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continued

Auditory Processing Disorders and Blast Trauma

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3

continued

LEARNING OUTCOMES:

AS A RESULT OF THIS COURSE,
PARTICIPANTS WILL BE ABLE TO:

- Describe characteristics of blast injuries and how they impact the auditory system.
- Address auditory skills with those who have had blast injuries.
- List treatment options for those that have had blast injuries impacting the auditory system.

4

CONTINUED

May raise more questions than answers

- Historically, thought of this population as noise induced hearing loss that may have been related to military noise exposure
- Currently, a broader perspective and these patients may end up in your office

5

CONTINUED

Expanded issues to be addressed today

- What types of injuries are these? Is it “just” blast injury or other types of acoustic trauma in that category?
- What is “blast exposed trauma?”
- How do we define “auditory processing disorder”
 - The historic perspective vs. what we address currently
 - Functional loss according to the World Health Organization (WHO)

6

CONTINUED

Expanded issues to be addressed today

- A world perspective: my daughter's recent trip to Laos
- How do these relate to other issues such as tinnitus and hyperacusis
- How do these patients arrive in our offices and how do we work with them

7

CONTINUED

Blast injury/blast exposed

- Beyond issues of noise exposure
- Veterans coming back from Iraq and Afghanistan reporting blast injury as part of their military service (Kubli, Brungart, & Northern, 2017)
- Hearing loss and tinnitus are the #1 and #2 complaints that service members report when they return from military service
- Exposure to improvised explosive devices (IED) from military exposure; others will be highlighted here
- However, what defines "hearing loss?"

8

CONTINUED

Blast injury/blast exposed

- Many of these patients report not being able to “hear”, particularly in less than optimal listening situations
- The audiogram is “normal”, contributes to stress the person experiences
- Goes beyond hearing only:
 - May report issues with anxiety, depression, post traumatic stress disorder

9

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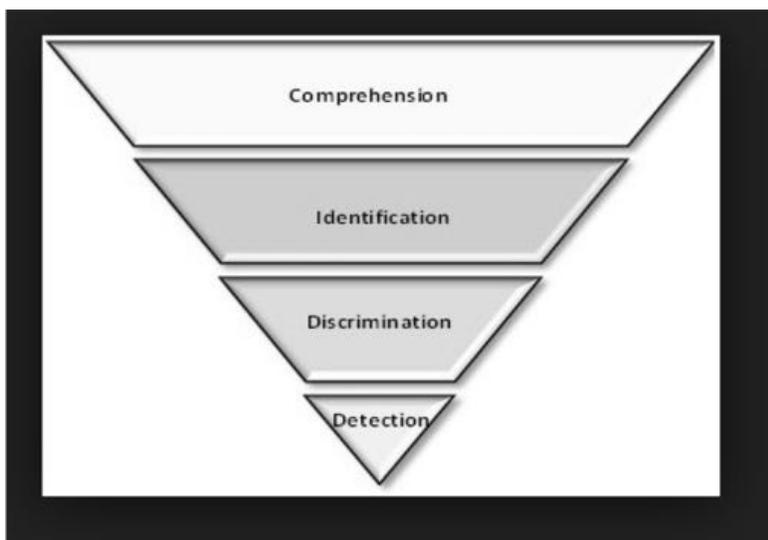
Blast injury/blast exposed

- Research by Lindsey Jorgensen, AuD/PhD at University of South Dakota
 - Podcast at <https://www.usd.edu/podcast>
- Because of the diffuse presentation, a number of experimental treatments may be tried, such as hyperbaric oxygen treatment

10

CONTINUED

Erber's Hierarchy (1992)



11

CONTINUED

What is happening in the auditory system?

- Traditional approach to looking at peripheral auditory system and using a detection task, like pure tone audiometry, for assessment
- Current focus on “hidden hearing loss”, the concept introduced by Kujawa and Liberman (2009) that supports that a blast injury may result in synaptic loss and damage to acoustic nerve fibers

12

CONTINUED

What is happening in the auditory system?

- Broader definitions of hidden hearing loss?
- Damage from blast injuries not well understood; shearing of fibers
- Modeling of damage is difficult through standard approaches, but research suggests that many areas of the brain are damaged by blast injuries, such as corpus callosum, brainstem, cerebellum, and temporal and frontal lobes (MacDonald, Johnson, Cooper, et al 2011)

13

CONTINUED

How do we look at this hearing loss?

