# CLINICAL AUDITORY EVOKED POTENTIALS: TIPS, TRICKS, AND CASES

CAITLIN SAPP, AU.D. PH.D. CCC-A


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## INTRODUCTION

Pediatric Audiologist & Researcher

Head of Pediatric Audiology at UNC Chapel Hill Medical Center

AuD and PhD at the University of Iowa

UNC HEALTH

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

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**EARLY HEARING LOSS LABORATORY**

UNC MEDICAL CENTER
CAITLIN SAPP, AUD, PHD
DIRECTOR

External Research Collaborations

- OCHL Consortium

Internal Research Projects

- cCMV Working Group
- Audiological care patterns in bacterial meningitis
- Pre-implant auditory experience

UNC HEALTH

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3.7 million total births
(3,791,712)

5

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39k require additional testing
(38,634)

6


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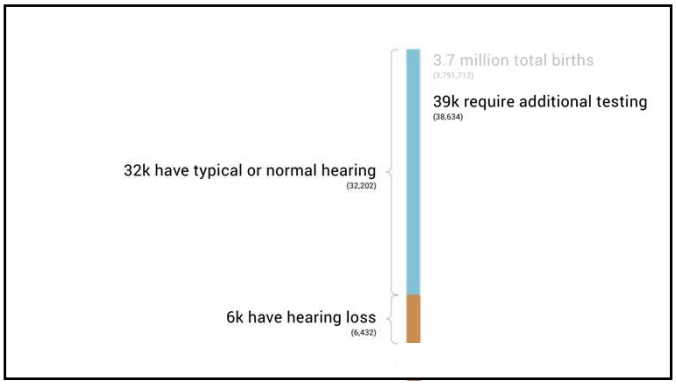
3.7 million total births
(3,791,712)
39k require additional testing
(38,634)
32k have typical or normal hearing
(32,202)
6k have hearing loss
(6,432)

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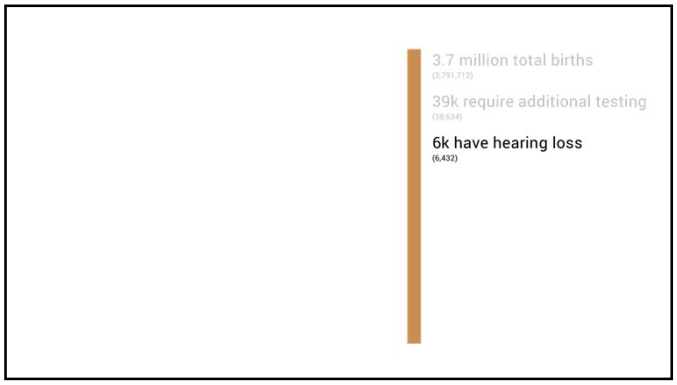
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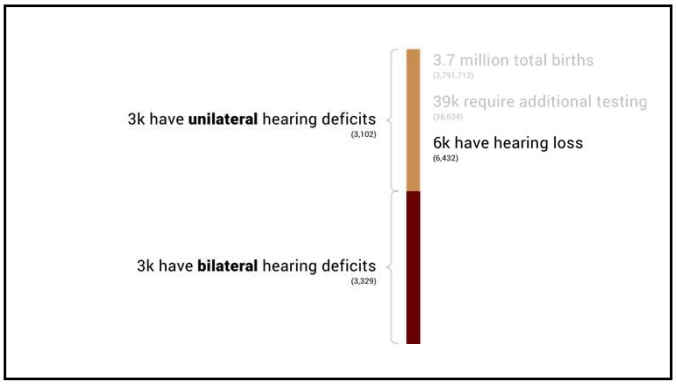
3.7 million total births
(3,791,712)
39k require additional testing
(38,634)
3k have **unilateral** hearing deficits
(3,102)
6k have hearing loss
(6,432)
3k have **bilateral** hearing deficits
(3,329)

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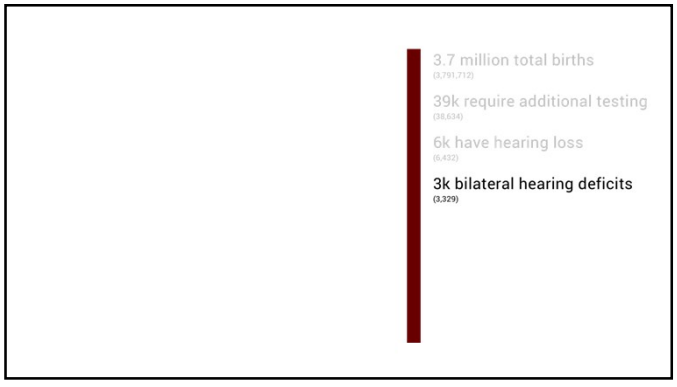
3.7 million total births
(3,791,712)
39k require additional testing
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6k have hearing loss
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3k bilateral hearing deficits
(3,329)

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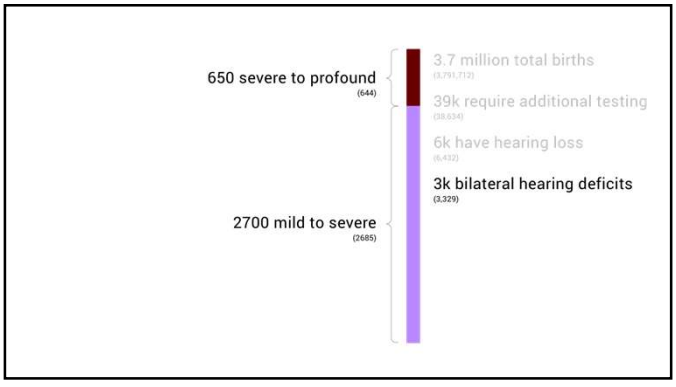
650 severe to profound
(644)
3.7 million total births
(3,791,712)
39k require additional testing
(38,634)
6k have hearing loss
(6,432)
3k bilateral hearing deficits
(3,329)
2700 mild to severe
(2685)

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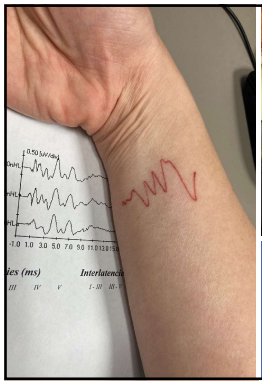

ABR plays an **enormous** role in our ability to deliver on the promise of newborn hearing screening and it's up to us to get it right!

