Red Flags: Barriers to Optimal Auditory Development, Part I
April 22, 2013

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Introduction
Cochlear Americas’ Commitment to Educational Outreach

Our Presenters
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RED FLAGS:
Barriers to optimal auditory development
Part 1

HOPE
22 April 2013
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THIS IS A TWO PART WORKSHOP

• Part 1 discusses audiology issues
• Part 2 discusses speech-language issues
• Ideally the course should be one two-hour course
• We recommend that attendees view both courses

GETTING STARTED

• Things are fine for most kids
• Why are some kids superstars and other kids not?
• Why the huge variation among kids who seem to be equal?
• We know that not all kids do equally well, but why?
LOOKING FOR EXPLANATIONS

- Some things are clearly a problem:
  - Not hearing as well with technology
  - Not getting appropriate therapy
  - Parents not involved
  - Developmental issues
- BUT sometimes everything is lined up and kids are still not achieving what we would expect

PHILOSOPHY

- If a child is not making appropriate progress, *there is a reason*!
- We have an obligation:
  - To figure out why
  - To try and address the problem
- All clinicians/team members need to work collaboratively to make this successful
- We must include parents as critical team members
- It is almost always possible to succeed

WHY AUDITION IS IMPORTANT?
WHY IS LISTENING CRITICAL?

- Hearing is the most efficient way to develop spoken communication and literacy
- Hearing = auditory brain development
- It is not really about the ears – it is about the brain!
- Technology is really a brain access tool
- Acoustic access to intelligible speech is critical for development of the auditory brain
  - The auditory cortex is involved in speech perception and language processing in humans

THE MOST BASIC RED FLAGS

RED FLAGS: BASIC behavioral observations

- Child not tolerating technology
  - Child resistant to wearing technology
  - Behavior management issues related to technology
- Behavioral observations
  - No response/poor response to sound
  - Hypersensitive to sound
  - Involuntary eye blinks/facial stimulation when wearing devices
**RED FLAGS**: BASIC behavioral observations

- **IF CHILDREN HEAR WELL WITH THEIR TECHNOLOGY, THEY SHOULD WANT IT ALL DAY, EVERY DAY!!**
- Parents (or other family members, especially grandparents) are concerned about progress
  - Parents are often hesitant to express concerns
  - If parents are concerned we need to take their concerns seriously
    - *Are they realistic?*

**INTERVENTIONAL RED FLAGS OR IS THE INTERVENTION APPROPRIATE?**

**RED FLAGS**: Ineffective Intervention

- Audiologists need to recognize ineffective intervention
- Child and family are enrolled in ineffective intervention if the intervention:
  - Involves the child without involvement of the parents and family
  - Does not monitor technology **every** day
  - Does not follow a normal developmental model
  - Does not stress the development of audition as the basis of all speech and language
  - Promotes visual language development (lipreading, sign language)
Audiologists support effective intervention

- **Hearing loss** limits access to speech and language; thus, the **hearing loss** creates the delayed speech and language

- **Effective therapy**
  - Defined auditory component
  - Auditory skill development in appropriate sequence is the focus of therapy
  - Auditory abilities are developed through the auditory modality
  - Parental guidance and coaching is provided at every session for transfer to all settings

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Audiologists support effective intervention by:

- **Teaching technology monitoring / checking**
  - Who is checking it daily?
    - Do parents, clinicians, and teachers have appropriate listening technology (hearing aid stethoscope, CI earbuds, CI listening check)?
    - Do parents know how to use the technology?
    - Do clinicians and teachers know how to use the technology?

