

This unedited transcript of a continued webinar is provided in order to facilitate communication accessibility for the viewer and may not be a totally verbatim record of the proceedings. This transcript may contain errors. Copying or distributing this transcript without the express written consent of continued is strictly prohibited. For any questions, please contact customerservice@continued.com

Grand Rounds, in partnership with The Ohio State University

Presenters: Gail Whitelaw, PhD, Jack Korsgard, BS, Christina Martin-Smith, MGS, Madison Pollock, BA, Aryn Robinson, BS, Liam Smyth, BA

Hello and thank you for joining today's webinar Grand Rounds in partnership with the Ohio State University. It's my pleasure to introduce our presenters from Ohio State. I'm going to turn the floor over to Dr. Gail Whitelaw who will tell you introduce the speakers to you and get us started. Dr. Whitelaw, I am turning the floor over to you. Thank you Christy.

I appreciate that. Thank you all for joining us today. This is one of our favorite things that we have the opportunity to do as a program each year and we've done it for many years now. And these are our graduate students who've selected cases that they think are interesting for a number of reasons and every year we get feedback that they're interesting to folks in the profession. So I would like to introduce you to the presenters for today.

Christina Martin Smith is a fourth year student in our program who who is completing her residency at the Pittsburgh VA Medical center in Pittsburgh, Pennsylvania. Christina is a veteran at this. She's presented with us a number of times and I think her case is fascinating and hopefully you will enjoy that. The next presenter is Liam Smith. He's also a veteran presenter on this forum and he is completing his residency at the Iowa City VA Medical Center.

Jack Korsgaard is a third year student in our program who has varied interests and he and Aaron Robinson, who's also a third year student in our program are going to be presenting together on one of the topics that I think we all enjoy talking about around here, cross hearing aids. And Erin's a veteran at this also. And then Madison Pollack will be the last student presenter in the cases and she's also a third year student in our program. Jack, Aaron and Madison are all busy in the process of interviewing for fourth years and I can assure you that anyone who is fortunate enough to have any of these three folks that are looking are going to be very fortunate indeed to have an outstanding extern. And I'm going to finish up today with case.

Assuming we have time. We've got a jam packed hour and a half for you. These are our disclosures. You will see relevant financial and non financial disclosures here and we have limitations and risks that you can read about participating in the webinar today and then also learner outcomes and these are some very basic learner outcomes that we hope for today. But there's so much more.

Like I said, we have a jam packed hour and a half. So I'd like to introduce you first to Christina Martin Smith who will present her case.

Hello everyone, my name is Christina. And I'm very excited to talk to you all today about bilateral implantation, but only one functional cochlear implant. So to give a brief overview of what I'll be talking about today, we're going to briefly surface level talk about Wagner's granulomatosis, what it is, how does it relate to the ears and how is it treated. Then I have the pleasure of introducing you all to Mrs. L, discuss her year of surgeries and then spring of 2025.

So what is Wagner's granulomatosis? This million dollar word first described in 1987 by McBride. It wasn't fully presented until Frederick Wegener in the early 20th century. You might hear it now called granulomatosis with polyngitis or GPA. However, for the purposes of this presentation, Mrs. L identifies herself as someone with Wagner's degeneration.

So I'll be saying Wagner's or Wagner's degeneration.

So what is this? Scientifically, it is a systematic autoimmune disease of unknown etiology, characterized by necrotizing granulomatosis, inflammation and vasculitis, affecting mainly small blood vessels.

So what does that all mean when we break it down? We have granulomatosis, which comes from granuloma. These are inflamed cells trying to eliminate a foreign body, also known as immune cells. So

these are inflamed immune cells. Necrotizing comes from necrosis, which is when body tissue is dying, and then vasculitis is inflamed blood vessels.

You put this all together, you have dying inflamed cells and inflamed blood cells. Now, that scientific definition included small blood vessels, which translates to predominantly affecting the upper and lower respiratory and kidney tracts. But what is our favorite organ that we all know and love that also has very small blood vessels? The inner ear. So the impact on hearing is very similar.

So we know that the labyrinth is constantly needing its blood supply as all the other parts of our body. But those blood vessels are very small. So you can have inflamed blood supplies or inflamed blood vessels in that inner ear. Thusly, it can affect balance. Although I will say in my research about Wegener's degeneration, balance is a rarely reported symptom, which I find interesting because we're talking about the labyrinth.

Also we're talking about clustered cells that could appear on the eighth cranial nerve. Now, a conductive hearing loss can come from when the blood cells on that eardrum cluster together, and then those dye, they die off, which causes perforations and chronic drainage. And then of course mixed hearing loss, if you can affect multiple parts would also cause the highest thresholds that you would see in these individuals.

So how do you treat Wagner's degeneration? How do you treat an autoimmune disease? It's not necessarily treatment as in a cure, rather putting it into REM remission. Now the three medications that you currently see on your slide are only the very like against brief overview of Wagner's degeneration. So this is a brief talk about the medications.

These are also the three medications Mrs. L is on. So with immunosuppressants. Rituxib is an alternative type of medication which has been used for autoimmune inner ear diseases to help resolve

hearing loss symptoms. The medication is also researched to be ototoxic. So it's interesting to see a drug to help resolve hearing symptoms can also be considered ototoxic.

There's also steroids that people take often orally and then to maintain remission they're taking azathioprine which is an anti rejection, anti metabolic drug. We don't know too much about its side effect, but it has shown to be helpful.

So I would love to introduce you all to Mrs. Lynn. So April of last year, the 75 year old female comes into the clinic that I was at in the Live Caption app on her smartphone. Granted I didn't see her last year I was here. I only saw her in 2025. She had reported her hearing loss was caused by her Wagner's granulomatosis and that she had normal hearing up until 2017.

She has a history of surgeries with a 2018 mastoidectomy for a suspected placeatoma. And she has chronic pain and drainage on her left side.

Looking at her audiogram that was taken that day. The left ear is in that severe down to profound mixed hearing loss range. The right ear only had three testable frequencies. Between 250-1000Hz SRT speech audiometry on that right side, 105dB SRT on the right and 85 on the left and then 12% at 110 word recognition score on the right and 52% at 105dB on that left. So she was seen at that appointment for a cochlear implant evaluation.

So she was fit with Phonak Nydia P90BTES with foam molds. Now they were unable to complete the real ear measure for that left side because of the drainage when they put her through the AZ bio Testing, which, if you're unfamiliar with the AZ bio, it's sentence, nonsensical sentences that you just ask for them to repeat back. So binaurally, she scored 53%. In the right ear, she had 0% and left ear was 44%. CNC words and phonemes.

So CNC words are a list of 50 words that have three phonemes each, like bat. And you kind of count the phonemes, count the word binaurally, it was 18% words and 42% of the phonemes.

So after all that testing and the approval from the enc, she went through having a surgery, but not just one surgery. So let me talk to you all about May of 24 to December of 2020.

At the beginning of May of last year, she had her left ear implanted. A couple weeks later, she had that initial activation. Then in July, around that first month, Mark, they could see the CI through the ear canal. But she was wearing the cochlear implant for 15 hours a day. She was enjoying wearing it.