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AGENDA

- When to choose ABR
- Sedated v. Non-sedated
- Types of sedation commonly used for ABR
- ABR versus ASSR
- ANSD presentation on ABR
- Look at some cases

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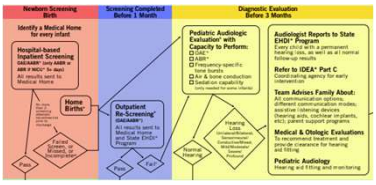
## WHEN TO CHOOSE ABR

- After "refer" or fail on the newborn hearing screening
- Concerns about accuracy of behavioral results
- Can't take part in behavioral assessment
- Confirmation of HL under age 3

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## REMINDER: ABR IS ONE OF SEVERAL EVOKED POTENTIALS

- The same auditory evoked potentials equipment can measure several distinct neural events in respond to sound
  - **ABR**
  - **Auditory Steady State Response (ASSR)**
  - Auditory Middle-Latency Response
  - Auditory Late Response
  - P300
  - Mismatch Negativity (MMN)
  - Electrocochleography (ECochG)

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## THINK ABOUT ASSESSMENT AS A HIERARCHY:

First • Behavioral hearing assessment

Second • Non-sedated ABR

Third • Sedated ABR

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## DIAGNOSTIC AUDITORY BRAINSTEM RESPONSE (ABR)

Two main evaluation purposes

- Threshold search ABR
  - Create an approximation of hearing thresholds at individual frequencies
  - Variable stimuli, presentation level
- Neurodiagostic ABR
  - Assess the integrity of the retrocochlear pathway
  - Typically fixed stimuli and level

(STARR ET AL., 1975; STAPELLS AND OATES, 1997)

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## MANAGING MEDICAL TEAMS OFTEN NEED HELP DIFFERENTIATING THE DIAGNOSTIC ABR FROM THE SCREENING AABR.

- AABR
  - Fixed level and stimulus type
  - Completed by any trained screening staff person
  - Digital algorithm analyzes the EEG information
  - Yields a Pass or Fail response
  - No interpretation required or possible
  - Hearing status is unknown, only need for further testing
- Diagnostic ABR
  - Completed by an audiologist
  - Can vary the stimulus type, frequency, and presentation level
  - Strong correlation with behavioral hearing thresholds
  - Yields estimated hearing thresholds across frequencies
  - Can be used to program hearing devices
  - Often co-scheduled with an ENT

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## PREPARING FOR A CLINICAL ABR

### Equipment

- AEP set up
- Electrodes
  - Disposable
  - Snap
  - Eardrum level
- Earphones

### Parameters

- **Stimulus Type**
- Rate
- Gating
- Display height
- Gain
- Time window
- Polarity

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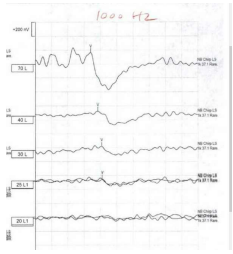
## PEAK PICKING IN A CLINICAL ENVIRONMENT

- Visual discernment
  - Growth
  - Latency shift
  - Replicability
  - Morphology varies with stimulus
- Chirp morphology complicates peak picking

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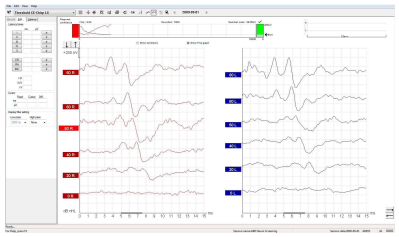
## PEAK PICKING IN A CLINICAL ENVIRONMENT

- Objective criteria
  - Considered present or absent based on measureable qualities of the waveform
  - Low Noise
  - Amplitude re: baseline
  - Statistical replicability

HTTPS://WWW.YOUTUBE.COM/WATCH?V=6DXA3CYK1NC



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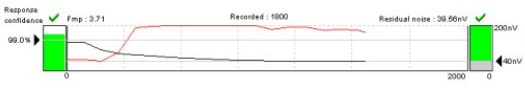
## PEAK PICKING IN A CLINICAL ENVIRONMENT

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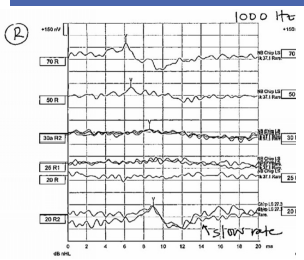
## ABR BEHAVIOR




- If it's an ABR, it will always display ABR-like behavior.
  - Grow with intensity
  - Shift in latency with level changes
  - Fixed across polarity changes
  - Respond to slower rate with improved morphology

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## NON-SEDATED ABRS

AKA

Natural sleep ABR

Sleep-deprived ABR

Swaddle and feed ABR

Takeaway: we rely on the patient to sleep for the duration of the exam

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## SETTING UP

### Space

- Avoid sharing wall plug with other equipment
- Position Cart away from electrical sources
- Prepare with low lighting
- Enter patient information ahead of time

### Patient

- Give parents instructions before exam
- Be systematic in how you scrub electrode sites
- Consider your view of the earphones during testing
- Trim earphone tips as needed for deep insertion

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## NON-SEDATED ABR- PLAN FOR SUCCESS

- The younger you can see kiddos, the better

  (But it might still be worth trying a non-sedated ABR for older patients!)
- Test with the mindset of "if my next tracing is my last one"
- Include parents in planning of the appointment
- Review what parents can expect during appointment

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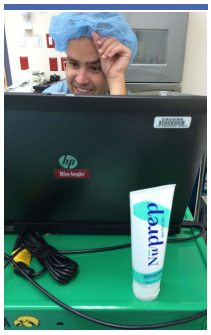

## NON-SEDATED ABR- KNOW YOUR ENVIRONMENT AND EQUIPMENT

- Try to be familiar with equipment and environment
  - If possible, use the same room for non-sedated ABRs every time
  - Plan for interference
- Biologic check
- Check earphones when anything looks off

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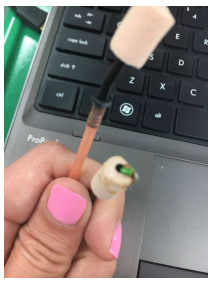
## WHEN TO MEASURE TYMPANOGRAMS?

- Abnormal eardrum function can impact the level of hearing loss
  - Complete at the beginning of exam: know ahead of time to look at latency cues
  - Complete at the end of exam: completing ABR with an open mind
- Complement bone conduction testing results
- Cornerstone of a complete, on-guideline JCIH infant hearing diagnostic exam
- Should not impact the decision to move forward with a diagnostic exam (especially under natural sleep!)



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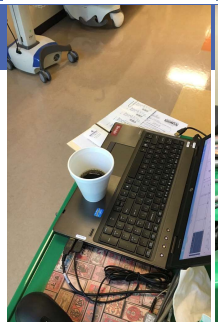
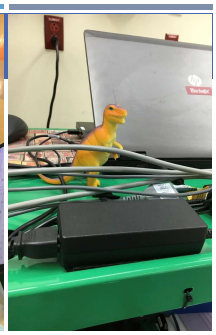
## BE KIND TO YOUR EQUIPMENT.