- The times, they are a'changing: Will we change with them?
- Hewett, D. (2018) Audiometry and Its Discontents. *Hearing Review* 25(1), 20-23.
- The pure tone audiometer was developed in 1879
- Pure tone audiometer considered today to be the "gold standard"

14

CONTINUED

Addressing hearing loss...

- Crandell and colleagues pointed out that pure tone audiometry was unable to reliably predict the issue that most older patients present with—difficulty hearing in typical environments where competition is present
- Recommended that speech in noise testing should be a standard of care
- 30 years later, pure tone audiometry still “king”

15

CONTINUED

Addressing hearing loss...

- Crandell's comments are relevant today, particularly with this population
- Another consideration in blast injury is the issue of traumatic brain injury and how does this interact with blast injury; is it unique, what is the synergy
- Huge issue facing audiologists...will present this in case studies later

16

What is “functional” hearing loss

- Human hearing is constantly shifting
- Complex
- Pure tone audiometry is of little use in cases where patients present with auditory disorders of listening in noise, etc. May call them auditory processing disorder but addresses their “functional” abilities in the real world

17

Focus on functional hearing loss

- World Health Organization
 - Functional impact
 - One of the main impacts of hearing loss is on the individual's ability to communicate with others
 - Social and emotional impact
 - Exclusion from communication can have a significant impact on everyday life, causing feelings of loneliness, isolation, and frustration
- Up our game and listen to patient report

18

CONTINUED

What is “functional” hearing loss

- Although pure tone results will likely be a “gold standard” it will not be THE “gold standard” in the future
- Need to look at binaural/dichotic listening issues
- Need to develop realistic speech in noise testing
 - Recognizes that what we have may not address the actual report of what patients report

19

CONTINUED

Diversifying the “audiology portfolio”: using our skills and knowledge to the best of our abilities and addressing patient needs

- Suggestion from Richard Gans, Ph.D.
 - Vision for the role of balance
 - Changed the face of balance assessment, treatment, and education in the profession
 - Reaching out to this patient population

20

BLAST INJURY and New approaches being developed to address the “real world”

- Patients with blast injuries often report difficulty listening in less than optimal environments despite having a “normal” audiogram
 - Telling them it’s “in their head” or insisting that their hearing is “normal” does not help this system
- Study by Kubli, Brungart, and Northern (2017) used a speech test that used localization skill as its target
 - Their results demonstrated that subjects that were blast exposed had greater difficulty with spatial hearing in complex listening environments
- Research from NCRAR demonstrates behavioral test result deficits when tests that tax the auditory system (e.g. Gaps in Noise, QSIN) are administered (Papish and Gallun, 2015)

21

Considerations

- Tinnitus and/or hyperacusis
- Relationship of tinnitus with blast exposure: Cochlear synaptopathy related to the injury
- Impact of tinnitus on listening
 - Fatigue
 - Concentration

22

Assessment

Using the Term 'Hearing Difficulties' (HD)

(Central)
Auditory
Processing
Disorder

Hidden
Hearing Loss

Hearing
Difficulties

continued

No Standard Protocol: Where to Start

- Careful case history
 - Most have the same response:
 - “I have been told I have ‘perfect hearing’”;
 - “The audiogram says I have normal hearing”;
 - “I was told this was all in my head”
 - Long standing issue vs. new/sudden onset
 - History of concussion/traumatic brain injury

25

continued

No Standard Protocol: Where to Start

- “Authentic assessment”
 - Auditory Processing Questionnaire (APQ)
 - Hearing Handicap Questionnaire for Adults (HHIA)
 - Tinnitus questionnaire
 - Cognitive **Screening** (e.g., Montreal Cognitive Assessment - MoCA)

26

Minimal Assessment

- Pure tone audiometry
- DPOAEs
- Speech in Noise assessment
- Tinnitus assessment, if appropriate