The visualization is kind of right now a bit of a red flag. A couple of days later, she had surgery at the ear canal closure to kind of help with, you know, replacing that electrode. Her sight wasn't healing very well. We weren't sure, or they weren't sure if it was just because her regular degeneration was causing a slower healing a couple of days or in the month afterwards because of after that surgery, she just had a lot of pain. So she went from 15 hours of wear time down to three.

It hurt to wear it. There was an exposed electrode. She continued to have chronic drainage in August. And then she had an CI explant. Essentially what that is, that's a surgery where they go in, scrape a part of that CI off and send it for cultures.

She had a second surgery in terms of trying to help replace the cochlear implant, both that internal part in October of last year, but ultimately December of the very last day of the year, it was determined to just remove everything from the left side and implant the right ear.

So how was she hearing, though? During the, give or take six months of wearing the cochlear implant, she was doing very well. So the first column has the frequencies, the azbio and the CNC words test results. The second column is that test from April and then December 4th. Initial activation by the end of

May to December 4th.

Her frequency wise, those thresholds are within the mild hearing loss range, which in cochlear implants, that is a very ideal place for thresholds. To be AZ bio shot up from 44% to 77%. And although words, CNC words and phonemes were not tested, in that initial April appointment, she had 40% words and 60% phonemes. And from what I've been learning through my perspective of success with a cochlear implant, it's 20% above the original score or 40%. So with all that time with the two surgeries, she was doing well with the cochlear implant on that left side.

So how is she doing now? This is where I first come to meet Mrs. L because she suddenly doesn't have a left CI, she now has a right. So I saw her for her initial fitting of that Cochlear N8 processor on the right side. She was reporting some difficulties with balance since the surgery, which is common after you have a CI surgery. We started the programming off the population mean and then we balanced for loudness, ensured audibility and comfort.

Because Mrs. L had her left CI in about again, give or take six months with it, she had all the technology ready. It was great. She's like, here's my iPhone, here's my iPad, here's my phone clip and here's my mini microphone. We got this. Her husband also attended that appointment.

He's like, we're good, we're got the, we got the connection.

I also saw her for her one and three month post activation. So in February she reported doing her doing well. Her husband said that she was just finishing another end of her four week dosage of medication. So she was a bit lethargic at that appointment. And this is how I.

And then she said that she perceived sound coming from her left side. And I found that to be extremely interesting. But it also makes sense because you hear from your left side for six months, all of a sudden

from the right. The brain's plasticity needs more time to figure out where the sound is coming from. And then in April she was continued to do well, no longer perceive sounds from the left side, doing well with all of her technology.

She actually drove herself to that appointment, which for her is a massive milestone with everything going on.

So how is she hearing? So again, that first column there is the frequencies and it is the testing. The second column is that the first April 2024 test. And then we have the one month and three month follow up. So let's look at the year difference.

Let's look at April 15 to April 23, a year apart. We have three testable frequencies, 50, 60 and 80. Now we're doing mild hearing Loss range with the cochlear implant and then a normal frequency at 6,000 hertz. So she's doing great in terms of the CI thresholds. AZ bio went from 0% to 67.

That's wonderful. CNC words again with that left side. We also did not test, but she shot to 48% and 70% on that after three months of activation. Again, depending on how your sites or facilities might look at success rates. 20% above the score, initial score or 40% and she's exceeded that.

So she's doing great with this right side hearing aid. She reports doing well and I know her six months of activation was about was sometime this month and I hope she's doing well. In summary of my presentation, Wagner's granulomatosis, or gpa is an autoimmune disease affecting small blood vessels. We all know that the cochlea, the eardrum, have those small blood vessels. So it's sensorineural.

It could be conductive hearing loss or it could be mixed hearing loss. Mrs. L was first implanted on that left side before it was removed ultimately and the right side was implanted. She had to undergo two

additional surgeries on that left side before they just decided to take it out. And to the best of my knowledge, she's only had the one surgery on her right. So the months following up after the right side activation have been going very well without any further complications.

So thank you all for listening and I'm going to pass it on to my classmate Liam Smith.

All right, thanks, Christina.

So the case we're going to take a look at is a case looking at traumatic brain injury and some different facets of auditory processing.

So quick agenda. We'll go over mild traumatic brain injury briefly, review some research on how it affects hearing in the auditory system, do our patient case report briefly related back to the research. Then we'll take a quick look at kind of a bonus project I did looking at auditory stream segregation in this patient and then some closing thoughts.

So mild traumatic brain injury, if we think of traumatic brain injury as being classified along a continuum, we divide it up into mild, moderate and severe categories and mild traumatic brain injury, which is what this patient had, which we'll be looking at in this presentation, is generally defined as a loss of consciousness lasting less than a half hour, post traumatic amnesia lasting less than a day. Neurological deficits, focal neurological deficits, they may or may not be transient and any sort of mental alteration at the time of the incident.

Most research studies looking at acoustic trauma generally focus on blast injuries. They did not focus on traumatic brain injuries resulting from things like a fall. So Harris et al in this review wanted to look at the effects of mild traumatic brain injury on the structures and pathways of the auditory and vestibular system. And they did that through a literature review and they kind of found both covert and overt

methods that mild traumatic brain injury affects the system. Hidden hearing loss can occur by synaptopathy, followed by neural axonal loss and neural degeneration, just damage to the hair cells and the neurons.

In the presence of full recovery of cochlear thresholds, more overt damage can be done by damage to the eighth cranial nerve, the endolymphatic duct, the epithelium, the vestibulocochlear apparatus, through laprine fluid shock pulses, and also histological damage to things like hair cell damage, organ of Corti degeneration, basilar membrane shearing and auditory nerve demyelination. From a more clinical standpoint, that was more an anatomical standpoint. From a clinical standpoint, the authors estimated that one third to one half of all patients with mild traumatic brain injury have report tinnitus, sensorineural hearing loss or vertigo not always correlated to the severity of the blow and the severity of the symptoms. But one trend that did shine through is that hearing loss resulting from a traumatic brain injury, a mild traumatic brain injury does tend to skew toward the high frequencies. And then Null et al in 2019 briefly looked at the effect of auditory symptoms of mild traumatic brain injury on quality of life.

So they did a full battery of questionnaires, the Hearing Handicap Inventory for Adults, the Tinnitus Handicap Inventory and the Hyperacusis questionnaire. And what they found was that hearing loss, tinnitus and hyperacusis were all associated with significant handicaps in patients with a history of mild traumatic brain injury. With a little bit of background, that brings us to our patient case study. A little bit of background about him. He was a 53 year old man at the time of the traumatic brain injury in 2021.

He's now 57. He's a former lawyer who has not been able to return to work, has not practiced since the accident. From the time of the accident he was living with a friend who helped with finances, medical care and transportation. As of May this year, he's living independently. So if we go all the way back To September of 2021, this is when the, when the accident happened.

He was cutting branches with chainsaw on a ladder one afternoon in his backyard and fell forward. This picture he provided you can kind of see where he started cutting that branch and didn't quite finish it. He had the left side of his head and the right side of his body. Has no memory of the accident, but he does remember waking up and hearing, you know, coming to consciousness and hearing paramedics, but not being able to form words. So, you know, after this event, this traumatic brain injury, obviously he was taken straight to the hospital and underwent brain surgery.

