Rehabilitation Assessment after Cochlear Implantation: What to Measure and How

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Learning Objectives

- To describe areas of development to be assessed after cochlear implantation
- To list what resources are available to use for assessment of skills
- To explain formal scores
- To describe delay versus disorder
- To list some disorders that are frequently diagnosed in children who have a cochlear implant and an additional disorder
- To identify steps to assist in determining differential diagnosis
Trends

- Increase in early identification due to mandated newborn hearing screening
- Increase in cochlear implantation due to awareness and success
- Increase in implantation at younger ages (FDA guidelines now > 12 months)
- Increase in survival rates of “at risk” infants
- Increase in deaf and hard of hearing population with multiple disabilities

Multiple Disabilities in the Deaf and Hard of Hearing Population

- Approximately 40% of children with hearing loss have additional identified special needs (handicapping conditions) with non-verbal and verbal learning disability and mental retardation as most common

Trends

• More children with identified other issues referred for implantation
• More children are referred before other issues are identified

Areas to be Assessed
Areas

• Access to speech (awareness, perception): Audiologist
• Reading, writing, math, etc. (academics): Teacher
• Speech, receptive and expressive language, articulation: Speech-Language Pathologist/Teacher

Specific Areas (Rehabilitation)

• Auditory/Receptive Language
• Expressive Language
• Vocabulary
• Articulation
Where to Start: Informal or Formal Tests?

- How much language does the child have?
- Can the child participate in picture pointing tasks vs needing manipulatives vs parent questionnaire?
- Can formal tests be used but are not age-appropriate?
Criterion-referenced vs. Norm-referenced?

- Norm-referenced tests are designed to rank test takers on a “bell curve,” – compare to distribution of scores.
- Criterion-referenced tests measure performance against a fixed set of criteria - has a specific skill been acquired?

Reliability and Validity

- **Reliability:** refers to the consistency of scores obtained with the theoretical concept of repeatedly testing the same individual on the same test under identical conditions (including no changes to the individual).

- Test is **valid** to the extend that it measures what it intends to measure. Requires multiple sources of information for validation.
Scores

- **Raw Score:** total number of items correct on the test

- **Standard/Scaled Score:** has normalized score scale that has a mean of 10 or 100 which describes the average of a given age group (about two-thirds of all students with typical language development earn subtest scores between one standard deviation above and below the mean). Is a statistic that expresses how much a child's score deviates from the average score of the test group. Represented in equal interval scale.
  - standard mean of 10, deviation +/- 3
  - standard mean of 100, deviation +/-15
    - one standard deviation = 85, 115
    - two standard deviations = 70, 130
    - three standard deviation = 55, 145

Standard Scores (continued)

- +1 standard deviation = above average
- within + or – 1 standard deviation = average
- within -1 to -1.5 standard deviations = borderline/mild
- within -1.5 to -2 standard deviations = low range/moderate
- -2 standard deviations and below = very low range/severe

Able to look at standard/scaled scores over time:
- if stays the same = 1 year of progress in 1 years time
- if increases = more than 1 years progress
- if decreases = child's language gap increasing
Scores

- **Percentile Rank**: indicates a student's standing relative to others of the same age in the norm group. Percentile rank of 25 means student performs as high or higher than 25% of other students of the same age and that 75% of the students in the standardization sample earned higher scores.

- Useful for explaining a student’s performance relative to the performance of others.

- Do not have equal intervals like standard/scales scores. For students who score within average range, a change of 1 or 2 total raw score points may produce a large change in the percentile rank, a student who scores very low with a change of 1 or 2 raw score points is not likely to produce a large change in the percentile rank.

- Percentile ranks from 16 through 84 are within one standard deviation of the mean.

Scores

- **Age-Equivalency**: indicates the age at which a given raw score is the one typically obtained by children of a given age.

- Does not give information about the range of scores for children in specific age group.

- Does not give information needed to determine if child has a language disorder.

- Even though age may be "one year" behind age group, may still be within normal limits.

- Is not true that a child’s skills are equivalent to children of the age indicated by the age equivalent (may have strong skills in one area ie: vocabulary, but not same age level grammatical structures), is only relevant to the correct number of responses on the test.
Scores

- **Confidence Band/Interval:** there is a margin for error in the results obtained on a test, you would never consider the score obtained on a standardized test as a perfectly precise measure of ability.
  - Is most appropriate to consider a child’s true score as lying within a range of scores (confidence band/interval).
  - You can establish the boundaries of this band/interval to reflect different levels of confidence in a child’s score.