ABR equipment is often portable.

It's made to last, but help it out when you can





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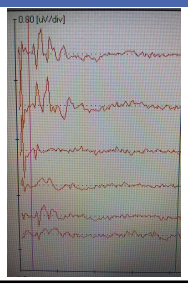


*SOAP BOX*

DON'T DO NON-SEDATED ABRS IF YOU CAN'T TRUST YOUR OWN RESULTS.

Let all your (billable) actions shape the resulting care they receive.

Don't be the reason a family is lost to follow up/documentation.

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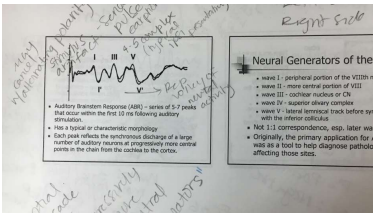
## KNOW YOUR RESOURCES

- Be ready to answer questions for your colleagues
- Know what parameters, protocols, and correction factors you are using
- Welcome feedback- get an ABR buddy

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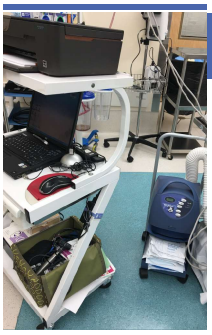

## NOTES ON SEDATED ABRS

- Recognize that they are always your second (or third) choice.
- Be consistent in arrival and fasting instructions
- Talk to the family BEFORE the ABR
- Know who all the people are in the room.
  - Circulating nurse
  - Anesthesia provider
  - Audiologist and graduate clinicians
  - For co-cases: additional providers, scrub techs, relief nurses
- Be aware of noise sources, position yourself accordingly
- For some co-cases or when entering a sterile part of the OR, be prepared to wear a mask

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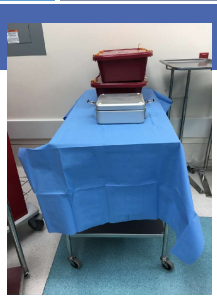
## OR NOTES

- Co-cases
  - Be aware of order of procedures
  - Be there when you say you'll be there/Stay in communication
  - Be aware of how other equipment can impact the ABR
- Play nice with others
  - Don't touch anything on the blue drape
  - Keep circulating nurse and OR board up to date if ABR is expected to run over
  - Schedule for the time you need, do your best to stick to that



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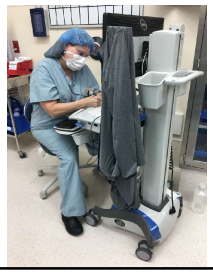
## TYPES OF SEDATION FOR ABR- GENERAL ANESTHESIA

- Administered by an anesthesiologist, a Certified Registered Nurse Anesthetist, or both.
  - These ABRs will take place in an operating room or a procedure room
  - Standard OR records will be kept
  - Time out completed
- Given through a combination of IV medications and inhaled gases
- The airway is secured at all time
- After the ABR, kiddo will go to a recovery room
  - Limited time to counsel family about results



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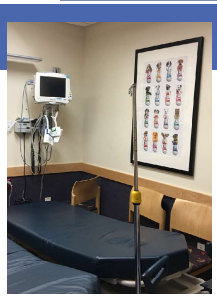
## TYPES OF SEDATION FOR ABR- PRECEDEX

- Dexmedetomidine
  - Sedative agent that is appropriate for non-intubated patients
  - Provides "conscious sedation", mimicking natural sleep
  - Not known to depress respiratory function
- Given through an IV (at UIHC and UNC) or delivered through nasal atomizer (DCMC)
  - Well accepted by families when non-sedated ABR proves to be impossible (ages 3-18 months)
  - At DCMC, preceded by a dose of oral Versed
  - Could be completed in a procedure room or pre-op room
- Attended by an anesthesia provider
  - Nasal canula O2 and EKG monitor were standard of care in our facility



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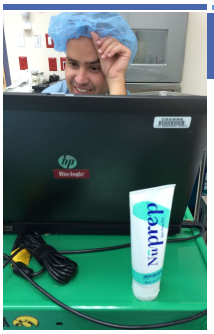
## TYPES OF SEDATION FOR ABR- LESS COMMON AGENTS




- Chloral Hydrate
  - Orally administered, previously the standard for ABR
  - Dosing issues
  - Less effective than Precedex: Reynolds, J., Rogers, A., Medellin, E., Guzman, J. A., & Watcha, M. F. (2016); DCMC based study in drafting which suggests the same so far: fewer results obtained in the same amount of time
- Monitored Anesthesia Care (MAC):
  - Propofol (with and without Ketamine)
  - Fentanyl
- Versed
- Ativan

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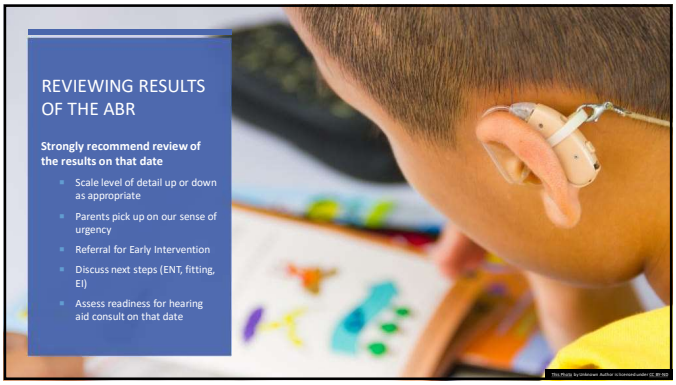
## REVIEWING RESULTS OF THE ABR



**Strongly recommend review of the results on that date**

- Scale level of detail up or down as appropriate
- Parents pick up on our sense of urgency
- Referral for Early Intervention
- Discuss next steps (ENT, fitting, EI)
- Assess readiness for hearing aid consult on that date

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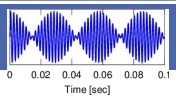
## AUDITORY STEADY STATE RESPONSE (ASSR)




- ASSR is used clinically for frequency specific threshold testing
- Analogous results to the toneburst or chip-evoked ABR thresholds
- ASSR take advantage of a neural phenomenon associated with modulated frequencies
  - Analysis of the EEG spectrum recorded via evoked potential electrodes
  - For frequency-specific stimuli, will also record energy at the modulation frequency
  - If the EEG spectrum contains modulation frequency→ the stimuli was audible!