Part of his skull had to be removed to relieve the swelling in the brain, and it was then subsequently replaced. In December of 2021, three months later, he could not walk at first and had difficulty understanding speech. He had left focal damage resulting in aphasia. And at that time, the only symptom really relevant to audiology or otolaryngology was that he was bleeding out of his right ear and swelling in his left ear. And then he spent the next three weeks after his stay in the hospital after that brain surgery in a rehab center near Columbus, Ohio, receiving pt, OT and speech therapy. Audiology first came into the picture in May of 2022, eight months after the accident.

His physical therapist, Ohio Health, which is a group here in Columbus Healthcare group, and they referred him for an audiogram which confirmed that his hearing in his left ear is a little bit better. He has basically normal thresholds up through 1000Hz, sloping down to a moderately severe hearing loss, and then in the right ear, starts out at a mild hearing loss and then slopes down to a severe mixed hearing loss.

Where we finally started seeing it was that at Ohio State was in September of 2022 in the aphasia Initiative. A speech clinic specializing specifically in aphasia at Ohio State began seeing him. But they reported in that initial evaluate that he had functional auditory comprehension, mildly impaired receptive language, and was independent with simple homemaking activities of daily living and medication management. Short term goal was returning to driving, which he did, and short term goal returning to

work, which he still has not done. If we dig into his auditory comprehension a little bit more, and again, keep in mind this is them looking at this from a speech perspective.

He answers yes, no questions, follows verbal commands, and is conversational. And a subsequent appointment in October 2022, October 26, he reported that he felt he heard better out of his right ear, which is inconsistent with his previous report, but in struggle with speech in background noise. So we gave him the adult Auditory Performance scale and came back as abnormal. So they referred him for an auditory processing evaluation, which is where Dr. Whitelaw and I come into the story here. So we saw him at the end of November of 2022.

I was only an observer for this appointment at Ohio State in the first year of our program. Students are not active participants in clinic, but they are observers in clinic. So this is one of the first patients I've seen or saw. And the communication limitations described by the Aphasia Initiative were apparent. When we saw him.

His case history information was limited. What he was able to provide. We are mostly seeing him just to get a baseline of his current hearing and development plan to improve listening and contribute positively to his quality of life. He was able to tell us that the pain and pressure and drainage that he had previously experienced his two ears had stopped. He still reported tinnitus in his right ear that had.

Which is consistent with what we see in the research.

And he reported that he heard better of his left ear and his right ear sounded muffled, which was again more consistent with what we were seeing on the audiograms. So this is what we got. In the initial audiogram, you see a little bit of fluctuation in the low pitches compared to the last audiogram in May of that year, Particularly in the left ear, what was essentially a normal hearing and had kind of gone down to a mild hearing loss in low pitches with an air bone gap. And the right ear had mostly declined from a

mild hearing loss to a moderately severe hearing loss with this upward slope towards 1000 and then declining down toward a more profound mixed hearing loss. Word recognition, perhaps ironically, was better in the right ear at 96% and 88% in the left ear.

Not a significant difference, obviously, but somewhat noteworthy. Much like he was limited in his ability to provide case history, his responses to word recognition and speech recognition were somewhat delayed. A quick sin showed an SNR loss of 22.5 dB. So he was very clearly struggling with understanding speech in background noise and understanding in general. And because of that hearing loss, APD testing was obviously not performed.

So fast forward four or five months to April of 2023. We fed him with Oticon Opn S1 many right hearing aids, which he reported helped him equalize hearing between ears and improve his overall hearing, which again contribute to quality of life. There's a brief side note, brief story. He initiated a conversation with his audiologist at this appointment about his communication difficulties. He found most people to be impatient with him in communication, to be frustrating.

He complimented Dr. Whitelaw on being a patient communication partner. And he wanted people to know that he's still in there. So the moral of that story is, obviously, be a good patient communication partner with Our patients. And then we kind of lost track of him for a while. Aphasia Initiative only saw him intermittently during the rest of 2023, and audiology didn't see him at all during that time.

He went underwent four back surgeries to assist with balance, and he ultimately underwent a total of 11 surgeries since the accident in 21. We finally did come back into our orbit in May of 24. The Aphasia Initiative did a report that just kind of checking in again, auditory comprehension was probably worse than written comprehension. He was most successful at communication when the message was not fully dependent on a moment of time. And by that I mean like distorting components in a signal and being able to reference information on his own, on his own time and space gave him the information,

helped employ process messages, and he was referred back to us.

So we saw him. I saw him. By now, I'm in my second year of clinic doing this at the end of 2024, July 2024, and he reports significant progress in his recovery, including the four surgeries and the back implant. He still reported some difficulties with balance. He reported that when walking, he lists slightly to the right and forward.

He reported they felt this hearing was worse than his right ear, again more consistent with the previous reports. And he reported that he still experiences intermittent non biosim tinnitus. And he reported trouble understanding music, particularly lyrics, which I thought was an interesting report. And you kind of face this about in a minute of my stream of segregation follow up.

Okay, let's slide here.

There we go. Went too far. So that's his audiogram. You can see the left ear still has an air bone gap. There's air bone gaps in both ears.

But the low frequency hearing, the left ear, is much better. Back up to the normal range and sloping down to still a moderately severe high frequency hearing loss. And the right ear is much improved. That's the best audiogram I think we got on him, showing what is essentially borderline normal hearing in the lower pitches and then sloping down to a severe hearing loss. He still has that mixed component that's been fairly consistent.

By this point, he had progressed to the point where we could give him his responses. We could give him the R spin the revised speech and noise test. And for high predictability sentences, senses that have a lot of context, the last word in the sentence is relatively easy to predict. He got 75% of those correct. But for low predictability sentences where the word was not very easy to Predict, he got 38%.

And then an informal observation just When I was walking into the booth of his walking pretty much confirmed his reported balance difficulties. He definitely listed a little bit and I think he said, listen to the right, which he definitely did.

So this was generally good news that his hearing had improved a little bit. He was getting benefit from the hearing aids. He had overall improved a lot since the accident. We ultimately fed him with Oticon Intense. We got him in something a little more powerful in October of that year.

So today he's living independently. Like I said, he moved out in May of 2025 and began living independently. He reported numerous changes to his routines and the conversations I have with him. But he has been able to resume hiking and photography, two of his key hobbies. And he's really focused on trying to understand his accident and have a positive attitude about moving forward and continuing to embrace the differences that come with his injuries.

The story unfortunately takes a little bit of a sad turn the summer in that he's now undergoing treatment for lung cancer. He's maintaining the same positive attitude.

But it is unfortunate that after so much progress since recovery from the traumatic branch where he now has to deal with this. So I guess. I guess this story is yet to be fully written.

Just to briefly tie us back to the research, Harris et al kind of looked at the anatomical changes that cause vestibular symptoms, and he had those.

