral cochlear implantation is not recommended for postlingual children with severe to profound deafness who do not receive adequate benefit from acoustic hearing aids, except in the context of research.

4. Bilateral cochlear implantation is not recommended for adults with severe to profound deafness.
USA Guidelines for Bilateral CI

- American Academy of Audiology: average 90dB or greater at 500 Hz, 1 KHz and 2 KHz and no benefit from hearing aids. (date?)

- Insurers Criteria: U care
  - hearing threshold of pure-tone average of 70 dB (decibels) hearing loss or greater at 500 Hz (hertz), 1,000 Hz, and 2,000 Hz, and have shown limited or no benefit from hearing aids.

- Medicaid:
  - Bilat severe to profound HL

- Dallas Group: Bilateral CI: 6-36mo bilat profound HL, not benefiting from aids

- Peters et al. Laryngoscope 120 May 2010: Survey results < 6kg contraindication?

- James Ramsden et al. Otol Neurotol.

- Currently we feel that the infant or child with unambiguous cochlear implant candidacy should receive bilateral cochlear implants simultaneously as soon as possible after definitive diagnosis of deafness to permit optimal auditory development; and atraumatic surgical technique designed to preserve cochlear function, minimise cochlea damage, and allow easy, possibly repeated, reimplantation is recommended.
Mainland European practice

- Unable to find strict audiometric criteria for most countries
- Threshold assessments not ‘fit for purpose’ anyway, but in infants will remain paramount.

- Belgium
  - 85 dB HL or worse bilat.
  - < 30% monosyllables
St Thomas’ Cochlear Implant Referral Criteria

- Thresholds in severe to profound range......
- Now more patients with more residual hearing in the low and mid frequencies are considered if their high frequency thresholds are in the profound range.
- Limited benefit from hearing aids
Referral criteria for all implants

**Cochlear Implant (CI)**
- Pure tone average >70dBHL at 5, 1, 2, 4kHz or >90dBHL at 2 and 4 kHz in the worse ear
- Limited benefit from hearing aids
- Children do not wait for speech/language delay
- Congenital, acquired, progressive, sudden onset

**Auditory Brainstem Implant (ABI)**
- Unsuitable for CI
- Non-NF2
- Cochlear nerve aplasia
- Cochlear obliteration (atresia, ossification)
- Cochlear nerve avulsion (skull base fracture)

**Electric-Acoustic Stimulation (EAS)**
- Air Conduction (AC) thresholds within shaded area
- Stable sensorineural hearing loss (SNHL)
- No air-bone gap >15dBHL
- Limited benefit from hearing aids
- No external ear contraindications to wearing an earmould
Extended Indications: Changing Audiometric Criteria?

- Rosie Lovett, Debbie Vickers, Quentin Summerfield, UCL 2014 BCIG

4:1 odds of better outcomes with Bilateral CI over H’aids:
- 500 Hz, 1,2,4, KHz = 79 dB, 86 dB, 76 dB in quiet, noise, babble
- 2KHz & 4 KHz = 83 dB, 92 dB, 80 dB

**Conclusion:** 4 frequency PTA mean 80 dB or poorer, 2&4 KHz 85 dB or worse.

- **Asymmetric hearing Loss (Unilateral CI):** Konnie Tzifa & Kate Hanvey, Birmingham UK, Nov 2013 Coch Imp Int. = bimodal benefits

- **A Meta-Analytic Comparison of Binaural Benefits between Bilateral Cochlear Implants and Bimodal Stimulation**
  *Journal of the American Academy of Audiology, 18*(9), 760–776 - See more at:
  http://www.asha.org/Members/ebp/compendium/reviews/A-Meta-Analytic-Comparison-of-Binaural-Benefits-between-Bilateral-Cochlear-Implants-and-Bimodal-Stimulation.htm#sthash.mRBu1ylt.dpuf
St Thomas’ Hearing Implant Centre
- Philosophy

- MULTIDISCIPLINARY TEAM
- Consideration of all factors
  - Audiometric
  - Non-audiometric
  - Expectations
- MDT and Parental/Patient Decision
Implanting the Better ear

Localisation Of Sound

Better Speech Perception in Quiet & Noise

Benefits of Bilateral Implantation

Never without Sound

Improved Quality Of Life
Early and Bilateral Synchronous – potential advantages

- No need for catch up development
- Achieve normal language at normal age
- Better speech in noise
- Binaural sound localisation
- Listener feels auditory ‘balance’
- Enhances neural plasticity
- Stops nerve atrophy
- **Individual achieves maximum potential**
Disadvantages of bilateral?