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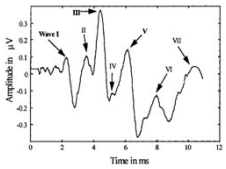
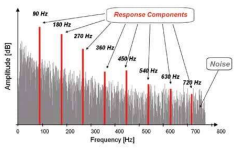
## OUTCOME METRICS: ABR VS ASSR

ABR




ASSR

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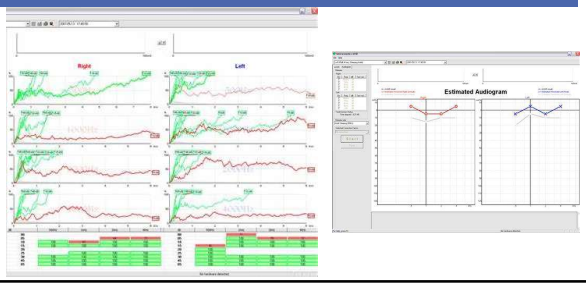
## AUDITORY STEADY STATE RESPONSE (ASSR)

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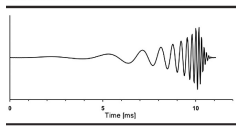
## FREQUENCY SPECIFIC STIMULI

Tonebursts

- Frequency specific, broader than puretones
  - Centered on test frequency
- Used for threshold assessment
- Several options for gating




BARGEN, 2015

Chirps

- Can be broad or frequency specific
- Used for threshold assessment
- Time gated so that the lowest-frequency components of the band are presented first
  - Accounts for behavioral of the traveling wave
  - Theoretically elicits larger amplitudes
  - 'Best case scenario' of that band

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## BONE CONDUCTION ABR

The worst tool except every other tool.

- Traditionally: limited to clicks
- Placement of the oscillator is challenging
- Variable effective force level
- Masking necessary
- Limited output makes it difficult to rule out mixed loss

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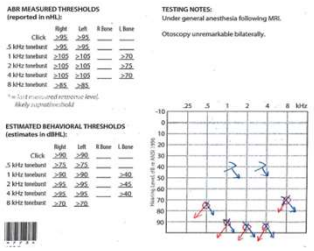
## EXAMPLE: LIMITATIONS OF OUTPUT RANGE FOR BC ABR



ABR MEASURED THRESHOLDS (reported in nHL):

| | Right | Left | R Bone | L Bone |
|---|---|---|---|---|
| Click | >95 | >95 | ____ | ____ |
| .5 kHz tonoburst | >95 | >95 | ____ | ____ |
| 1 kHz tonoburst | >105 | >105 | ____ | >70 |
| 2 kHz tonoburst | >105 | >105 | ____ | >75 |
| 4 kHz tonoburst | >105 | >105 | ____ | >70 |
| 8 kHz tonoburst | >85 | >85 | | |

TESTING NOTES:
Under general anesthesia following MRI.

Otoscopy unremarkable bilaterally.

ESTIMATED BEHAVIORAL THRESHOLDS (estimates in dBHL):

| | Right | Left | R Bone | L Bone |
|---|---|---|---|---|
| Click | >90 | >90 | ____ | ____ |
| .5 kHz tonoburst | >75 | >75 | ____ | ____ |
| 1 kHz tonoburst | >90 | >90 | ____ | >60 |
| 2 kHz tonoburst | >95 | >95 | ____ | >65 |
| 4 kHz tonoburst | >95 | >95 | ____ | >60 |
| 8 kHz tonoburst | >70 | >70 | | |

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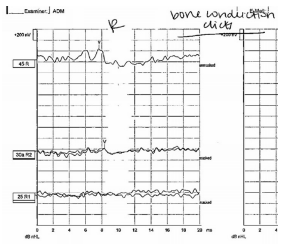
## MICROTIA/ATRESIA CASES BENEFIT FROM EARLY BONE CONDUCTION ABR

- Goldenhar Syndrome
- Nager Syndrome
- Treacher Collins Syndrome
- CHARGE/Trisomy 18

- Require diagnostic confirmation that underlying hearing is sufficient for soft-band BAHA or to confirm additional SNHL component

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## AUDITORY NEUROPATHY SPECTRUM DISORDER

"Auditory neuropathy is a hearing disorder in which sound enters the inner ear normally but the transmission of signals from the inner ear to the brain is impaired." – NIDCD

Hearing loss that occurs from damage to structures beyond the inner ear-easy parent explanation

Sininger 2002 analysis of data suggest 1 in 10 children with permanent SNHL, as high as 13% in other sources

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## SITE OF LESION FOR ANSD

ANSD is an appropriate diagnosis when evidence of a functioning cochlea exists, but evoked potential measures of hearing sensitivity (ABR) predicts a more significant decrease. Suggested breakdown sites include pre-synaptic (inner hair cell, ribbon synapses) and post-synaptic (unmyelinated dendrites, auditory ganglion cells, auditory brainstem) sites.

-Absent or abnormal ABR

-Present DPOAEs or an isolated cochlear microphonic

-Either is sufficient to suggest the presence of ANSD (or ANSD component to a detected hearing loss)

-Some children will display both for cross check

RANCE, G., & STARR, A. (2015). PATHOPHYSIOLOGICAL MECHANISMS AND FUNCTIONAL HEARING CONSEQUENCES OF AUDITORY NEUROPATHY. BRAIN, 138(11), 3141-3158.

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## COCHLEAR MICROPHONIC

- Early latency activity in a click-evoked ABR suggesting depolarization of hair cells.
  - Early peak, changes direction with stimulus polarity change
  - Not stimulus artifact
  - Grows with intensity
  - May be initially missed during non-sedated ABR if baby doesn't tolerate high levels of stimulation
- Only present in a cochlea containing SOME functioning hair cells
- Will also be seen in ABRs of a normal hearing child with adequate intensity stimulation

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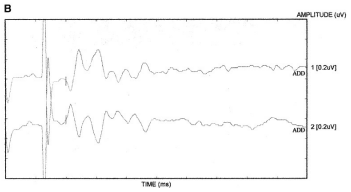
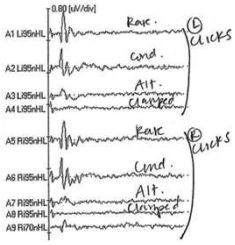
## COCHLEAR MICROPHONIC IDENTIFICATION




Berlin, C. I., Morlet, T., and Hood, L. J. (2003). "Auditory neuropathy/dyssynchrony: its diagnosis and management." Pediatr. Clin. N. Am. 50, 331-340.