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Audiologists support effective intervention by:

- **Teaching technology monitoring / checking cont.**
  - What is being done to check technology daily?
    - Ling sounds?
    - Other discrimination?
    - Close and far?
    - Will a drop in function be recognized?
  - Who is helping the child recognize and report technology malfunction?
Audiologists support effective intervention by:

• Evaluating signs of difficulty reported by clinicians/parents
  • No or poor response to high frequency stimuli
  • Distorted vowel production
  • Dropping certain consonants consistently
  • Speech sound deterioration
  • Mishearing
    – Increased “what?”
  • Reporting static
  • Any sudden and/or dramatic change in performance

Audiologists support effective intervention by:

• Monitoring parent education and training:
  – PARENTAL INVOLVEMENT AND EDUCATION ARE CRITICAL!!
  – Auditory based therapy model
  – Parents need to be involved in the therapy sessions and trained in sessions
  – Therapy for 1, 2 or even 3 hours does not replace parental involvement and reinforcement 24/7

Audiologists support effective intervention by:

• Confirming that equipment is working
  – Accepting responsibility for technology malfunctions
    – When in doubt, CHANGE IT OUT!!!!
• Ensuring that the child is:
  – Hearing throughout the frequency range
  – Hearing soft speech
  – Hearing in noise
Audiologists support effective intervention by:

- Discouraging visual speech
  - Focus on audition and limiting vision
    - Understand the strengths of auditory access for speech-language development
    - Understand the limitations of vision to access speech
  - Eliminate exaggerations
    - If it seems unnatural, it is probably going to create a problem

SPEECH/LANGUAGE RED FLAGS OR IF INTERVENTION IS APPROPRIATE, WHAT PROBLEMS INDICATE IT’S TIME FOR ADDITIONAL HELP?

- Poor voice quality
- Developing consonants in the appropriate sequence
- Identify consonants that are consistently absent when they are age appropriate
- Problems with phoneme development
- Inappropriate or abnormal production of consonants
RED FLAGS: Language Development

- Expectation: one year’s growth in one year
- Deterioration of speech skills
  - Production
  - Discrimination
- Language plateau or regression

NEVER ASSUME!!!!

- ALWAYS COLLECT DATA!!!
- Parent, teacher, and clinician data and documented observations are essential to appropriate remediation of the problems
- We must test to begin to determine what is affecting progress
IF A CHILD HAS APPROPRIATE PARENTAL AND INTERVENTIONAL SUPPORT, THEN RED FLAGS POINT TO TECHNOLOGY ISSUES.

TECHNOLOGY ISSUES FOR HEARING

- The most important use of our hearing is for speech and language perception
- Very simply, speech and language perception issues result from one or more of four situations:
  - I did not understand because it was too quiet
  - I did not understand because it was too loud
  - I did not understand because it was not clear
  - I did not understand because I do not have the language development

WHAT DOES TECHNOLOGY TELL US ABOUT HEARING?

- Real ear measures and CI mapping do NOT tell you what the child is hearing!
  - Real ear only tells you what is reaching the eardrum
  - CI MAPs/NRT only tell how much electrical stimulation is being provided
  - Real ear and CI MAPs tell you nothing about what the auditory brain hears!!
IF HA AND CI PROGRAMS DO NOT TELL US WHAT A CHILD HEARS, THEN WHAT DOES?

- Children provide us with accurate and reliable information about what they hear:
  - When we observe and understand their behaviors
  - When we listen to what they say and how they say it
  - When they complete detailed audiological testing with an experienced pediatric audiologist
  - Parents, interventionists, teachers, family members, and friends are essential to this process

FOR A DETAILED AUDIOLOGICAL EVALUATION, WHAT DO WE NEED TO TEST?

- Unaided thresholds
- Thresholds with technology – Right (R), Left (L), and Binaural (B)
- Speech perception with technology
  - 50 dB HL (normal conversation) – R, L, B
  - 35 dB HL (soft conversation) – B (R, L if possible)
  - 50 dB HL +5 S/N Ratio, B

RED FLAGS: Audiological Evaluation

- Audiological red flags with technology:
  - Hearing very soft sounds
    - Thresholds 0-15 dB HL, especially for young children
  - Not hearing soft conversation
    - Thresholds 35 dB HL or poorer
  - Poor speech perception at normal conversational level (50 dB HL)
  - Poor speech perception at soft speech level (35 dB HL)
  - Poor speech perception at loud speech level (70 dB HL)
RED FLAGS: Audiological Evaluation

- Audiological Red Flags cont.
  - Poor single word speech perception with good sentence recognition
  - Good single word speech perception with poor sentence recognition
  - Poor single word speech perception with poor sentence recognition
  - Speech perception testing completed with inappropriate test materials

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WHAT RED FLAGS INDICATE SPEECH IS TOO SOFT? HOW DO WE ADDRESS THESE?