27

Audiologic Assessment

- How is that auditory system taxed to address patient report?
 - Minimally, address dichotic listening skills based on research
 - May select test battery like SCAN-3:A
 - May create a test battery or select tests that address HD in general or specific concerns expressed by the patient
 - Gaps-in-Noise (GIN)
 - Masking Level Difference
 - Historic tools from the VA-CD (e.g., Dichotic Digits, CD, etc.)
 - LiSN (Listening in Spatialized Noise)

28

CONTINUED

Research on blast exposure

- If the auditory system is taxed, the listener demonstrates deficits that are consistent with a broad based diffuse neurologic/audiologic injury

29

CONTINUED

CASES

30

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Survivor of bombing

- Marathon runner
 - Knocked down twice at the finish line
 - Didn't have issues until returned to work
 - Business partner told her she "couldn't hear" and her husband told her she "couldn't hear"
 - She saw 7 audiologists with the main complaint that she "couldn't hear", specifically in complex listening situations which had never bothered her before her blast exposure
 - She was told 7 times that her hearing was "perfect", "normal" etc....she was told by an audiologist that she had "PTSD"
 - No speech in noise testing

31

CONTINUED

Survivor of bombing

- Marathon runner
 - When QSIN performed, her score was 13.5 dB
 - This is what she experienced
 - Dichotic listening deficits and speech in noise
 - Recommendations offered
 - Hearing aids worked remarkably well for her
 - Auditory training
 - Speech/language treatment

32

CONTINUED

Call Center worker

- Unique type of blast injury
- 67 year old woman complained about increased difficulty listening in background noise, sound sensitivity, and bilateral tinnitus that she described as a “ringing sound” and “loud”
- She was using noise cancelling headphones constantly when not at work
- Had asked her employer to turn down “sound” at work as they played loud music to “motivate” the employees

33

CONTINUED

Call Center worker

- She had a mild flat sensorineural hearing loss bilaterally with word recognition scores of 84% for the right ear and 96% for the left ear
- Speech in noise was poorer than would be anticipated for a mild hearing loss
- Tinnitus pitch match at 2000Hz with loudness match at 7 dB SL
- TRQ of 67
- Reduced sound tolerance with right ear seeming more sensitive than the left ear

34

CONTINUED

Call Center worker

- After further research, the onset of her presentation and hearing results were consistent with those observed with an acoustic shock injury (Whitelaw & Miller, 2013).
- Common “blast” exposure in call centers that result from sudden loud shrieks or piercing tones
- May result in reported pain around the ear, headache, vertigo, tinnitus, sound tolerance issues, and perceived hearing loss.
- Most symptoms are subjective and people who experience these are often perceived as malingerers

35

CONTINUED

Call Center worker

- Recognized in the UK and Australia
- Started to be recognized in US
- Tinnitus treated with habituation program in hearing aids
- Cognitive behavioral therapy yet also focused on being a “faker” according to her employer and previous audiology testing

36

continued

ELECTROCUTION

- Blast to the auditory system
- Lightning hit phone land line, “fried” the auditory system
- The things your grandparents said...”don’t use the phone during a thunderstorm” “don’t be in the bathtub when there’s lightning”
- Not well understood since many patients die from this

37

continued

ELECTROCUTION

- 40 year old woman who had a lightning strike while talking on a land line at work
- 10 years ago; many other symptoms have resolved but auditory systems persist
 - Normal detection thresholds
 - Can’t hear in noise, poor auditory processing skills
 - Unlike most injuries that have some resolution, electrocution injuries progress
 - Tried hearing aids, concern about “burning them out” but can hear well

38

CONTINUED

Referral from the VA

- 34 year old female who returned from blast exposure in her military service
- Had always been a “great” student and school was easy Attended law school and she described it as a “bust”; had never had difficulty learning in the past and stated that she was “hearing impaired”
- Failed the bar and wanted to improve auditory skills as she prepared again
- Also impacted her family life
- Normal audiogram; deficits in every area of auditory processing for both ears
- Tried both hearing aids and DM system; preferred hearing aids