49

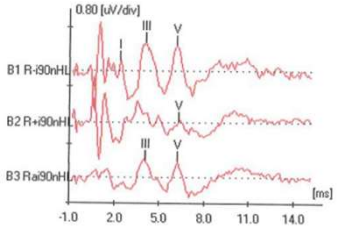
## ISOLATING A COCHLEAR MICROPHONIC




- Rarefaction tracing
- Condensing tracing
- Alternating tracing
- Clamped tracing
  - Demonstrate that the response is not attributable to stimulus artifact
  - Generators are stable, only auditory stimuli are interrupted

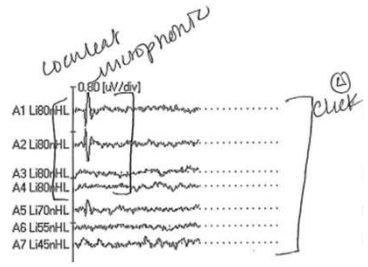
50

## NON-PATHOLOGIC COCHLEAR MICROPHONIC




51

## POTENTIAL TO BE OVERLOOKED

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## ANSD VERSUS OTHER RETRO-COCHLEAR HEARING LOSSES

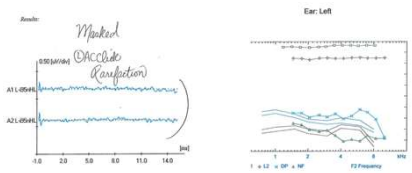
- ANSD may act as a stand-in diagnosis
- EHDI efforts mean these hearing losses are often detected before other associated neurological disorders
- If explanatory diagnoses are made, at that point ANSD is no longer an appropriate primary diagnosis
  - Brain and cranial tumors
  - Neurological Disorders such as Charcot-Marie-Tooth syndrome and Friedreich's ataxia
  - Auditory nerve aplasia
  - Underdeveloped central auditory nervous system

53

## ANSD V. RETROCOCHLEAR LOSS EXAMPLE 1

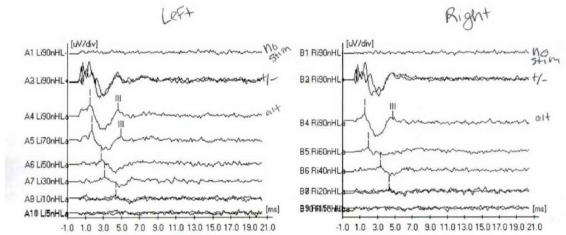

54

## ANSD V. RETROCOCHLEAR LOSS EXAMPLE 2




55

## WHAT IF IT DOESN'T LIKE LIKE ANSD OR SNHL? ABNORMAL WAVEFORM MORPHOLOGY




56

## NORMAL HEARING

57

## CASE STUDY-MAEBEL

- Two month old female infant
- Parents reported that she continues to be responsive to sound
- Hospitalized for bacterial meningitis
- ABR completed on day 20 of a 21 day IV antibiotics course

58

## REMINDER: THRESHOLD CLICKS ARE NOT REQUIRED

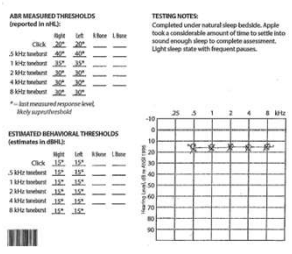
**High level clicks are critical to:**

- Help rule out ANSD
- Assess for interaural differences in morphology and latency
- Calculate LI function

**Many protocols of well-regarded practice sites skip threshold clicks**

- Not as useful for intervention planning
- Can take up valuable testing time that could be devoted to frequency specific testing or bone conduction

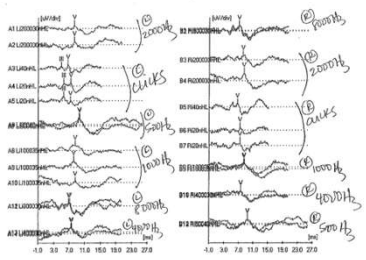
59



## CASE STUDY MAEBEL

60

## CASE STUDY MAEBEL



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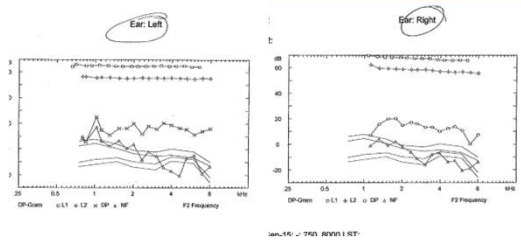
## CASE STUDY MAEBEL




62

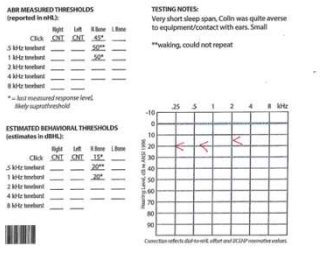
## MICROTIA/ATRESIA

63

## CASE STUDY BRODY

- Three month old male infant with suspected Nager syndrome
  - Bilateral anotia/atresia
  - Airway issues received emergent tracheostomy at birth
- Lengthy NICU stay
- Did not receive NBHS, proceeded straight to diagnostic ABR
- Followed by a pediatric ENT

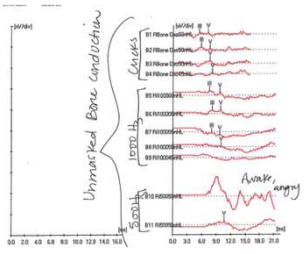
64




## CASE STUDY BRODY

65

## BRODY, ABR




66

CMV

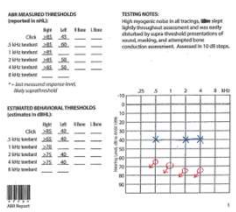
67

CASE STUDY-LOLA

- Three month old female infant, a twin
- 29.5 weeks gestation with 49 day NICU stay
- Standard <30 week neonatal CT scan showed calcifications, led to CMV testing
- Followed by Pediatric Infectious Diseases
  - Six month course of valganciclovir
- Referred on AABR three times prior to discharge

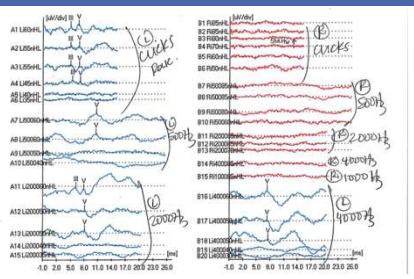
68

LOLA, FIRST ABR-NONSEDATED



69

LOLA, FIRST ABR-NONSEDATED



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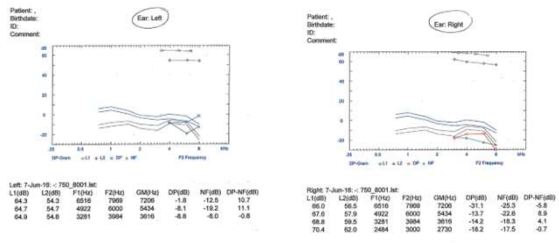
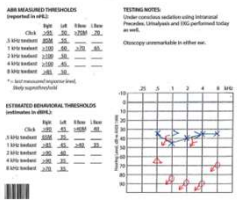
LOLA, FIRST ABR-OAES