And he had definitely tinnitus, sensorineural hearing loss, and mixed hearing loss and balance symptoms, which about a third to half of all mild traumatic brain injury patients have. And hearing loss skewed toward the high pitches definitely put a damper on his quality of life, especially in the beginning.

Like I said, the Adult Auditory Performance Scale showed an abnormal deficit in speech and noise processing in the Vanderbilt Fatigue Scale, which unfortunately I couldn't locate for this presentation. But we have our notes that we gave it to him and it showed a similar quality of life deficit. If we wanted to do a retrospective study down there, I guess we could have done the Tinnitus Handicap inventory of the Hyperacusis questionnaire.

But clearly the subjective hearing loss was at play here. And again, in working with him for two and a half years, I could see over time as we improve the hearing. He was definitely. That positive attitude definitely was helped by improving the hearing. There's no research into very little research that I could find into psychoacoustic tasks and how mild traumatic brain injury might affect them.

So we're going to do a little thought experiment in the next section of this presentation, talking about auditory stream segregation, which I think most folks At OSU know that I have a niche interest in this. I did my capstone project on this.

So I brought this patient in back to the clinic in June of 2025. And the reason I did that was because his reported difficulty parsing lyrics in a song and parsing components of a signal made me wonder how he would perform on some of these stream segregation tasks. So a quick background. I won't bore you to death too much with auditory stream segregation, but it's part of a framework called auditory scene analysis, proposed by Al Braggman, an experimental psychologist at McGill University up in Canada. Basically looking at how the auditory system makes sense of the world, how it separates and integrates components of a signal into distinct streams.

He published a framework and a book in 1990, which, if anyone's looking for something to lift weights with, I highly recommend. That book and subsequent CD in 1996 provided some auditory demos. So scene analysis is.

Or stream. Stream segregation is the basis of scene analysis. Kind of before the analysis, if we could look at this simple ABAB sequence, we would expect that to be perceived as one continuous stream. And post analysis, when we. With the segregated out of A and B, expect two different.

You can perceive two different streams. So that.

Excuse me.

So I did some demos with him off of Braggman's CD. The first one was based on Braggman of 1971. This is basically, we present him a cycle of six tones, three high and three low. At that slower speed, we would expect that we would perceive one continuous stream, which he did. And at a faster speed, he would perceive two different streams, which he did.

We move on to the second part of the Braggman 1971 paper, which is looking at pattern recognition both within and across perceptual streams. What I'm getting at here is that the brain naturally groups acoustic components likely to form patterns. And that expectation can be defeated in the lab by arranging a sequence of tones so that it doesn't align with what the listener is expecting to hear, which we call auditory camouflage pattern recognition. This second part looked at finding when we embedded the three tone standard in the sixth tone cycle of the high and low tones, when it was embedded within one stream, one distinct stream, it was much easier for the patient to determine that. And when we split up or arrange that standard in a way that it doesn't easily fall in one stream, it's kind of bouncing between the two streams.

We find that's a much more difficult task. And the patient fell within expectations within stream. He was able to easily determine the pattern and across Stream. He struggled. And I don't think I have the ability to move between slides.

Oh, there we go. Thank you. So then I pivoted away from the frequency domain into the time domain. Because the auditory system takes a few moments when analyzing a signal, when analyzing the summation on signal, before inducing streaming. So the idea of this demonstration was that we present a three tone cycle designed to induce streaming.

And that if we presented more repetitions of, you know, 2, 4, 6, 8, you know, 16, 32, we would expect to get more easily, more easy streaming more easily stream. And the patient found that to be progressive, to be easier. Then I pivoted to another element of this connected. The effect of connectedness. Basically, if we have that high, low, high, low alternating sequence, if we add a smooth transition between the two tones, it's much easier to perceive only one stream.

It's much more difficult to stream them into distinct streams. And if we don't add that transition, the auditory system naturally finds that much more jarring and induces streaming. And effectively, that's what this patient found as well, that when we had those smooth connections, that it's easy to perceive only one stream. And when they're not connected, it's easy to perceive too. So then we pivot.

Up until now, we've been talking about sequential stream segregation. This is basically the idea that we're segregating components over time. We're not trying to do multiple things at once in the auditory system. We now turn to simultaneous stream segregation. And this is where some of the differences that I thought I might find in mild traumatic brain injury showed up for this exercise.

The idea is to capture a tonal component out of a mixture. We have two alternating sequences of A and B, and then C is interleaved. He's supposed to find C. And no matter what condition we provided, he was not able to discern really anything out of the signal. So then, Even though the scan 3 is usually contraindicated with this hearing loss, I was curious how he might do with, if we turned it up a little bit, how he might do with competing words, free recall. I thought it was interesting that, you know, that last column, he did not get a single item, and he was able to get most of the items on the other task on the

other side.

So basically, the nutshell here is that in this little demonstration of stream segregation, I found that it was more difficult for the patient to do simultaneous components that seemed to have been impaired with his traumatic brain injury. Obviously, none of this is standardized, but it is an interesting thought experiment. On how we could apply some basic psychoacoustic research to some basic psychoacoustic tasks to this patient case. So Concluding thoughts Again, just briefly, the auditory component in this patient's case is a relatively small, but one that we can have significant component on quality of life and to that and I think we occupy a unique vantage point in the realm of interdisciplinary care and I think we can play a big role in that interdisciplinary team. And I also think it shows that we can potentially look at some basic psychoacoustic tasks.

I think that deserves further explanation or further exploration. Brief Acknowledgments Some folks from Ohio State Jennifer Brello and Aaron Shuler of the Aphasia Initiative, Larry Feth, our resident psychoacoustics expert, and Gail Whitelaw are thanked for their guidance in the support and I now throw it to Jack Horsegarden. Aaron Robinson Thanks Liam. This presentation is called At a Crossroads. I am one of the co presenters, Aaron Robinson, and I'm the other co presenter, Jack Korsgaard.

So me and Aaron kind of had similar cases and so we decided to combine ours just into one big case because we were planning on talking about some similar things. So just an outline, we'll go over both of our respective cases here. Some management options for people with unilateral severe to profound hearing loss. And then the bulk of this presentation will be about ROS devices. If you couldn't guess by our by our title.

And then we'll do some takeaways at the end here.

So my patient Dean is a man in his 70s. He does have a history of high frequency sensorineural hearing loss, probably just age related. And then in October of 2024 last year while on a trip just driving around, experiences this subjectively total loss of hearing in his left ear.

And so just talking a little bit about sudden hearing loss. So the estimated incidence kind of varies depending on how you define things. It's rare, it's probably a bit more common than the literature indicates, just based on the fact that there are probably people that don't seek out treatment. Commonly it co occurs with tinnitus, which is almost ubiquitous with sudden sensorineural hearing loss and can sometimes occur with dizziness vertigo, although that's less common. It just kind of depends on the etiology.

Of course, when you have a sudden hearing loss, you always want to rule out a conductive hearing loss as sort of a first order of business.

So recovery from sudden hearing loss, roughly a third to two thirds of people recover spontaneously. Again kind of depending on how you define the Loss in this case and recovery. And I just want to point out, just for the sake of this case, because I think it's a relevant sort of topic, is the degree of hearing loss is one factor that is related to the likelihood that someone will recover and the extent to which that they, they'll recover.

