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American Cochlear Implant Alliance Task Force Guidelines for Determining Cochlear Implant Candidacy in Adults with Single-Sided Deafness or Asymmetric Hearing Loss

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Matthew Carlson, MD

Donna Sorkin, MA

Margaret Dillon, AuD, CCC-A

Margaret Dillon, AuD is an Associate Professor and Director of Cochlear Implant Clinical Research in the Department of Otolaryngology/Head & Neck Surgery at the University of North Carolina at Chapel Hill. Her clinical research investigates new indications for cochlear implantation and individualized mapping methods for cochlear implants and electric-acoustic stimulation devices.

Matthew Carlson, MD

Matthew Carlson, MD is a Professor of Otolaryngology and Neurosurgery at the Mayo Clinic, in Rochester, Minnesota. He is currently the cochlear implant program medical director, neurotology fellowship program director, and division chair of neurotology at Mayo Clinic. Dr. Carlson serves as the site director for Headmirror.com, an independent non-profit open access educational resource for otolaryngology trainees and practicing physicians and is the co-chair of the Hearing Health Collaborative, dedicated to overcoming the challenges in advancing good healthcare practices and public policy on hearing care. Dr. Carlson's primary clinical and research interests surround cochlear implant and vestibular schwannoma care and outcomes.

Donna Sorkin, MA

Donna Sorkin, MA is the executive director of the American Cochlear Implant Alliance, a non-profit organization working to expand access to cochlear implants through research, advocacy and awareness. Prior to joining ACI Alliance in late 2012, Donna was Vice President of Consumer Affairs for Cochlear Americas where she led public policy initiatives and activities aimed at the broad life needs of cochlear implant users including insurance practices, habilitation, and educational needs of children with cochlear implants. Ms. Sorkin was previously the executive director of Hearing Loss Association of America and the AG Bell Association for the Deaf and Hard of Hearing. She has served on federal, corporate and university boards including the U.S. Access Board, the National Institute on Deafness, NIH and Gallaudet University. She holds a Masters from Harvard's Kennedy School.

- Presenter Disclosure:
  - Financial: Margaret Dillon is the Associate Professor and Director, Cochlear Implant Clinical Research at UNC Otolaryngology/Head and Neck Surgery. Dr. Dillon is supported by a research grant from MED-EL Corporation. She received an honorarium for this course. Non-financial: Margaret Dillon has no relevant non-financial relationships to disclose.
  - Financial: Matthew Carlson is an employee of Mayo Clinic, in Rochester, Minnesota. Dr. Carlson is supported by research grant provided to Mayo Clinic by Cochlear Corporation. He received an honorarium for this course. Non-financial: Dr. Carlson is on the program committee for the American Cochlear Implant Alliance, Director of Headmirror Inc, and Co-chair of the Hearing Health Collaborative.
  - Financial: Donna Sorkin is employed by the American Cochlear Implant Alliance. Non-financial: Donna Sorkin wears a cochlear implant. She has served on federal, corporate and university boards including the U.S. Access Board, the National Institute on Deafness, NIH and Gallaudet University.
- Content Disclosure: This learning event does not focus exclusively on any specific product or service.
- Sponsor Disclosure: This course is presented by the American Cochlear Implant Alliance in partnership with AudiologyOnline.

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Learning Outcomes

After this course, participants will be able to

- Describe the audiologic, medical, and patient characteristics for consideration in the assessment of cochlear implantation candidacy for adults with SSD and AHL.
- Review the observed performance benefits of cochlear implant use for patients with SSD and AHL on measures of speech recognition in quiet.
- Discuss the guidelines for the preoperative evaluation and post-activation assessment and management of adults with SSD and AHL.

American Cochlear Implant Alliance Task Force Guidelines for Determining Cochlear Implant Candidacy

American Cochlear Implant Alliance
www.acialliance.org

Why another organization in hearing health?