71

LOLA, ABR 2- CONSCIOUS SEDATION



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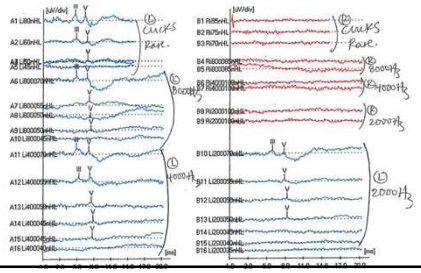
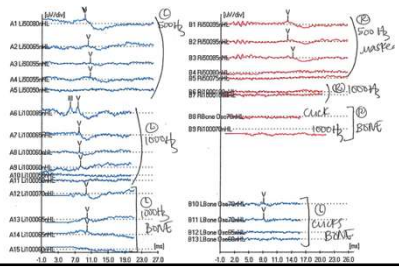
## LOLA, ABR 2-CONSCIOUS SEDATION



73

## LOLA ABR 2-CONCIOUS SEDATION



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## ONCOLOGY PATIENTS

**Ear and labyrinth disorders**

| Adverse Event | Grade 1 | Grade 2 | Grade 3 | Grade 4 | Grade 5 |
|---|---|---|---|---|---|
| Hearing impaired | Adults enrolled on a Monitoring Program (on a 1, 2, 3, 4, 6 and 8 kHz audiogram): Threshold shift of 15 - 25 dB averaged at 2 contiguous test frequencies in at least one ear.<br><br>Adults not enrolled in Monitoring Program: subjective change in hearing in the absence of documented hearing loss.<br><br>Pediatric (on a 1, 2, 3, 4, 6 and 8 kHz audiogram): Threshold shift >20 dB at 6 kHz in at least one ear. | Adults enrolled in Monitoring Program (on a 1, 2, 3, 4, 6 and 8 kHz audiogram): Threshold shift of >25 dB averaged at 2 contiguous test frequencies in at least one ear.<br><br>Adults not enrolled in Monitoring Program: hearing loss but hearing aid or intervention not indicated, limiting instrumental ADL.<br><br>Pediatric (on a 1, 2, 3, 4, 6 and 8 kHz audiogram): Threshold shift >20 dB at 4 kHz and above in at least one ear. | Adults enrolled in Monitoring Program (on a 1, 2, 3, 4, 6 and 8 kHz audiogram): Threshold shift of >25 dB averaged at 3 contiguous test frequencies in at least one ear; therapeutic intervention indicated.<br><br>Adults not enrolled in Monitoring Program: hearing loss with hearing aid or intervention indicated, limiting self care ADL.<br><br>Pediatric (on a 1, 2, 3, 4, 6 and 8 kHz audiogram): hearing loss sufficient to indicate therapeutic intervention, including hearing aids; threshold shift >20 dB at 3 kHz and above in at least one ear; additional speech-language related services indicated. | Adults: Decrease in hearing to profound bilateral loss (absolute threshold >80 dB HL at 2 kHz and above); non-serviceable hearing.<br><br>Pediatric: Audiologic indication for cochlear implant and additional speech-language related services indicated. | |

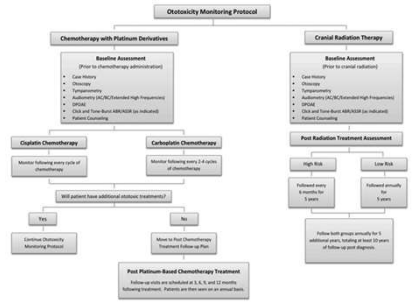
CTCAE 4.03 - June 14, 2010 - Ear and labyrinth disorders

Common Terminology Criteria for Adverse Events (CTCAE) Scales for ototoxicity.
-HHS, 2010

75

## OTOTOXICITY PROTOCOL

- Developed ASHA position statement guidelines
- Challenges in ototoxicity monitoring in the pediatric oncology population
- (Bass & Bhagat, 2014)

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## ONCOLOGY-CASE ONE

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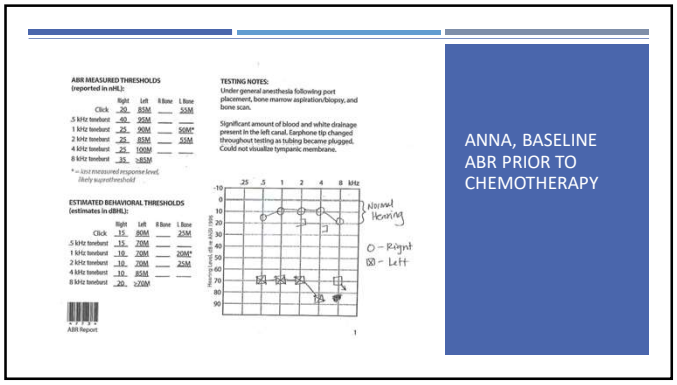
## ANNA BACKGROUND

- Four year old female
- Newly diagnosed with Langerhans Cell Histiocytosis
- Followed by an ENT for apparent drainage.
- Passed newborn hearing screening, no family history of childhood hearing loss
- Current hearing concerns

Treated for otorrhea, canal bleeding with laceration,

Referred to Hematology/Oncology following culture of drainage

78

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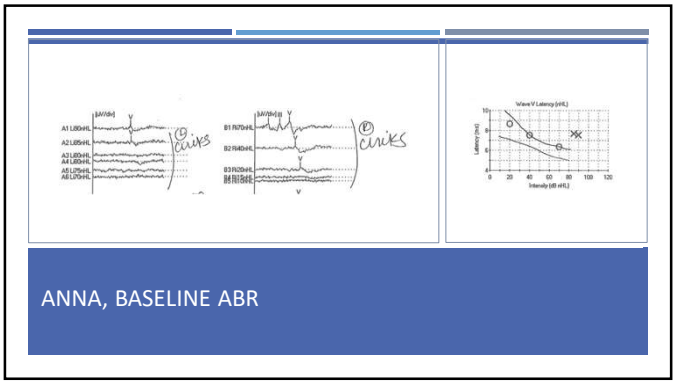