And so this was Dean's audiogram in October. So right after that incident, so you can see that pre existing hearing loss in his right ear and then he's getting basically nothing out of that, that left ear. He's got a couple of thresholds in the mid frequencies, but otherwise not a whole lot.

And so he did exactly what you should do in this situation, which is go seek out a medical evaluation. And so his physician prescribed him with a round of oral steroids which he underwent. And he also discussed potentially doing hyperbaric chamber treatments with his physician, but he just didn't

ultimately pursue it within the window for treatment.

And so this is his audio couple months after this incident, after he's gone through that treatment. And so just to sort of put things next to each other here. So we've got this first one in October, right after he had that sudden loss and then a few months later. So you see there has been some improvements in that left ear in terms of the thresholds. But notably he has zero word recognition in that ear.

So even though he's recovered some thresholds, he is not really getting anything functionally useful out of that year.

So he came to our clinic, actually referred by another patient at the clinic, and he did say at our first appointment, I think somewhat facetiously that he was looking for a cure. I think he knew that that wasn't really on the cards for him at this point. But really what I think this illustrates is just how much he was struggling with his situation and how much he felt like he really needed a big improvement to feel like he could be functioning adequately. So he describes really immense communicative difficulties, safety concerns, so he's not able to localize sound. He doesn't feel safe walking around.

It's affecting his social life, obviously, issues and noise and really bothersome tinnitus in that left ear. No dizziness, thankfully. But all these other things have coalesced for this to be a pretty big change in Dean's life.

And so the way he describes it is fairly interesting. So he can't understand anything through that left ear. Above a certain level, he can sort of tell that something is going on in that ear, but at best it's so distorted that it's not really doing anything to help. And at worst, the distortion is actually actively interfering with his listening ability. And so at our appointment with him, this was what we found.

So you can see that loss in his preexisting loss in his right ear and then sort of a severe sensorineural loss in his left ear. Again, no. No word recognition was able to be obtained in that. In that left ear. And when we put him in noise in the sound field, which was one of his.

One of his concerns, you can see with this r spin down here that he's really quite struggling with that. So at this point, gears start turning. You start thinking about what would be the best option for Dean. But before we talk about that, just want to sort of pass things over to Erin so she can talk about her patient.

So this is Jane. She's a female in her 80s. She's had tinnitus for 20 plus years. But then her main audiological complaint changed in 2021 when it was discovered that she had squamous cell carcinoma that had invaded her temporal bone on the left side. So squamous cell carcinoma is a benign or malignant tumor that forms in squamous cells, flat cells found in the tissue that forms the surface of the skin.

The incidence of squamous cell carcinoma impacting hearing is rare. Some risk factors include being of fair skin, exposure to solar ultraviolet light, and having a compromised immune system. The presentation is typically chronic discharge from the ear. Bleeding, ear pain, hearing loss. Facial palsy is less common, but you can see it.

But you might also see otitis externa or otitis media. And it's often treated as a persistent infection before a tumor is suspected and a diagnostic biopsy is ordered.

So when squamous cell carcinoma has invaded the temporal bone, the only treatment option is surgery. The extent of the surgery will depend on how much the cancer has spread, but it typically involves some of the temporal bone and middle ear structures being removed, followed by reconstruction of the ear canal, which is exactly what happened for Jane. A portion of her temporal

bone was removed along with the malleus and incus. Then the skin of her ear canal was pulled outward to surgically close off the ear canal. And this is a picture of Jane just showing that wall of skin that now sits where the entrance of the ear canal used to be.

So this is her audiogram from 2022, about a year after her surgery. It demonstrates that the right ear has pretty good hearing, but the left does not have much. And this is my test with Jane earlier this year. The right ear looks about the same. Her word recognition is still great and the left ear is essentially nothing.

And like Jack said, now we begin to think about device options.

There are a number of device options for people with an unaidable ear. And so for people with sensorineural hearing loss, of course just a monaural hearing aid, a cross or a Bicros device or a cochlear implant sort of depending on the candidacy. And then people with a mixed loss, you can throw in the, the bone anchored hearing aid device as an option for, for some of them. And so just to talk about some of these options. So a monaural hearing aid obviously advantage is the cheapest option.

It's non invasive. You don't have to go through any surgery. Disadvantage of course being that you're kind of cutting your losses here and there's no access to sound on your unaidable side. Bone anchored hearing aids advantages you are in individuals that have a mixed loss, you can stimulate some of the residual bone conduction hearing and in theory can maybe recoup some of their localization abilities with those binaural cues. Disadvantages of course the cost associated with it and the fact that it's a surgery for some people, cochlear implants advantages of course you are directly stimulating the auditory nerves.

You kind of have. So you have the best sort of ceiling for improving your thresholds here. Localization potentially to some degree in the event that you sufficiently kind of restore the those binaural cues.

Disadvantages cost, of course it's a surgery and you're learning to listen in a very different way.

And then the fourth option here, the CROs device, what we ultimately picked for both of our patients.

Advantages, it's non invasive, it's relatively cheap compared to the option of a cochlear implant or a bone anchored hearing aid. Disadvantages, we'll get into this more but no ability to localize with this.

And there were some special considerations for Jane that Erin will talk about due to her surgical ear. I know she had some previous difficulties with across but they were fortunately able to be creative and work around that.

And so Dean, ultimately. So we're lucky enough to have a trial program here, a demo program here at Ohio State. And so he was initially a little bit hesitant about hearing aids just because of some previous negative experiences with them years ago. And he opted to trial a hearing aid and a CROs device as a bycross.

I'm just going to skip over this next line just for the sake of time here and I'll hand things over to Aaron to talk about Jane's options. Jane's initial audiology ENT team discussed a cochlear implant or a bone anchored device. But she was not interested in more surgery, which is her right as a patient. She trialed a bone conduction device with a soft headband and she loved it and she was very happy and successful. But then she was told that an adult could not wear one long term.

That happened at a different clinic, so I'm not going to get into that. Then she trialed just standard cross devices and she was very unhappy because they wouldn't stay in her ear because the dome at the end of the cross really had nowhere to anchor and sit in the ear canal. So she came to our clinic because she was unhappy in social situations and felt like she was missing out on things that happened on her left side. My amazing and creative preceptor, Dr. Jodi Baxter, looked at Jane's ear and immediately thought, why not a custom ear mold? We were concerned about the end of the receiver fitting a mold with such a short canal.

But as you can see on this slide, it worked out just fine. So this, these are Jane's real devices. And then here it is in her ear. Fits perfectly.

So now I'd like to take a step back and discuss the concerns of patients with unilateral or single sided issues. These are the concerns that we encountered with Dean and Jane, but they are likely to be what you hear from most patients in these situations. So first, I can't hear in noise. Unfortunately, that's everyone with hearing loss.

Second, I can't hear people on my left. This is because both patients have an unusable left ear. Head shadow also comes into play here. We know from psychoacoustics that high frequency sound waves, the ones that carry the phonemes responsible for the clarity of words, cannot bend around the head easily. And then third, I can't hear where things are coming from.