- Membership organization focused on cochlear implantation and access to care
- Members are audiologists, physicians, speech pathologists, educators and others on CI teams + scientists, adults with CI/parents, advocates
- Website designed for those in and out of CI
- Highly collaborative with other organizations
- Welcome your involvement!

www.acialliance.org

https://www.facebook.com/ACIALLIANCE.ORG/

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American Cochlear Implant Alliance

- Mission: Advance access to the gift of hearing provided by cochlear implantation through research, advocacy and awareness
- Address factors contributing to underutilization of cochlear implants
- Improve awareness regarding candidacy and outcomes
- Objective today: Share information on how CI candidacy is determined for specific population

Four Part Series on Determining Candidacy in Adults and Children

- In 2019, CI utilization by US adult candidates was 5-8%
- ACI Alliance Task Force on how we determine CI candidacy for different populations
- **Adults**: (1) Bilateral deafness and (2) SSD+Asymmetric hearing loss
- **Children**: (1) Bilateral deafness and (2) SSD

American Cochlear Implant Alliance Task Force Guidelines for Clinical Assessment and Management of Adult Cochlear Implantation for Single-sided Deafness and Asymmetric Hearing Loss

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Outline

- Background
  - Influence of SSD and AHL
  - Cochlear implantation as a treatment option
- Candidacy considerations for adults with SSD and AHL
- Post-activation management of cochlear implant (CI) recipients with SSD and AHL
- ACI Alliance Guidelines

Background

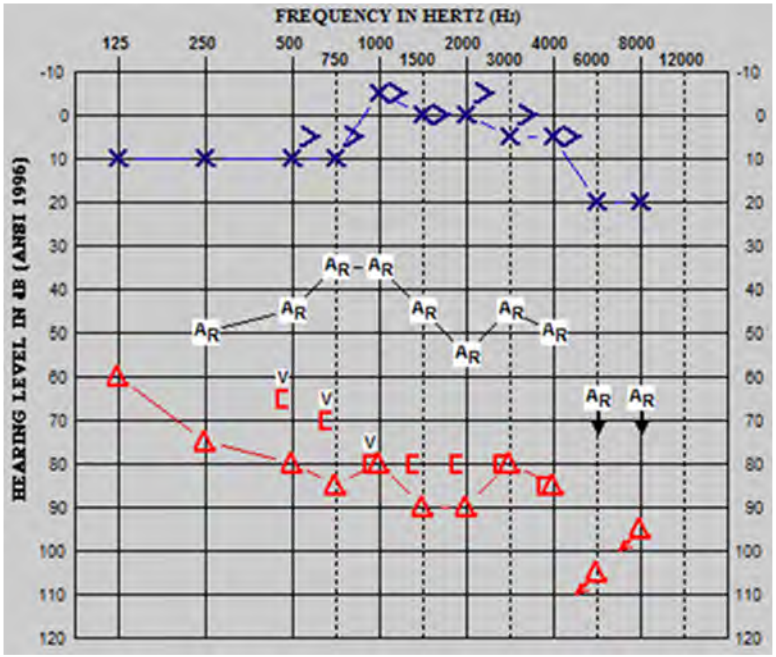
SSD: Influence

Spatial Hearing

- Poorer sound source localization
- Limited speech recognition in noise

Quality of life

- Poorer reported quality of life
- Increased report of hearing handicap



Slattery & Middlebrooks, 1994; Rothpletz, Wightman, & Kistler, 2012

SSD: Treatment options

Non-surgical options

- No treatment
- Conventional hearing aid
- Contralateral routing of the signal (CROS) hearing aid
- Bone conduction hearing aid