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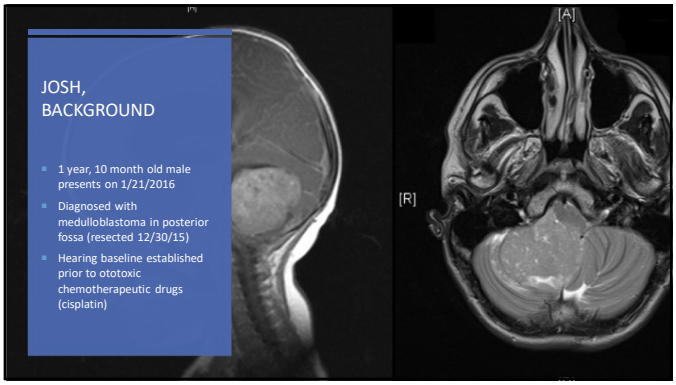


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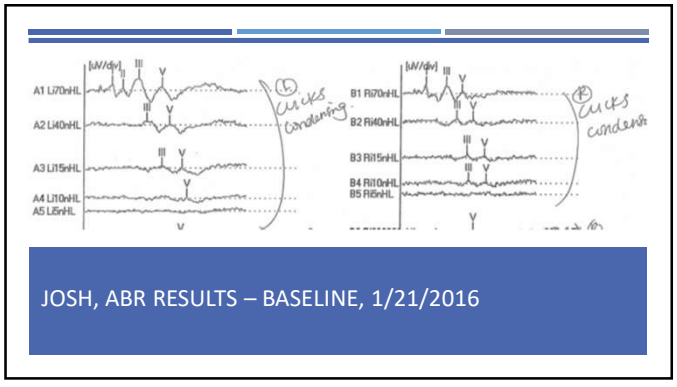


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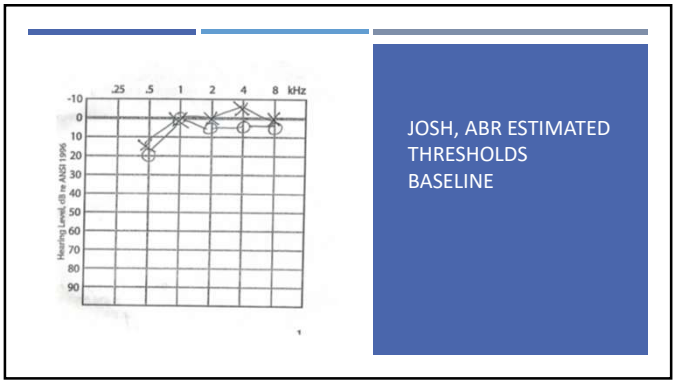


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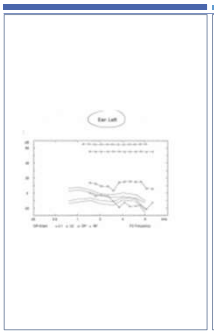

JOSH, OAE RESULTS – BASELINE - 1/21/2016

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## JOSH, ABR 2 – 8/12/2016

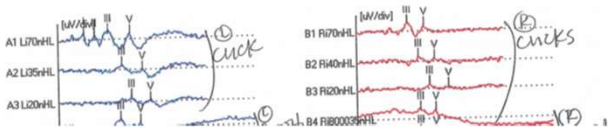
Patient returned for 2nd ABR to monitor hearing sensitivity while receiving cisplatin. He is now 2 years, 4 months old.

Parents report he is responsive to sounds

New history of hydrocephalus (shunt placed)

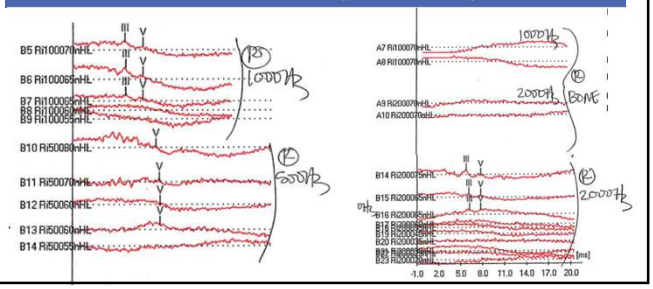
86

## JOSH, ABR RESULTS - 8/12/2016




87

## JOSH, ABR RESULTS - 8/12/2016 (CONTINUED)

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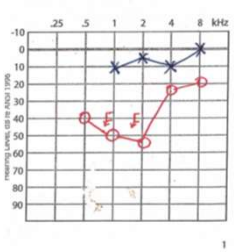
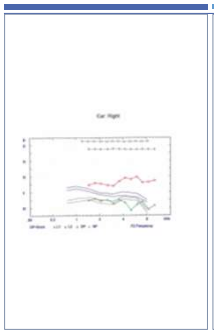



JOSH, ABR ESTIMATED THRESHOLD

89



JOSH, OAE RESULTS - 8/12/2016

90

## WHAT GIVES?

- ABR indicates right sided sensorineural hearing loss.
- But OAE's are normal and robust – outer hair cells are functional.
- What about the tracings?

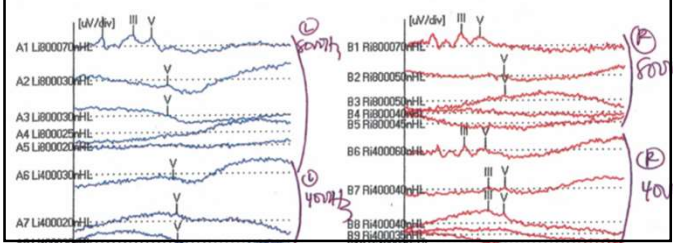
91

## JOSH, ABR 7 – 3/14/2017

- Patient is now 2 years, 11 months old.
- Still receiving cisplatin for a recurring posterior fossa medulloblastoma
- Has previously been identified with right sided retrocochlear hearing loss.

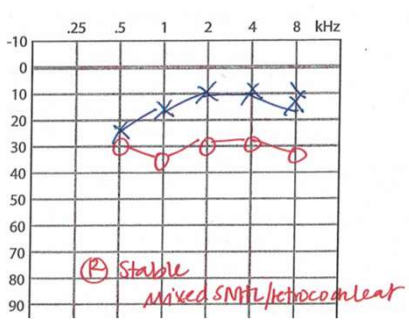
92

## JOSH, ABR 7- 3/14/2017




93

## JOSH, ABR 7 ESTIMATED THRESHOLDS

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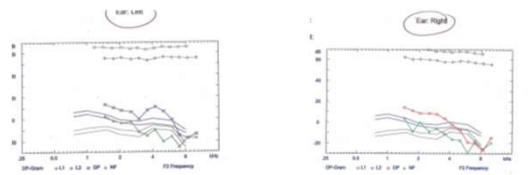
## JOSH, ABR 7, OAE RESULTS



95

## NOW WHAT?

- ABR suggests right sided mild hearing loss
- DPOAE's are reduced/absent bilaterally in high frequencies.
  - Secondary to Cisplatin – the outer hair cells affected by ototoxic drug.
- How would we classify this hearing loss?