- **Composite Scores/Quotients:** some tests provide information about a child’s strengths and weaknesses across receptive and expressive modalities, the scores are formed from the scores of several subtests.
Auditory Skills Pyramid

Level 5A and B
Processing
Comprehension

Level 4
Identification

Level 3
Segmental-Association/
Identification

Level 2
Suprasegmental-Discrimination/
Association

Level 1
Awareness

Language Levels

Level 6
Complex Sentences

Level 5
Expanded Sentences

Level 4
Simple Sentences

Level 3
Connected Utterances

Level 2
Word Production

Level 1
Word Approximation
Early Intervention (0 – 3):

- Rossetti Infant Toddler Language Scale
- Early Language Milestones-2 (ELM-2)
- Preschool Language Scale-5 (PLS-5)
- Sequenced Inventory of Communication Development-Revised (SICD-R)
- Receptive-Expressive Emergent Language Test-3 (REEL-3)

Formal Tests: 3 to 12 Years of Age (not all)

- Preschool Language Scale-5
- Clinical Evaluation of Language Fundamentals-Preschool 2 and 5 (CELF-P:2) (CELF-5)
- Test of Language Development-Primary 4 (TOLD-P:4)
- Test for Auditory Comprehension of Language-4 (TACL-4)
- Test of Semantic Skills-Primary and Intermediate (TOSS-P, TOSS-I)
Formal Tests: 3 to 12 Years of Age (not all)

- Oral and Written Language Scale-II (OWLS-II)
- Test of Early Language Development (TELD-3)
- Comprehensive Assessment of Spoken Language (CASL)
- Test of Auditory Processing Skills-3 (TAPS-3)
- Language Processing Test-Revised (LPT-R)
- The Listening Comprehension Test (LCT)
- Test of Problem Solving-3 (TOPS-3)

Formal Tests: Older than 12 Years of Age

- Clinical Evaluation of Language Fundamentals-5 (CELF-5)
- Test of Language Development-Intermediate 4 (TOLD-I:4)
- Oral and Written Language Scale-II (OWLS-II)
- Comprehensive Assessment of Spoken Language (CASL)
- Test of Adolescent and Adult Language-4 (TOAL-4)
- Fullerton Language Test for Adolescents (FLTA)
- Test of Auditory Processing Skills-3 (TAPS-3)
Vocabulary Testing

- MacArthur-Bates Communicative Development Inventories (CDIs)
- Peabody Picture Vocabulary Test-4 (PPVT-IV)
- Receptive One-Word Picture Vocabulary Test-4 (ROWPVT-4)
- Expressive One-Word Picture Vocabulary Test-4 (EOWPVT-4)
- Expressive Vocabulary Test-2 (EVT-2)
- Boehm Test of Basic Concepts-3 (Boehm-3)
- CREVT-3 Comprehensive Receptive and Expressive Vocabulary Test-3 (CREVT-3)
- The Word Test-Elementary 2
- Test of Word Finding-2 (TWF-2)
Hierarchy of Speech Intelligibility

- Stage 6: Sentences
- Stage 5: Phrases
- Stage 4: Words
- Stage 3: Sound Sequences
- Stage 2: Isolation
- Stage 1: Pre-Speech

Tests and Tools:

- Goldman Fristoe Test of Articulation-2
- Structured Photographic Articulation Test-Revised (SPAT-D II)
- Photo Articulation Test (PAT-3)
- Khan-Lewis Phonological Analysis (KLPA)
- Kaufman Speech Praxis Test for Children (KSPT)
- Arizona Articulation Proficiency Scale
Tests Specific to Children with Hearing Loss

- LittlEARS® Auditory Questionnaire (LEAQ)
- Auditory Skills Checklist
- Open-and Closed-set Task® (O&C)
- Evaluating Auditory Responses to Speech- Revised (EARS ®)
• The SKI*HI Language Development Scale
• Grammatical Analysis of Elicited Language Pre-Sentence Level (GAEL-P)
• Grammatical Analysis of Elicited Language Simple Sentence Level (GAEL-S)
• The Teacher Assessment of Grammatical Structures (TAGS-) P (Pre-sentence), S (Simple Sentences), C (Complex Sentence)
• Cottage Acquisition Scales for Listening Language Speech (CASLLS)

Delay vs. Disorder
Delay vs. Disorder

Speech delay
Language delay
Speech and language delay
Hearing loss + concomitant disorder

= 

Child with hearing loss may have a delay OR a disorder

DEFINITIONS

Delay: skills are developed in accordance with a normal developmental sequence but may not be at the same rate of normal developmental peers. Expect to catch up.