This is because these patients no longer have two ears, which is essential to be able to receive the binaural cues essential for localization.

So you'll see as we go along that we can address some of these, but we can't do anything about the localization.

This is a simple cartoon depicting the cross setup. The top guy is has an unaidable right ear which makes him sad because he cannot hear the sounds coming from his right. Whereas the guy on the bottom is happy because his cross transmitter on the right picks up that sound and sends it over to his at able ear.

And so Like I said before, we're not, we can't address localization because with a cross, we're not stimulating the unaidable ear. We're just taking the sounds on that side and sending them to the ear

that still has hearing.

So just to talk a little bit about some of those patient concerns, specifically speech and noise here, there's been some interesting work done to see sort of in what situations CROs devices can help in noise versus in what situations CROs devices can't help. And the answer to whether they can help kind of is kind of, it depends. So if the speech is on the side of their bad ear, the thing they want to listen to is on the side of their bad ear, and the noise is on the side of their good ear, then in this case, definitely, yes, a CROs device can help. In this case, you're just, they may in theory be losing some of that speech to that head shadow effect that Aaron was talking about. You turn on the CROs device here, just a straight increase in signal to noise ratio and that can improve speech and noise.

And so just going to skip to this third one here, because I think this is kind of a more, the more important one. So this third one here, if speech is on the side of the aidable ear and noise is on the side of the unaidable ear, so the reverse situation is in this first one here, then cross devices definitely won't help in this case. All you're doing is just taking the noise that's on the side of their bad ear and transferring it over to the side of their good ear. Obviously in that case, that isn't going to help the signal to noise ratio. And so this is kind of a situation where counseling is going to be helpful and important to, for them to kind of know in what situations may be good to use the cross versus experimenting with turning it off.

So localization, as Aaron said, localization inherently relies on binaural cues. We're only providing sound to one ear with a CROs device, and so it cannot help with localization. It may improve lateralization to some degree. So whether they heard it out of the left or the right ear, being able to tell whether it was left or right ear, but in terms of actually locating where the sound was, it will not be able to help.

So verification and validation, obviously something you want to be doing with any hearing aid fitting, but there are some sort of unique aspects to verification and validation with cross fittings. So we'll get into some of those here.

So you'll see kind of different variations on this, just depending on what resource you look at. But really, the important thing here is to ensure. And what we've learned is to ensure that you are not losing speech sounds to the head shadow effect. And so a way of doing this is with real ear verification, just sitting the patient first step, sitting them in front of the verifits and running real ear verification as normal, with the devices on, just doing everything you kind of would do, usually with a monaural hearing aid fitting. And then sort of this additional second step, you turn the person so that their bad ear is facing the verifits, and you try and match the response there with the response from.

With that original response that you get. And so the idea here is to kind of make sure you're not losing any of that sound as it crosses. As it crosses over the head to that head shadow effect.

And so just sort of an example of that here. I'll have you focus on the right one just for now, just so we get. I don't have to talk about all the different colors, but on the right here, the green line is the gain with. In just that first step that I mentioned. So where the patient is just sitting straight in front of the verifit, the purple line is where the patient has now been turned away from the verifit and their bad ear is facing it.

And so you can see this difference here with this green line between that. Between the green curve and the purple curve is that head shadow effect. So they're losing speech sounds above, around that 1600 Hertz range. And then the blue line is with that CROs device flipped on. And you can see here, the response from the CROs has now been matched to the response from that hearing aid.

In this case, we now have evidence that we've overcome that head shadow effect, and they're not losing sound to the head shadow.

So it's also important to verify in a way that more closely examines the patient's real world, where things are noisy and difficult. These cartoons depict the setup for speech and noise verification in the booth. So select a speech and noise test where you can separate the speech and noise into different speakers. Position the patient so that the noise is on the side of the aidable ear hearing aid, and the speech signal is on the side of the unaidable ear cross. So this is a difficult setup for the patient.

First, you run the test with the CROs off, and then you repeat with the cross on. And we're hoping to see the patient do better when the CROs is on. So we both use the revised speech perception and noise test at a 8 signal to noise ratio. I just want you to focus on the overall score column. I know we don't typically score the R spin for overall correctness, but we did this so that we could use the Kearney and Schlaau 2007 table for a 25 word list.

And both patients demonstrated significant difference in the two conditions, which suggests a significantly better performance with the CROs device.

So validation is also important because that's when the patient is telling you how things are working for them, which is the most important piece. So Dean reported an easier time and noise and less stress in social situations. His ability to localize has not improved, which we knew it wouldn't, and this is a great opportunity to counsel more. But he does feel more aware of his environment, which I'm sure is comforting. He was happy enough to purchase his own devices.

So I used the client oriented scale of improvement or COSI. With Jane, her first goal was to be aware of sounds on the left side. I believe initially she said something about localizing and we discussed, discussed that that would not happen. So with the devices, she found hearing sounds from the left side to be much better most of the time. Her second goal was to decrease perception of tinnitus, which she found better most of the time.

She attributed this decrease to a decrease in stress levels from wearing the cross. And we know that increased stress increases your perception of tinnitus. So I was happy that her tinnitus perception decreased. It's kind of a happy byproduct of the cross fitting. So cross devices can be difficult to understand.

It's important to speak clearly and use redundancy when talking to patients. When we say redundancy, we mean good redundancy. Present the information multiple times in different ways and in different formats, one of which being written materials, something that the patient can take home and digest in a less stressful environment. And as we've mentioned, counseling about the limitations of the cross are paramount. Most patients with a single sided issue want to restore localization, but we cannot do that.

So this slide lists the things that we learned from these patient visits and we hope you learned them as well. Think outside the box for your patient. We were able to make Dean and Jane happy. But even if you can't make your patient happy, being creative will show the patient that you've listened to them and care about their journey. Verification and validation are part of best practices and they provide us with a lot of useful information.

And hopefully this last bullet came across loud and clear. Counseling is essential so that you establish realistic expectations. So thank you for listening. And now we will turn the floor over to Madison Pollack.

Hello. So today I'm going to be talking about a case that has to do with a pediatric very medically complex child who ended up having a conductive hearing loss. But kind of the considerations along the way.

So our patient today is a 10 year old boy that has a history of Witten vein Kolk syndrome, which is a rare genetic syndrome, as well as a history of cell B lymphoblastic leukemia. So both of those are pretty

significant to the point of medical history.

So going into kind of the cell B lymphoblastic leukemia, the patient was diagnosed at age five and finished treatment in June of 2022. So around age seven, so about two years of treatment. The chemo was administered via intrathecal, which is the space between the membranes around the spinal cord and the brain that is filled with cerebral spinal fluid to bypass the blood brain barrier. So currently family and providers are watching for long term side effects. I did want to note that there are reported cases in adults of fluctuations in hearing due to cerebral spinal fluid changes.

We don't know if that was an occurrence here, but is a note that when we're dealing with hearing that that had happened, we're also unsure of what type of chemotherapy medication was used. This was all done in an outside fac and so we were just kind of getting the bare bones and kind of understanding what was going on. We can also acknowledge that there was a potential for ototoxicity in this case. However we don't have any data but just something to keep in mind when we are looking at the history and what is coming up. So Witten vein Koch syndrome is a mutation of the SYN3A gene.