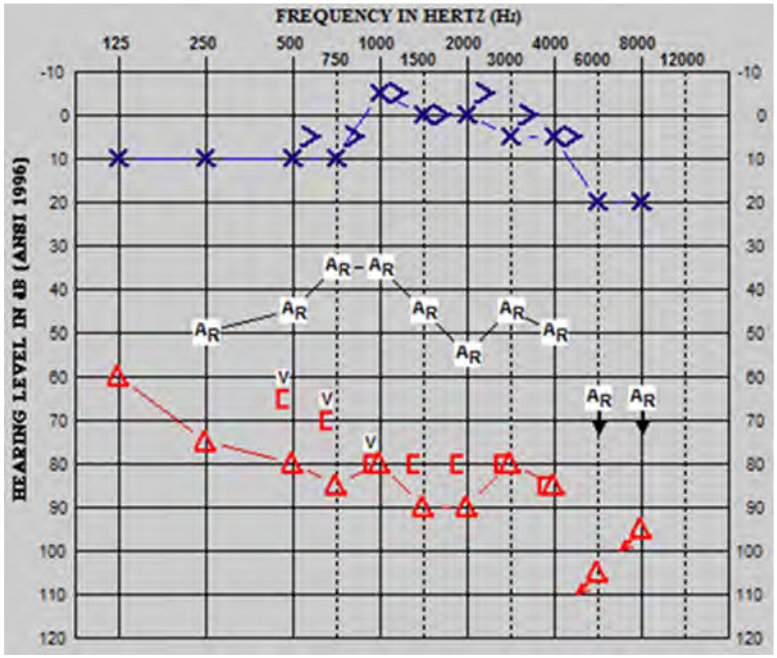
Limited benefits

- Increased sound awareness
- Performance benefit in specific situations
- Limited performance on spatial hearing tasks (localization & speech recognition in noise

Agterberg et al., 2019; Hol et al., 2005; Kitterick et al., 2016; Snapp et al., 2017; Snapp & Ausili, 2020

SSD: Cochlear implantation

Are cochlear implant (CI) recipients with SSD able to integrate the signals from the CI and the normal hearing ear for improved spatial hearing and subjective benefit?



SSD: Cochlear implantation

History

Treatment for incapacitating tinnitus

- Significant reduction in tinnitus severity
- Significant improvement in speech recognition and performance on tasks of spatial hearing

Comparison to rerouting technologies & unaided conditions

- Significant improvements with CI use on measures of sound source localization, speech recognition in noise, & subjective benefit/quality of life

van de Heyning et al., 2008; Vermeire & van de Heyning, 2009; Arndt et al., 2011, 2017; Punte et al., 2011; Firszt et al., 2012; Hansen et al., 2013; Távora-Vieira et al., 2013; Döge et al., 2017

SSD: Cochlear implantation

History

2013

- Approval for SSD and AHL indications for children and adults in the EU

2019

- US FDA approval for SSD and AHL indications for individuals 5 years of age and older

SSD: Cochlear implantation

- Cochlear implantation is an effective treatment option for adults with SSD
- Considerations for candidacy, test methods, and mapping specific to this patient population
- Benefits of CI use for adults with SSD:
  - Improved speech recognition in the CI ear
  - Improved spatial hearing in the combined condition
  - Tinnitus suppression
  - Improvements in subjective benefit compared to preoperative performance

Cochlear implantation: Candidacy considerations

Candidacy considerations

- Etiology
- Potential contraindications
- Imaging
- Duration of SSD
- Age at implantation
- Tinnitus severity
- Experience with alternative hearing technologies
- Subject benefit/Quality of life

Candidacy considerations

Etiology

- Most etiologies are not a contraindication for CI

- Consideration of onset
  - Medical work-up for cases of sudden and/or rapid progression
  - Adaptation to monaural condition

- Risks for future hearing loss

Candidacy considerations

Potential contraindications

- Severe cochlear ossification
- Cochlear nerve aplasia
- Retrocochlear tumors
  - Some cases may benefit if auditory nerve is intact

Carlson et al., 2012, 2016; Deep et al., 2019

Candidacy considerations

Imaging

- Magnetic resonance imaging (MRI)

- Temporal bone computed tomography (CT)

Candidacy considerations

Duration of SSD

- Longer durations of SSD may be associated with poorer performance
- Discrepancy in the literature as to the effect of duration of SSD on performance & subjective benefit
- Considerations of congenital SSD versus adult-onset

Távora-Vieira et al., 2013, 2015; Arndt et al., 2011, 2017; Cohen & Svirsky, 2019; Kral et al., 2013; Firszt et al., 2018

Candidacy considerations

Age at implantation

- Advanced age is not a contraindication to CI

Távora-Vieira et al., 2015; Firszt et al., 2012; 2018

Candidacy considerations

Tinnitus severity

- Reduction in tinnitus severity reported by CI recipients
  - Preoperative reports ranging from slight to incapacitating
  - Benefit beyond simple masking
  - Residual inhibition