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RED FLAGS: UNDER AMPLIFICATION and UNDERSTIMULATION

<table>
<thead>
<tr>
<th>HEARING AIDS</th>
<th>COCHLEAR IMPLANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt. consistently removes technology</td>
<td>Pt. consistently removes technology</td>
</tr>
<tr>
<td>Pt. turns up volume</td>
<td>Pt. turns up volume and/or sensitivity</td>
</tr>
<tr>
<td>Pt. relies on visual input</td>
<td>Pt. relies on visual input</td>
</tr>
<tr>
<td>Pt. does not turn or respond to name</td>
<td>Pt. does not turn or respond to name</td>
</tr>
<tr>
<td>Vocalizations do not change with technology</td>
<td>Vocalizations do not change with technology</td>
</tr>
<tr>
<td>Pt’s voice is loud</td>
<td>Pt’s voice is quiet or Whispered</td>
</tr>
<tr>
<td>Listening/speech/language development is slow or non-existent</td>
<td>Listening/speech/language development is slow or non-existent</td>
</tr>
<tr>
<td>Speech perception at 70dB HL is 12% better than at 50dB HL</td>
<td>Speech perception at 70dB HL is 12% better than at 50dB HL</td>
</tr>
</tbody>
</table>
**UNDER AMPLIFICATION and UNDERSTIMULATION**

- **RX:**
  - Check to ensure technology is working appropriately
  - Audiological testing to verify unaided/aided hearing thresholds
  - Aided speech perception testing at 35dB HL
  - Phoneme perception testing
  - Reprogramming to increase amplification/stimulation for soft speech, normal conversation, and possibly loud sounds as needed
  - Trial with different technology
  - Cochlear implant evaluation if using hearing aids

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**CASE STUDY: UNDER AMPLIFICATION**

5.5 yr old boy aided at age 3.6

<table>
<thead>
<tr>
<th></th>
<th>RIGHT EAR</th>
<th>LEFT EAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaided at 70 dB HL</td>
<td>52%</td>
<td>52%</td>
</tr>
<tr>
<td>Aided SRT</td>
<td>25dB HL</td>
<td>25dB HL</td>
</tr>
<tr>
<td>Aided PBK Words at 50 dB HL</td>
<td>32%</td>
<td>32%</td>
</tr>
<tr>
<td>Aided PBK Words at 35 dB HL</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Aided HINT Sentences at 50 dB HL (in quiet)</td>
<td>78%</td>
<td>80%</td>
</tr>
</tbody>
</table>
CASE STUDY: UNDER AMPLIFICATION

2 weeks later (new Ear Molds, HAs reprogrammed)

<table>
<thead>
<tr>
<th></th>
<th>RIGHT EAR</th>
<th>LEFT EAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aided SRT</td>
<td>20dB HL</td>
<td>25dB HL</td>
</tr>
<tr>
<td>Aided PBK Words at 50 dB HL</td>
<td>86%</td>
<td>84%</td>
</tr>
<tr>
<td>Aided PBK Words at 35 dB HL</td>
<td>72%</td>
<td>84%</td>
</tr>
<tr>
<td>Aided HINT Sentences at 50 dB HL (in quiet)</td>
<td>87%</td>
<td>89%</td>
</tr>
</tbody>
</table>

LESSONS FROM EXPERIENCE:
UNDER AMPLIFICATION and UNDERSTIMULATION

- The HA or CI program dictated by the computer may need adjustment
- It is essential to ensure a battery can support the HA or CI program and any auxiliary inputs
- Adult HA algorithms may underestimate the overall, low frequency, and/or high frequency gain needed for children
- Feedback circuits can significantly reduce gain
- A standard earmold or a poor fitting earmold can significantly reduce gain
- Can any prelingually deafened person accurately rate loudness? Can any of us accurately rate loudness of tones?