- Increased surgical complications
  - Not significant
- Preserve ear for future technology
  - Weigh against lost window of opportunity:
    - Neuroplasticity and auditory pathway neuronal nonmaturation/degeneration
    - Critical periods 3.5 yr, 7 years, 12 years

- Bilateral Vestibular damage?
  - 16% caloric hypofunction in early CI literature
  - 1/3 adults had symptoms from unilat.
  - EAS soft surgery cases 0/13 calorics & 1/11 VEMPS altered.
  - Bilat. congenital vestib. loss with good vision do well
When should we implant Unilaterally?

- One ear in criteria and one ear out of it
  - Gives bimodal advantages
- Progressive asymmetric deterioration in ears
  - Eg EVAS
- Patient Preference
  - teenagers - cosmesis
- Medical/Surgical reasons
  - Very low weight, bleeding diathesis, serious medical comorbidity, suppurative ear
- Severe Disabilities
Evidence Bilateral is better
-Auditory & Neuro-Physiology
Binaural Fusion

- Head Shadow Effect
  Physical

- Binaural Squelch Effect
  Central Processing
  Sound Localisation &
  Improved Speech in Noise

- Binaural Summation
  Superior Olivary Complex
Interaural Level Difference (ILD) Cue
HEAD SHADOW EFFECT – Physical Effect mainly for high frequency sounds {up to 20dB (mean 6.4dB)}

Interaural Time Difference (ITD) Cue
Ears determine phase differences (<800Hz) - low frequencies, Centrally processed
Binaural Squelch Effect

- Occurs if noise and signal from different directions
- SNR is more favourable in one ear than the other
- Dependent on central processing (1dB, 0.6 ms) the brainstem compares differences in timing, amplitude, and spectral information between the two ears
- Gives better speech in noise discrimination than one ear alone
Binaural Summation

- Also due to central processing
- Signal received in each ear summated centrally to give perception of a sound twice as loud as if only presented to one ear.
Binaural Squelch and Summation

- Dependent on differences in timing (phase) and amplitude of signal in the brainstem

- Therefore, loss of synchronicity with bilateral implants will stop or reduce central processing benefits.

- However – bilateral CI users and bimodal users do integrate the sounds
Sequential Implant Timing and Outcomes

- Peters et al. 2007
  - 1st implant < 3 yrs age
  - Binaural benefit shows inverse relationship to time of 2nd CI
  - If > 8 yrs at 2nd CI take much longer to show modest gains.

- Cortical auditory evoked potential studies...P1 delays and if 1st CI >7yr never get normal P1 latency

- Longest period between implants 12 years, ideally both between 0 and 6 years
Bilateral Cochlear Implants - Research

- The benefits of bilateral implants include
  - Sound localisation
    (Scherf et al, 2007; Litovsky et al, 2006; Beijen et al, 2007)
  - Better perception of speech in noise & quiet
    (Kuhn et al, 2004), Peters et al, 2007; Wolfe et al, 2007)
  - May ↑ rate of speech & language development
    (Vermeire et al, 2003)
  - Child is never without hearing

- Children who receive bilateral implants earlier may benefit more
  (Wolfe et al, 2007)
Other Bilateral Literature

- Copious....
- Bilateral gives better speech understanding in noise

*William House Study Group 2007*

- Recommended bilateral in children and adults
- Bimodal hearing (one CI and one H’aid) also do better than hearing aids alone
- Bilateral Synchronous increased surgical risks 20% ??
Bilateral Advantages

- Unilateral Cochlear Implant Users Show:
  Poor Speech Understanding in Noise

- Normal-Hearing Two-Ear Listeners Show Binaural Advantages:
  - Improved Speech Understanding in Noise
  - Improved Ability to Locate Sound Sources
But

- Optimal Binaural hearing has not yet been achieved with bilateral CI
- 2 implants lack time dependent synchronisation
- Need to coordinate the two processors (for temporal synchronicity)
- New Processing strategies?
Summary & Recommendations

- Bilateral Simultaneous CI at early age is the default
- Bilat. Gives better Speech in Noise and localization
- Other significant Bilat. Advantages
- Sequential or Unilateral if
  - 1 ear out of criteria, progressive asymmetric loss, patient choice, medical reasons
- Audiometric Candidacy could be changing
  - 2 & 4 KHz move to 85 dbHL or greater?
  - 4 freq PTA mean > or = 80 dbHL?
- Multidisciplinary approach in decisions
- Need for future synchronicity between processors and to achieve full binaural advantages.

THANK YOU