Van de Heyning et al., 2008; Vermeire & Van de Heyning, 2009; Punte et al., 2011; Dillon et al., 2017; Arndt et al., 2011; Litovsky et al., 2019; Sladen et al., 2017; Poncet-Wallet et al., 2020

Candidacy considerations

Experience with alternative hearing technologies

- Discussion & trial(s) with a non-surgical hearing technology prior to CI
  - CROS hearing aid
  - Bone conduction hearing aid

Desmet et al., 2012; Friedmann et al., 2016; Kitterick et al., 2014

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Candidacy considerations

Subject benefit/Quality of life

- Speech, Spatial, & Qualities of Hearing Scale (SSQ; Gatehouse & Noble, 2004)
- Health Utilities Index (Furlong et al., 2001)
- Cochlear Implant Quality of Life (CIQOL; McRackan et al., 2019)
- Tinnitus Handicap Inventory (THI; Newman, Jacobson, & Spitzer, 1996)
- Tinnitus Functional Index (TFI; Henry et al., 2016)

Vermeire & Van de Heyning, 2009; Távora-Vieira et al., 2013; Arndt et al., 2011, 2017; Firszt et al., 2012; Mertens et al., 2015; Dillon et al., 2017; Galvin et al., 2019

Candidacy considerations

Counseling

- Alternative technologies
- Implications of no treatment
- Description of surgical procedure
- Postoperative management
- Devices
- Assessment & mapping follow-up timelines
- Realistic expectations
- Commitment to “full time” use

Cochlear implantation: Post-activation management

Post-activation management

- Audiologic assessment
- Mapping
- Aural rehabilitation

Post-activation management

Audiologic assessment

Test Battery

- Unaided hearing detection thresholds
- Need to isolate the input to the affected ear
- Spatial hearing abilities

Post-activation management

Audiologic assessment

Unaided hearing detection thresholds

- Preoperative
  - Diagnostic evaluation of hearing
- Postoperative
  - Residual hearing in implanted ear
  - Monitor hearing stability of contralateral ear

Post-activation management

Audiologic assessment

Affected ear

Isolate the input from the normal-hearing ear

- Preoperative
  - Assess performance with a conventional HA
- Post-activation
  - Assess performance with the CI

Post-activation management

Audiologic assessment

Affected ear

Test Methods

- Use of direct audio input (DAI) technology
- Plug & muff
- Masking & muff

Firszt et al., 2012; Buss et al., 2018; Friedmann et al., 2016; Galvin et al., 2019; Hansen et al., 2013; Zeitler et al., 2015; Sladen et al., 2017; Deep et al., 2021

Post-activation management

Audiologic assessment

Affected ear

Test Materials

- CNC words (Peterson & Lehiste, 1962)
- AzBio sentences in quiet (Spahr et al., 2012)

Firszt et al., 2012; Buss et al., 2018; Friedmann et al., 2016; Galvin et al., 2019; Hansen et al., 2013; Zeitler et al., 2015; Sladen et al., 2017; Deep et al., 2021

Post-activation management

Audiologic assessment

Spatial hearing

- Primary reason for pursuing CI
- Performance with CI alone may not reflect performance with the CI+NH