Disorder: aberrant production and/or reception of linguistic units. Have gaps in speech and/or language development. May have atypical developmental sequence of acquisition. May always have disorder. May not catch up.
Possible Disorders

- Articulation/Phonological Processes
- Apraxia of Speech (motor speech disorder where children have problems saying sounds, syllables, and words. The brain has difficulty coordinating the muscle movements).
- Dysarthria (articulation errors speech due to disturbances of muscular control resulting from central or peripheral nervous system damage).

Speech Disorders
Language Disorders/Other Disorders

- **Auditory/Language Processing, Specific Language Impairment** (In absence of cognitive issues, vocabulary slower to develop, auditory memory issues, difficulty with following lengthy directions or understand larger paragraphs of information, difficulty with comprehension—especially abstract information)

- **Attention Deficit Disorder** (Harder time staying on topic, topic switching, difficulty with extracting or choosing appropriate information, pragmatic issues (interrupting), difficulty focusing on and processing what is heard)

Language Disorders/Other Disorders

- **CHARGE Syndrome**
  - Is a constellation of congenital malformations. The name is an acronym of some of the most frequent features:
    - C = coloboma of the eye and cranial nerve abnormalities
    - H = heart malformation
    - A = choanal atresia
    - R = retardation of growth after birth and retardation of development
    - G = genital hypoplasia (underdevelopment) in males and urinary tract malformations
    - E = ear malformations and/or deafness

  Development of verbal expressive and speech production appear more impacted than auditory receptive language
  
  May take extended periods of time to make some progress
Auditory Neuropathy Spectrum Disorder

Panel of experts met at NHS 2008 and Deborah Hayes and Yvonne Sininger developed guidelines based on input

• use term ANSD to refer to disorder characterized by evidence of normal cochlear outer hair cell (sensory) function and abnormal auditory nerve function

• minimum audiological test battery to diagnose includes presence of normal or near-normal otoacoustic emissions or cochlear microphonics and absent or markedly abnormal auditory brainstem response

• developmental trajectory of each child is unique

Language Disorders/Other Disorders

• Autism
• Cerebral Palsy
Differential Diagnosis

Why: Facilitate vs. Remediate

How: Informal assessment to formal assessment and monitoring progress over time.
Differential Diagnosis

1st: Identify the problem

2nd: Auditory discrimination-hearing appropriately?

3rd: Remediate

4th: Monitor progress-resolving in a timely manner? (response to intervention)

5th: Make determination of delay versus disorder

Example: K

Current Age: 1.7
Age at Time of Implant: 1 year
Services: Home-based early intervention-teacher of the deaf 2 hours/week
Mode of Communication: Listening and spoken language
K: 7 months post-implant

**Auditory Skills:** understands around 100 words, follows one-step directions = Level 4 Identification
Timeline: low goal- 1 key word by 9 months
Yes

**Expressive Language Skills:** uses around 10 single words = Level 2 Word Production
Timeline: Level 2 (under 2)- produce 10 true words by 9 months
Yes

Speech Skills: primarily uses intonation or nasal /ah/ to mark sounds and number of syllables; uses some /m/-mostly prolonged production; no babble = Stage 1 Pre-Speech
Timeline: Stage 2 (under 2)- Isolation-produce 2 – 3 different consonants in babble by 6 months
No
K Differential Diagnosis:

1st: Identify the problem

Lack of oral resonance and lack of consonants, lack of babble

2nd: Auditory discrimination-hearing appropriately?

Auditory skills appropriate

3rd: Remediate

Referred for speech therapy

4th: Monitor progress-resolving in a timely manner? (response to intervention)

After 2 years of therapy: produces /b, p, m, w, n, d, t, g/; mostly oral resonance; examples: window/window, boat, dow/cow, teboh/telephone, dindow/dinosaur, ebint/elephant but continued to have persistent articulation errors

5th: Determination: speech disorder with prognosis of intelligible speech
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