WHAT RED FLAGS INDICATE SPEECH IS TOO LOUD? HOW DO WE ADDRESS THESE?
### RED FLAGS: OVERAMPLIFICATION and OVERSTIMULATION

Patient consistent with technology usage, BUT:

<table>
<thead>
<tr>
<th>HEARING AIDS</th>
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</thead>
<tbody>
<tr>
<td>Pt. consistently removes technology</td>
<td>Pt. consistently removes technology</td>
</tr>
<tr>
<td>Pt. turns down volume</td>
<td>Pt. turns down volume and/or sensitivity</td>
</tr>
<tr>
<td>Pt. startles, cries, or blinks to loud sounds</td>
<td>Pt. startles, cries, or blinks to loud sounds</td>
</tr>
<tr>
<td>Pt. is very quiet or withdrawn</td>
<td>Pt. is very quiet or withdrawn</td>
</tr>
<tr>
<td>Pt’s voice is quiet</td>
<td>Pt’s voice is loud or gravelly</td>
</tr>
<tr>
<td>Poor or deviant consonant development</td>
<td>Poor or deviant consonant development</td>
</tr>
<tr>
<td>Receptive language development without expressive language development</td>
<td>Receptive language development without expressive language development</td>
</tr>
<tr>
<td>Speech perception at 70dB HL is poorer (&gt;12%) than at 50dB HL</td>
<td>Speech perception at 70dB HL is poorer (&gt;12%) than at 50dB HL</td>
</tr>
</tbody>
</table>

### OVERAMPLIFICATION and OVERSTIMULATION

- **RX:**
  - Check to ensure technology is working appropriately
  - Audiological testing to verify unaided/aided thresholds
  - Check for deterioration of speech perception at 70dBHL
  - Phoneme perception testing
  - Reprogramming/remapping to reduce amplification of loud sounds and possibly normal conversational and soft sounds

### CASE STUDY: OVERSTIMULATION

41 year old congenitally deaf patient implanted at age 40
CASE STUDY: OVERSTIMULATION

41 year old congenitally deaf patient implanted at age 40

<table>
<thead>
<tr>
<th></th>
<th>SAT</th>
<th>SRT</th>
<th>HINT-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old MAP</td>
<td>10 dBHL</td>
<td>DNT</td>
<td>66%</td>
</tr>
<tr>
<td>New MAP</td>
<td>DNT</td>
<td>25 dBHL</td>
<td>88%</td>
</tr>
</tbody>
</table>

LESSONS FROM EXPERIENCE: OVERAMPLIFICATION and OVERSTIMULATION

- Don’t assume the degree and configuration of the hearing loss
- Not all hearing aids can appropriately fit all hearing losses
- Hearing aid use can distort the perception of loudness
- If speech perception at 70 dB HL is significantly poorer (approx. 12% poorer) than speech perception at 50 dB HL, then technology is providing too much amplification
- For bilateral patients, both ears need to be assessed separately and together

WHAT RED FLAGS INDICATE SPEECH IS NOT CLEAR? HOW DO WE ADDRESS THEM?
POOR CLARITY

- English has approximately 44 phonemes (not just the Ling 6)
- Assess the majority of consonants
- Assess vowels as needed
- Assessing phoneme perception at 3 ft. and 10 ft. can identify specific areas of programming to change
- Use the frequency allocation charts to identify the specific frequency bands needing change
- Programming changes can and do lead to **IMMEDIATE** speech perception changes