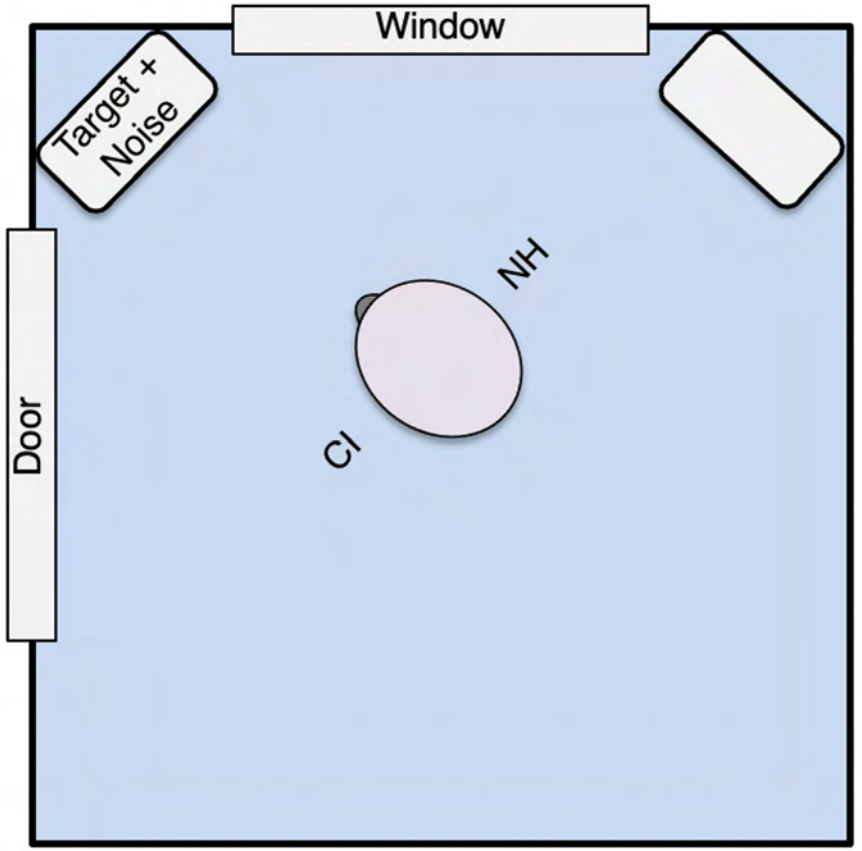
- Tasks
  - Speech recognition in spatially-separated noise
  - Sound source localization