The prevalence is less than one in a million currently as of December 2020 there had only been 40 reported cases ever. So really a one in a million child and he really is. So he is one of 40 ever reported. It's also an autosomal dominant gene. So there are a ton of characteristics with the Wittenfean Kolk syndrome and with that I am really just looking at the ones that pertain to us as audiologists that would noteworthy for our kind of scope of practice.

There are several, several, several characteristics of this which look at many parts of the body and development, many of which have pertained to some of the 40 who have been reported and some do not. So some that were of note to us as Audiologists are the small head circumference note of brain anomalies, seizures, eye anomalies, intellectual development and learning difficulties, and speech and language difficulties. Back In December of 2020, when those 40 cases had been reported, there had

been one report of a sensorineural hearing loss, two reports of a conductive hearing loss, and two reports of a mixed hearing loss. So as we talked about at the beginning, this child did have a conductive hearing loss. So that has at least gone up by one in the past five years, but don't have any other data at the moment.

So the initial appointment they were he was referred by the craniofacial clinic and was originally seen for an auditory processing evaluation. And so for the reason of that was the parents would see or ask him a question or talk to him and he would wait about 30 seconds before responding and then would continue responding like that pause had never happened. So really they wanted to understand was this something that was part of the genetic condition or was it separate and could be improved?

So development and hearing history. This patient had been meeting developmental milestones about three to six months later than his peers. His newborn hearing screening, he did not pass at first first, but after being retested had passed. And then we had known that about a year Prior, at age 9, there had been a hearing test done that was reported to be within normal limit. So that was great information to have.

So learning history, there was a report of low IQ from some psychological testing that had been done. We don't know what hearing status was at the time of this testing, but just there was a report of low iq. The patient, as I had previously reported, waits at least 30 seconds before responding when being asked a question. And they weren't sure if it was his processing of information, his auditory processing or kind of what that was. So the patient struggles with expressing himself, articulation and following directions.

And in the classroom, the patient struggles with reading, spelling, comprehension and writing sentences.

So the current interventions, there's quite a few that he is involved in which is speech, language therapy, school based special education, reading intervention, tutoring, psychological testing, physical therapy, occupational therapy, and he is on an IEP at School 8. They were referred by the cranial facial clinic, but I don't know how often they see the physicians there.

So during our first appointment, the audiometric findings were a flat tympanogram with a mild sloping severe conductive hearing loss in the right ear and a mild flat conductive hearing loss in the left ear. Nothing really noteworthy with the word recognition or the srt, but Just that we had had that conductive hearing loss.

So a referral was made to otology and it was determined that the patient needed PE tubes. So the patient received PE tubes about a month after the initial appointment and evaluation.

So then after the PE tubes had been placed, the patient was seen for a follow up appointment back at our clinic. The parents reported signal significant improvement in hearing since the tubes have been placed. But they still have major concerns about the patient's attention and the processing of auditory information. So that 30 seconds delayed response has not really improved from the PE tubes being placed as well as speech production from the patient when they're not focusing is unclear. Very sounds mumbled, kind of the letters and the enunciations are jumbled together.

So the follow up hearing status was flat tympanograms with a large ear canal volume. Noting that the PE tubes were open at this appointment there was a note that there was an SRT PTA disagreement. I'm not sure exactly what what was going on there with that, especially since there was not one at the first appointment. But just noteworthy. The scan for children screening was also administered to kind of help understand what was going on with that processing and the delayed responses.

So within the screening the gap detection test was within normal limits. The auditory figure ground test which is done at a plus 8 signal to noise ratio was also within normal limits. But it was noted that the competing words free recall was disorder with a significant right ear advantage.

So the recommendations for this patient are to repeat testing in six months. So that is something that we're going to continuously follow this patient until kind of we get a better understanding of what hearing truly looks like and how it's impacting his day to day life. As well as arranging a consultation with speech language pathology based on the parental rapport and auditory processing screening scores. So the speech language pathology that he was going to previously was focused mainly on articulation and production that I believe is being done as well in the schools. So this is really focusing on that processing of information and looking at his processing skills a bit more in the language hemisphere.

So there's a lot of unknowns in this case. He has had a significant medical history before ever getting to us. So really my biggest question when looking at this child is what's the biggest factor in this case? Was it the contribution from the cerebral spinal fluid? What did that play?

Any part? We also have the part of potential ototoxicity. We again don't have data on either of those, but can acknowledge that there have been reported cases in the past that this could be a potential, a potential factor. We also know that having PE tubes placed, there was absolutely some otitis media going on, whether it was chronic and for how long and did chemotherapy play any role in that with immunocompromization. So that again, is a, is an unknown as well as what role does the Witten vein Koch syndrome play into this?

So really looking at all four of these and if not more factors that, that play into the roles brought forth by parents. So this is a continuing case that we will continue to follow the child and these unknowns we may never know, which is something that we just have to work on our interprofessional practice and

kind of getting the patient where they need to be into their future. So thank you so much. And I am now going to turn it over to Dr. Gail Whitelaw. Thank you so much.

Thank you, Madison. I appreciate that. I want to just give a kind of a briefcase at the end of this, not knowing if we were going to have time for it or not. But I'm excited to talk to people about this because I've always had a passion for pediatrics, but my passion for pediatrics continues to grow. I look at a case like Madison's and think about how many kids can be affected by learning more about that.

Not just the 40 that have been identified, but so many more. And one of the things that I'm passionate about is pediatric tinnitus. So I called this case hearing the unheard of and it's a case of tinnitus in children. We see a goodly number of children with tinnitus and just want to kind of bring this to the forefront. So there's a lot of myths about tinnitus in children.

First of all, I'm told routinely that children don't experience tinnitus. We really don't know what the prevalence is because of the fact that we never ask the kids. Prevalence is thought to be similar as in the adult population. And this is in a number of publications and research articles and also from the American Academy of Otolaryngology. The other part of it is we assume that children can't report tinnitus.

Children reported as consistently as adults and then 50% of children with hearing loss are thought to have tinnitus. Based on the data that we have, children report that audiologists don't listen to listen to their concerns about tinnitus. And we have a lot of sophisticated kids who come and tell us and feel like they aren't heard. And then many cases that I work with both the child and the parents have been told that the child is a malingerer because it's not possible to have tinnitus as a child. So I want to talk about this 10 year old who presented our clinic with the primary complaint of tinnitus.

And he is such a remarkable child. He is an excellent reporter and has such a supportive family. He's homeschooled because he's a way cool kid. He's a race car driver. He started racing in cars at age 3.

When he turns 13, he can be really a race car driver. But right now he does a lot of neat stuff. He races cars, he's learning to rebuild car engines. He's knowledgeable as a driver and a mechanic. He's interviewed on podcasts, and he reported tinnitus that was similar in both ears.

He described it as ringing. He's sensitive to weather changes, so he believes that his hearing decreases and his tinnitus increases during that time. He has a family history of tinnitus. He talks about the fact that his tinnitus keeps him awake at night and he has difficulty hearing over his tinnitus, which he says makes it muffled for him. He has a lot of difficulty listening in noisy environments, and he says it's difficult when he's on stage.