96

## BEHAVIORAL AUDIOMETRY VISIT – 6/21/2018

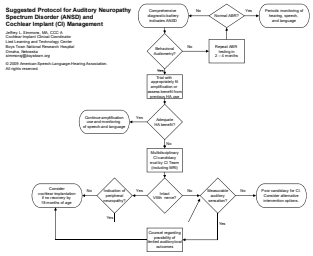
- Patient is now 4 years, 2 months old.
  - Old enough to behaviorally test!
- Behavioral audiometry indicates bilateral, moderate hearing loss in high frequencies.
- Speech results are critical due to nature of hearing loss type and age.
- Very poor intelligibility responses to WRS.

97

## BEHAVIORAL AUDIOGRAM


98

## AUDITORY NEUROPATHY SPECTRUM DISORDER




99

## ANSD

100

## HAYDEN

- Twin, with lengthy NICU stay and complicated medical history including blood transfusion, external ventilation
- Born at 25 weeks gestation
- He did not pass the newborn hearing screening via AABR.
- Referred by newborn hearing screener directly for diagnostic evaluation keeping with best practice.

101

## HAYDEN

He was referred for follow up at an ENT clinic whose audiologists did not offer diagnostic ABR services

ENT evaluation of ears was unremarkable (also received baseline airway exam during this appointment)

Hayden was evaluated with OAEs and "passed" in both ears.

102

## HAYDEN

- Was Hayden good to go?
- Why or why not?

103

## HAYDEN

- NO!
  - This is an example of over screening
  - Over screening reduces the sensitivity of the screening tools we use in UNHS programs (also eats up valuable time!)
  - Fell in our highest risk category (for both ANSD and SNHL)
  - Rescreening with DPOAEs following a birth screen performed with AABR in the NICU goes against JCIH protocol on two fronts
- Luckily the ENT based audiologist knew about his risk and his birth screen and referred on for ABR exam "out of an abundance of caution".
  - Parents willing to complete recommended testing
  - Referred to DCMC for non-sedated ABR assessment

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## HAYDEN

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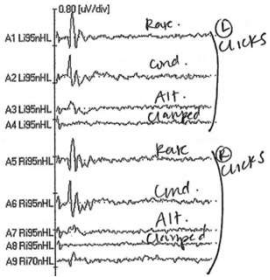
## HAYDEN: CLICK ABR

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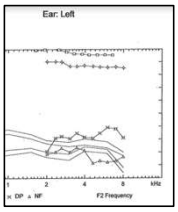
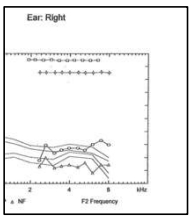
## HAYDEN-OAES

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## HAYDEN

- Hayden was identified with bilateral auditory neuropathy spectrum disorder.
- He was referred for early intervention, pediatric ENT evaluation/work up, monitoring with a pediatric audiologist, and family began learning manually coded language
  - He was fit with hearing aids at age 11 (non-adjusted) months after not displaying responses to sound below 85 dB HL during sound field VRA
  - Received a unilateral cochlear implant at 18 months (non-adjusted) of age based on lack of speech and language progress.
  - Family is using SEE, considering moving to Auditory Verbal Therapy

(FYI twin sister also evaluated, normal hearing)

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# NON ACCIDENTAL TRAUMA

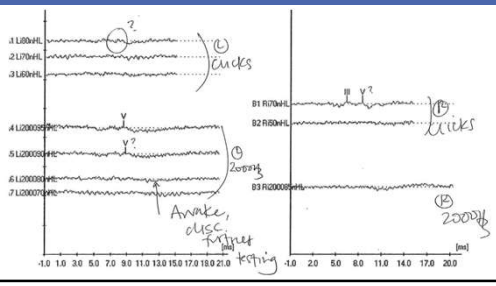
109

## GRACE

- Two month old baby girl, inpatient for 10 days
- Referred for audiology consult by the trauma team, considered "non-accidental trauma"
- Sustained skull fracture, traumatic brain injury, intraventricular and sub-arachnoid hemorrhages, rib fracture, pulmonary contusions, and retinal bleeding.
- Imaging showed that her middle ear spaces were clear

110

## GRACE, ABR




111

# ONE MORE!
# AN EHDI SUCCESS STORY

112

## EMELINE

Nine month old female → First seen at 8 weeks for a non-sedated ABR which showed no responses → Fit with hearing aids by an educational audiologist at about 4 months

Limited responses to sounds with high power hearing aids ← This ABR part of final work up for cochlear implant candidacy

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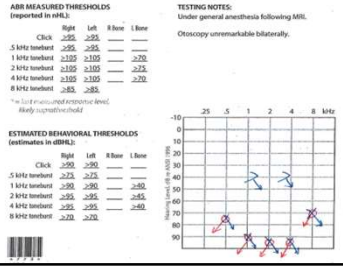
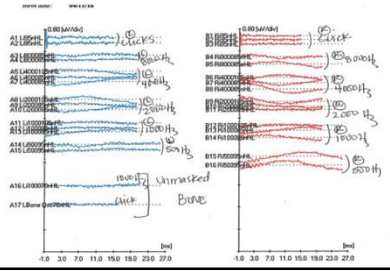
## EMELINE, ABR 2




114

## EMELINE, ABR 2

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## JCIH, 2019

- Clinical guideline developed by AAA, ASHA, A.G. Bell, American Academy of Pediatrics, etc.
- Updated to reflect current state of evidence
- Updated released 10/23/19:
  - Natural sleep ABRs are feasible
  - Threshold search ABRs using toneburst or chirp ABR, with use of click for ANSD only
  - Due to variable correction factors, move to VRA for cross-check as early as possible
  - Yes, chirps are out there.
  - Update to screening algorithm for type of screening

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## JCIH 2019- DIAGNOSIS IN THE NICU

- "Because the majority of very preterm infants may still be in the NICU at 3 months of age, a recommendation is made that for very preterm infants with prolonged hospitalization, a diagnostic audiologic evaluation prior to discharge from the NICU be completed. "

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## CONSIDERATIONS FOR TESTING IN THE NICU

Extremely small canals (especially left) with very shallow earphone insertion. Earphones found to be occluded with wax, changed out during exam. Tympanic membranes not visualized. Questionable bone oscillator fit around trach equipment. Could not adequately mask.

- Noise
  - Many of the same sources as in the OR
- IV placement
- Poor access for otoscopy
- Parents may be absent
- Regimented feeding and rounding schedules
  - Make the nurse your friend- don't show up at shift change!

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## IN CONCLUSION

- Do ABRs as soon as you can.
- Stop doing ABRs as soon as you can

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