RED FLAGS: POOR CLARITY

<table>
<thead>
<tr>
<th>HEARING AIDS</th>
<th>COCHLEAR IMPLANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt. relies on visual input</td>
<td>Pt. relies on visual input</td>
</tr>
<tr>
<td>Poor or unusual voice quality</td>
<td>Poor or unusual voice quality</td>
</tr>
<tr>
<td>Inappropriate/unusual consonant development</td>
<td>Inappropriate/unusual vowel and/or consonant development</td>
</tr>
<tr>
<td>Consistent omission/substitution of specific consonants</td>
<td>Consistent omission/substitution of specific consonants</td>
</tr>
<tr>
<td>Speech production not improving</td>
<td>Speech production not improving</td>
</tr>
<tr>
<td>HA program is completely flat or heavily weighted to lows and highs</td>
<td>CI MAP is completely flat or heavily weighted to lows and highs</td>
</tr>
<tr>
<td>Very small or large difference between gain for soft and normal conversation</td>
<td>Very small or large difference between T levels and C/M levels</td>
</tr>
<tr>
<td>Speech perception at poor at 35dB HL, 50dB HL, and/or in noise</td>
<td>Speech perception at poor at 35dB HL, 50dB HL, and/or in noise</td>
</tr>
</tbody>
</table>

POOR CLARITY

**RX:**
- Check to ensure technology is working appropriately
- Audiological testing to verify unaided thresholds
- Audiological testing to verify aided speech perception at
  - 50 dB HL
  - 35 dB HL
  - 50 dB HL +5 S/N Ratio
- Reprogramming/MAPping based on aided thresholds and aided error patterns
- Trial with different technology and/or CI evaluation
LESSONS FROM EXPERIENCE: POOR CLARITY

• Evaluating perception of soft speech (35dB HL) and normal conversational speech (50dB HL) can indicate the specific areas of programming to change in both HAs and CIs
• Low frequencies can mask high frequencies in HAs and CIs
• Increasing mid-frequency gain can increase loudness and clarity without introducing low frequency masking
• Shaping the MAP to neural responses appears to provide improved clarity

LESSONS FROM EXPERIENCE: POOR CLARITY

Articulation errors may be clarity or “hearing” errors!!

We recently completed a retrospective review of 230+ CI patient MAPpings to determine the most common errors.

• IMPORTANT: The majority of errors were not identified using the Ling 6 sound test!!

LESSONS FROM EXPERIENCE: POOR CLARITY

• Vowel errors:
  – Significant vowel confusion usually indicates more global programming issues
  – If all vowels seem similar, low frequency stimulation often needs to be decreased
  – Often low frequency stimulation levels needs to be less than mid-frequency stimulation levels
• Consonant errors:
  – Preliminary data indicate phoneme assessment should include:
    • /m/ /n/ /b/ /d/ /h/ /p/ /t/ /k/ /ch/ /sh/ /s/
LESSONS FROM EXPERIENCE: POOR CLARITY

<table>
<thead>
<tr>
<th>Specific Articulation Error</th>
<th>% of Occurrence</th>
<th>% of Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>/s/ heard as /m/</td>
<td>69%</td>
<td>84%</td>
</tr>
<tr>
<td>/sh/ heard as /sh/ or /f/</td>
<td>67%</td>
<td>87%</td>
</tr>
<tr>
<td>/s/ omitted, distorted, or heard as /sh/</td>
<td>42%</td>
<td>95%</td>
</tr>
<tr>
<td>m/n confusion</td>
<td>41%</td>
<td>85%</td>
</tr>
<tr>
<td>Omission of /b/</td>
<td>36%</td>
<td>98%</td>
</tr>
<tr>
<td>/sp/ heard as /h/ or omitted</td>
<td>29%</td>
<td>96%</td>
</tr>
<tr>
<td>/sh/ heard as /sh/</td>
<td>21%</td>
<td>91%</td>
</tr>
</tbody>
</table>

LESSONS FROM EXPERIENCE: POOR CLARITY

Increasing stimulation is not always appropriate!

E.g. /s/ errors of omission, distortion, or /sh/ substitution

<table>
<thead>
<tr>
<th>Specific CI programming change</th>
<th>Rate of Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulation decrease</td>
<td>48%</td>
</tr>
<tr>
<td>Stimulation increase</td>
<td>37%</td>
</tr>
<tr>
<td>Electrode deactivation</td>
<td>15%</td>
</tr>
</tbody>
</table>

TECHNOLOGY ISSUES

• Cochlear Implant Failures
  – A CI failure is every parent’s worst nightmare
  – External parts fail often, but the internal device failure rate is very low (<1%)
  – So, always think external before internal
  – If a child can hear, but you are concerned about red flags, recommend MAPping before integrity tests
  – CT scan / x-ray should also be considered to look at placement
BINAURAL BALANCING: WHAT RED FLAGS INDICATE SOUND IS NOT BALANCED?