39

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TREATMENT

40

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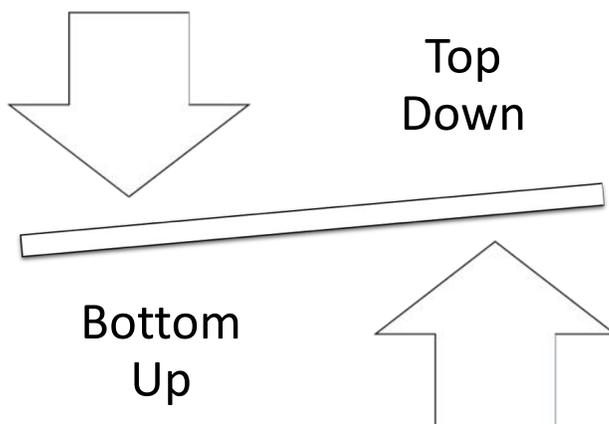
Talking with the Patient and Their Family

- Providing patients results:
 - “This is exactly what’s been happening to me!”
 - “I have been trying to tell people this is what happens when I listen/hear.”
 - Range of recommendations that are available to both address communication issues and to perhaps build a better auditory system

41

CONTINUED

Management Techniques



42

Bottom Up

- **Goal: Provide best possible signal**
 - *Improve audibility of soft speech*
 - *Improve SNR.*
 - *Manage competing sounds*
- **How?**
 - *Hearing Aids*
 - *Digital Modulation Technology*
 - *Environmental management & communication strategies*

43

Evidence for Mild-Gain Amplification

- Roup, Post, & Lewis (2017)
 - 19 adults (18-58 years) recruited based on subjective complaints of HD
 - 20 control participants
- **Auditory Test Battery**
 - 2 questionnaires
 - HHIA and an auditory processing questionnaire
 - 5 behavioral auditory tests
 - *SCAN:3-A, dichotic digit recognition, gaps-in-noise (GIN) test, 500-Hz MLD, and speech-in-noise (R-SPIN) test*

Auditory Test	Participants with Performance below the Normal Range	
	Number	Percentage
MLD	2	12%
SCAN-3:A	2	12%
DDT—free recall	7	41%
DDT—directed recall	9	53%
GIN	9	53%
R-SPIN high predictability		
12 dB SNR (<39.2%)	15	88%
8 dB SNR (<71.2%)	14	82%
4 dB SNR (<91.3%)	14	82%
0 dB SNR (<97.6%)	13	76%
R-SPIN low predictability		
12 dB SNR (<23.2%)	12	71%
8 dB SNR (<46.3%)	15	88%
4 dB SNR (<66.9%)	15	88%
0 dB SNR (<79.6%)	15	88%

44

Evidence for Mild-Gain Amplification

- Roup, Post, & Lewis (2017) (cont.)
 - HD participants completed a 4-week HA trial
 - Fitting procedures:
 - Widex Dream 440 RIC hearing aids with open domes
 - Default DM, NR, and Speech Enhancer settings enabled
 - 5-10 dB of insertion gain prescribed for 1000-4000Hz for soft and conversational inputs
 - MPO verified not to exceed 100 dB SPL
 - Functionality of DM confirmed with front to back ratio of speech:noise
 - Asked to wear for a minimum of 4 hours per day
 - Hearing aid usage (# of hours, listening environments) and
 - Perceived benefit

45

Auditory training

- Angel Sound: Free and basic place to start
- Listening and Communication Enhancement (LACE)
- CAPDOTS
- cLEAR: customized learning: Exercises for Aural Rehabilitation

46

CONTINUED

TOP DOWN Strategies

- Working with Speech-Language Pathologist
- Blast injury also impacts language processing abilities (the other side of the same auditory processing coin)
- Bombing patient worked with an SLP who has worked with many TBI patients; this treatment, in conjunction with hearing aids was beneficial

47

CONTINUED

CONCLUSIONS

- Blast exposure results in diffuse issues with the auditory system, primarily NOT related to significant peripheral hearing loss
- Issues are the “processing” of auditory information, including issues with hidden hearing loss and those with a broader impact such as difficulty with listening in complex situations and spatial hearing
- In order to assess this patient population, **MUST** address how to tax the auditory system; minimally must look at speech in noise

48

CONTINUED

CONCLUSIONS

- Listening to these patients tells more than performing an audiogram
- Must feel comfortable listening to patients then can proceed with treatment, such as fitting with hearing aids
- Consider these patients as having hearing difficulties (HD), which goes a bit beyond hidden hearing loss
- Aural rehabilitation is a critical component

49

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50

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