Buss et al., 2018; Bernstein et al., 2020; Deep et al., 2021

Post-activation management

Audiologic assessment

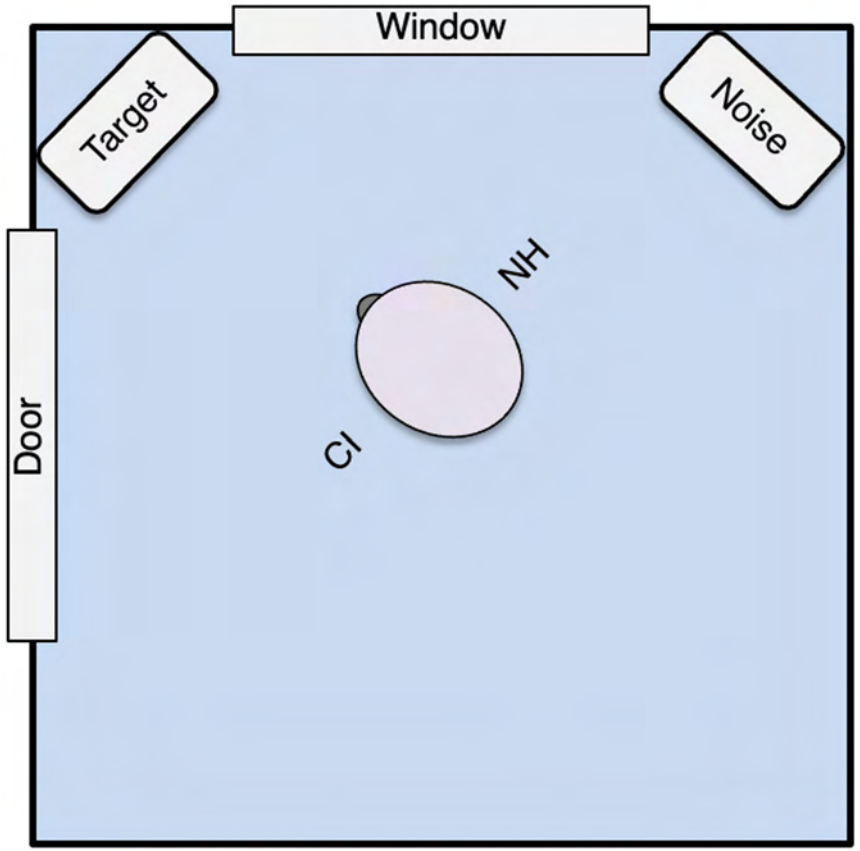
Spatial hearing



Post-activation management

Audiologic assessment

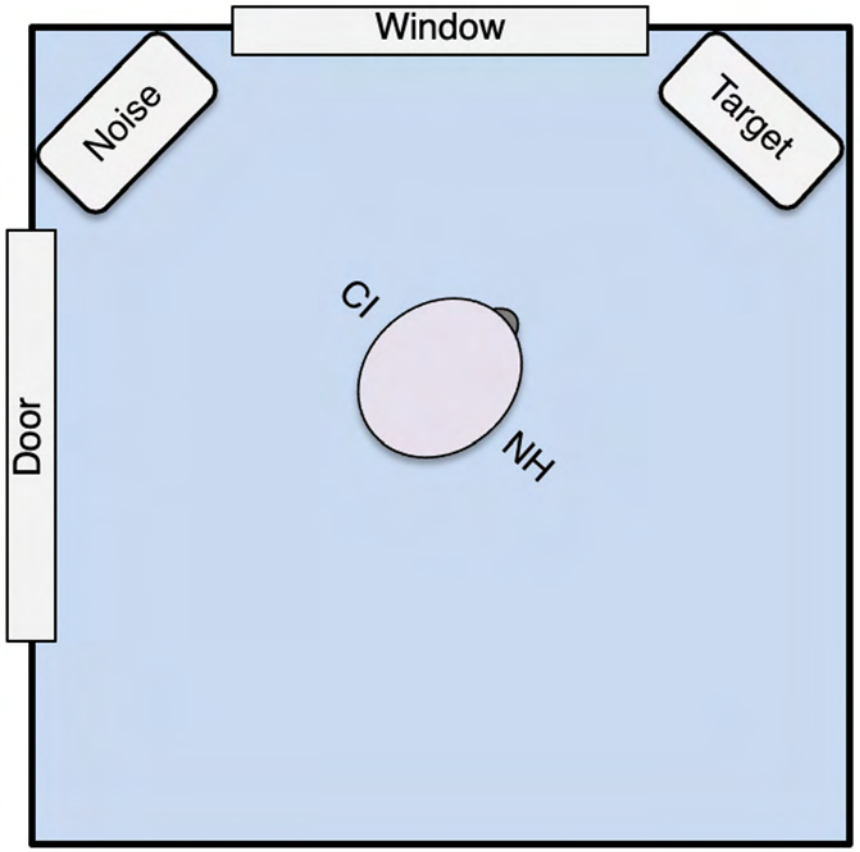
Spatial hearing



Post-activation management

Audiologic assessment

Spatial hearing



Post-activation management

Audiologic assessment

Tools to assess benefit

- Word recognition with the CI alone
- Speech recognition in spatially-separated noise
- Questionnaires specific to tinnitus perception & subjective benefit

Post-activation management

Mapping

Electric thresholds & maximum comfortable loudness

- Plug normal-hearing ear
  - Threshold levels (limit environmental noise)
  - Comfort levels
    - Rank loudness on individual channels
      - Behavioral measurement
      - Electrical Stapedial Reflex Threshold (ESRT)
    - Balance loudness across channels

Shapiro & Bradham, 2012; Buss et al., 2018; Dillon et al., 2019

Post-activation management

Mapping

Electric maximum comfortable loudness

- Unplug normal-hearing ear
  - Loudness balancing with normal-hearing ear

Dillon et al., 2019

Post-activation management

Mapping

Mapping frequency information with the contralateral ear

- Frequency-to-place mismatch
  - Discrepancy between the frequency filter information and the cochlear place frequency
- Poorer spatial hearing observed with interaural mismatches
- Matching the frequency information
  - Long electrode array
  - Map filter frequencies to match the cochlear place frequency

Goupell et al., 2013; Kan et al., 2013; Zhou et al., 2017; Xu et al., 2020

Post-activation management

Aural rehabilitation

- Incorporated into the initial weeks & months of CI use
- Some recommend 20-30 minutes/day

Methods

- Isolate input to CI via DAI
- Bilateral training
- Localization training

Arndt et al., 2017; Buss et al., 2018; Nawaz et al., 2014; Távora-Vieira & Marino, 2019; Yu et al., 2018; Távora-Vieira et al., 2015; Firszt et al., 2015

ACI Alliance Guidelines

ACI Alliance Guidelines

1. It is recommended that individuals with sudden and/or rapid progression of SSD undergo standard medical work-up and monitoring to determine if the hearing spontaneously improves or is recoverable with treatment, and that cochlear implantation should not occur earlier than 3 to 6 months after sudden hearing loss to allow ample time for potential recovery of hearing. The potential exception to this is cases exhibiting evidence of progressive ossification (e.g., meningitis, after vestibular schwannoma resection, otic capsule fracture) where early implantation may be advantageous.