BINAURAL PHENOMENA

• Binaural Summation
  – Sound is louder and clearer with 2 ears
  – Without binaural summation, a patient will want increased amplification

• Binaural Balance
  – Which ear is louder?
  – The correct answer: “I don’t know.”

• The Stenger Principle
  – The louder of 2 inputs will be perceived

• Binaural Interference
  – Significantly affects speech clarity

RED FLAGS: UNBALANCED BINAURAL TECHNOLOGY

<table>
<thead>
<tr>
<th>HA + HA / HA + CI / CI + CI unbalanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt. consistently localizes to one direction</td>
</tr>
<tr>
<td>Pt. consistently turns one ear to speaker/music/TV</td>
</tr>
<tr>
<td>Pt. consistently removes one device</td>
</tr>
<tr>
<td>Pt. does not replace one device when it falls off</td>
</tr>
<tr>
<td>Pt. startles, blinks, or asks for quiet when putting on 2nd device</td>
</tr>
<tr>
<td>Pt. does not indicate when one battery dies</td>
</tr>
<tr>
<td>Original HA or CI is not reprogrammed when 2nd is added</td>
</tr>
<tr>
<td>Pt. can tell you one is louder than the other</td>
</tr>
</tbody>
</table>
BINAURAL TECHNOLOGY: UNBALANCED

- **RX:**
  - Check to ensure technology is working appropriately
  - Audiological testing to verify unaided thresholds
  - Aided threshold and speech testing with each device *separately*
  - Aided speech testing *in noise*
  - Reprogramming/reMAPping to balance

LESSONS FROM EXPERIENCE: UNBALANCED

- Quantity of loss and quality of loss are not the same
- If the quality is significantly different, children will do everything in their power to eliminate the interference
- Children with hearing loss DO experience binaural summation
- 1st CI needs to be reprogrammed after receipt of 2nd CI

LESSONS FROM EXPERIENCE: UNBALANCED

- If devices are not balanced, progress in one ear will be delayed
- If devices are balanced, sound quality with both together should be good—even if one is new
- If devices are balanced, patient should note benefit from 2nd very quickly
- If one ear is performing more poorly, practice listening with the POORER ear alone 2-3 hrs/day (outside of school)
THE BEST WAY TO HANDLE RED FLAGS: TEAM WORK!!

WE NEED PROFESSIONALS WHO:

• Like kids
• Can keep the child motivated and engaged
• Think outside the box
• Are willing and motivated to learn
• Are willing and able to modify as needed as we learn more about the child
• Investigate their observations and collect data
• Realize that no one person has all the answers
• Seek and encourage collaboration
• Look for solutions, not excuses
• Always act in the best interest of the child

HOW DO WE TALK TO OUR COLLEAGUES

• Be collegial
• Believe that everyone wants to help
• Share information on a regular basis
  – Provide data
• Do not ask parents to transmit concerns
• Follow-up with colleagues and indicate if things have gotten better
• Say, “Thank you”
REVIEW OF KEY POINTS

- LISTEN TO THE KIDS
- Monitor everything
- If progress is not optimal, INVESTIGATE TECHNOLOGY FIRST
- Monitor technology and change as needed
- Monitor therapy and change as needed
- Be sure parents and kids are involved in monitoring and in making changes

TAKE AWAY MESSAGE

- It takes a team to raise a child with hearing loss!
- This field is constantly changing
- The population is changing
- The technology is changing
- We all need to change with it
- Because the kids are depending on us!

PLEASE WATCH PART 2 FOR MORE INFORMATION
Thank you.

Questions?

Contact Cochlear Americas

For inquiries and comments regarding HOPE programming, please contact:

hope@cochlear.com

A Certificate of Participation is available for download from the Handout feature in the lower left-hand portion of your screen.