ACI Alliance Guidelines

2. Consideration of the potential for significant bilateral hearing loss is warranted, as well as the benefits of early implantation of the impaired hearing ear for long-term performance benefit.

3. Preoperative imaging may include MRI with or without temporal CT. In most cases of acquired adult-onset SSD, an MRI alone is sufficient to evaluate for retrocochlear lesions, labyrinthine ossification, and inner ear malformations.

ACI Alliance Guidelines

4. Cases of advanced cochlear ossification, severe labyrinthine dysplasia, and cochlear nerve aplasia are potential contraindications for cochlear implantation, particularly in the setting of SSD where there is a heightened risk of device non-use.

ACI Alliance Guidelines

5. Some consideration is recommended for the potential effect of long durations of SSD on functional outcomes; however, prolonged duration of deafness in an adult with post-lingual onset is not a contraindication to cochlear implantation. Additional consideration is recommended for an adult with congenital SSD onset. Prolonged duration of deafness combined with congenital SSD onset may result in limited CI outcomes.

ACI Alliance Guidelines

6. Advanced age is not a contraindication for cochlear implantation. Consideration for cochlear implantation should prioritize the overall health of the individual as opposed to the chronological age at implantation.

7. Reduced tinnitus severity is frequently reported after cochlear implantation and/or with CI use. It is recommended to obtain subjective measures preoperatively to establish a baseline of tinnitus severity that can be compared to postoperative and post-activation perceptions.

ACI Alliance Guidelines

8. It is recommended that non-surgical options are discussed with adult cases of SSD, and where possible, that patients are offered a trial with a non-surgical hearing technology prior to undergoing cochlear implantation.

ACI Alliance Guidelines

9. Preoperative counseling for cochlear implantation typically includes a description of the surgical procedure and associated postoperative management, CI devices, and mapping and assessment follow-up recommendations/protocols. It is recommended that the counseling of CI candidates with SSD also include discussion of alternative hearing technologies for SSD, the implications of no treatment, CI device considerations, and realistic expectations.

ACI Alliance Guidelines

10. The preoperative and post-activation test battery should include subjective questionnaires to assess the perceived benefit of CI use, quality of life, and/or tinnitus severity.

11. For CI recipients with preoperative moderate or better acoustic low-frequency hearing detection thresholds in the affected ear, hearing preservation should be monitored postoperatively by assessment of unaided hearing detection thresholds.

ACI Alliance Guidelines

12. One consideration when assessing the impaired ear for cases of SSD is the need to isolate the input from the contralateral, normal-hearing ear. Test methods used to isolate the input to the affected ear during the measurement of aided sound field thresholds and speech recognition include: 1) use of direct audio input technology, 2) plugging the contralateral ear and placing a circumaural phone over the pinna, and 3) presenting masking to the contralateral ear via an insert phone and placing a circumaural phone over the pinna.

ACI Alliance Guidelines

13. It is recommended that the test battery for adults with SSD also include the assessment of spatial hearing, such as speech recognition in spatially-separated noise.

14. For the behavioral measurement of electric threshold levels, it is recommended to plug the normal-hearing ear with an insert plug to limit the influence of environmental noise. For the behavioral measurement of MCL levels, the normal-hearing ear may remain plugged during procedures to rank loudness for individual channels and to balance loudness across channels.

ACI Alliance Guidelines

15. Wear time of the CI is associated with outcomes for adults with SSD. A minimum of 8 hours of device use per day is recommended.

16. Auditory training is recommended within the initial months of CI use.

Thank you!

- **References:** PDF of references available for participant download