He's in these podcast environments with adults all the time, and when they're interviewing him, he feels like he's not able to put his best face forward because he's confused or he can't hear over his tinnitus. And it's important to note in this case that he has worn custom fit hearing protection that is well fit and is checked by somebody who does race car hearing protection since the age of three.

So he believes he has a loss of hearing, but he believes that it's also secondary to his tinnitus perception. And as audiologists, I think what we have to do is be very cautious about looking at an audiogram and jumping to a conclusion. And in this case, I wish somebody had jumped to a conclusion even sooner. But this child has been given a lot of misinformation about himself. He had previous hearing tests that were considered to be a fair reliability, and he was told that he was a malingerer to his face.

In retrospect, the family believes that the hearing loss and the tinnitus were first reported by the child at age 3 very consistently. Audiologic evaluation a few months ago prior to this appointment was

performed and it demonstrated a moderate hearing loss which appeared to be sensorineural. But he was told he Exaggerated his hearing loss, and it was noted in the report to wait until his loss was progressed, if it was a real loss. To address this, no one took the time to address his tinnitus concerns. So we saw him.

Actually, the audiologist who made his hearing protection referred him to our clinic, and his otoscopic and tympanometric results were unremarkable. At the time of our hearing test, mild to moderate sensorineural hearing loss was determined bilaterally with pure tone averages of 43dB for the right ear and 48dB for the left ear. And he had absolutely great reliability. Speech reception thresholds were 35 dB for the right ear and 40 for the left ear, commensurate with pure tone results. Word recognition scores were excellent for both ears.

And his word recognition and noise using the Bamford Cowell bench speech and noise test demonstrated a mild signal to noise ratio loss at 4dB.

We always do extended high frequencies on almost every patient that we see, but on every tinnitus patient we see, and it's interesting, he had a mild loss for the right ear and a moderate loss for the left ear, which followed his traditional pure tone audiogram. His tinnitus handicaps inventory, which there's another test out now, but I chose to use the THI for him was a 72, which demonstrates severe tinnitus disturbance. His tinnitus pitch match was 2000 Hz and his tinnitus loudness match was 60 BSL. And for those of you who might not be familiar with that, the tinnitus loudness match is not always correlated to the person's tinnitus disturbance. You can have a very mild loudness match in sensation level and still report a significant functional tinnitus.

So in this kid's case, that was the case. So we know a couple things. Hearing aids for a child like this can address both his hearing loss and possibly his tinnitus. If we're going to address tinnitus with hearing aids, the hearing aids have to be well fit. So there has to be a verification of the hearing aids

that can reduce the tinnitus perception.

And we also. So we recommended hearing aids for him. We also recommended cognitive behavioral therapy based on his thi. We know that sleep hygiene is critical. And my dear friend who passed away from us way too soon, David Bagley, would always remind me that it's a vicious cycle, that if you sleep poorly, your tinnitus ramps up.

And when your tinnitus ramps up, you sleep poorly, and we've got to break that cycle. So we gave him some Ideas about using tinnitus app through a sound pillow. And then also considering a CBD isolate from Rowdy Wellness pending discussions with his pediatrician. So pending tinnitus benefit from hearing aids. We also talked about considering linear tinnitus treatment.

Linear tinnitus treatment is able to be used in children. It's an off label use but it is possible. And with a sophisticated 10 year old like this, he was all about it. If hearing aids were not going to work for him. The British Society of Audiology has some excellent materials and if you cannot locate them, I'm happy to share them with you.

And then also an examination by otolaryngologist was recommended.

So in his case he opted to try start with hearing aids. And we retested his hearing and his pure tone results. The day that we went to to fit him he was totally consistent, no evidence of malingering. He was fit with Oticon intent 1 Rix with tinnitus support activated. We did real ear verification.

It was beautiful. His hearing aid fitting according to this kid has changed his life. And he was one of those kids where he's very funny and we have a great relationship because we're both so sarcastic. But on the day where I fit him, he wanted his parents to talk to him. And I said we're not playing that game today.

They're not going to whisper to you in this room. And he's like oh please, please, please. And it was quite shocking when his dad whispered something to him and this kid had his back to him and he turned with tears in his eyes and he said I can hear that and guess what? I can hear it over my tinnitus. His tinnitus now is nearly imperceptible, acceptable.

He says he's hearing great and he had a little bit speech impediment going on. And that's why his parents think that his speech was impacted early from both hearing loss and tinnitus. His speech started to resolve on its own within a week. So he came in telling me in his second appointment, in his follow up appointment that he was able to hear very clearly and he was less embarrassed about his speech. So his confidence has increased and we may pursue other aspects of this plan.

But right now he's thrilled with his hearing aids and his hearing and one of the things I would say as a consideration is we need to listen to children. In this case he dropped his preconceived note. We need to drop our preconceived notions about what faking is or what tinnitus says. And everybody that's on this today knows that one of my, you know, bucket list things or my things that I say over and over is textbooks don't talk, patients do. Tinnitus is real in children and it has to be discussed and explored.

There's now a great tinnitus specific questionnaire for pediatric metrics. It's called the Impact of Tinnitus in Children questionnaire. You can get it online. Again, we want the child to rank order the issues. Many kids with tinnitus also have sound tolerance, either misophonia or hyperacusis.

And so we would rank order them in terms of what's worse for them. Tinnitus can also interfere in the classroom, so it interferes with listening, focusing, executive functioning, activity in class, sleep, and can cause anxiety. And we may need to work with the school to create a 504 plan or an IEP. And this kiddo was already involved in mindfulness, but mindfulness and cbt, cognitive behavioral therapy can help with this. So we're at the thank you part of this.

Thank you for joining us today. And I want to open it up for questions. We have a few more minutes for questions. So if you have a question and you want to put it in the chat, you're welcome to do that. If you have a question and you want to, I guess, raise your hand or chime in, turn your mic on.

Is that good, Christy? They can do that if they could just type it in the Q and A, that would probably be the best. Type it in the Q and A, please. We'll field any questions that come our way, no matter how they come. I want to thank everyone for these really excellent presentations.

Really, really interesting clinical cases. I enjoyed listening to all of them. While we're waiting to see if anyone else has any questions that they have for the presenters. Oh, one has just popped up, so let's go there. How might early audiological intervention using bicros systems impact cognitive load and quality of life in patients with unilateral hearing loss compared to delaying the intervention.

Oh, that's an excellent question, Jack. Aaron.

Yeah, I'm not familiar with any kind of research literature on that topic, but it's a good thought in terms of especially people that might have kind of sort of other cognitive issues. Maybe you want to, in theory, hold off on starting straight out with a Bycross so they can get used to just working with the hearing aid. I think maybe the bigger part of that consideration would be less so the actual input is and more so just them kind of Taking in all the information that you're giving them about their hearing aid and their CROs system, I feel like that would be a lot for. It's a lot for anyone and it would especially be a lot for someone that might have sort of, you know, cognitive considerations. So I might take this next one, Jack, if that's okay with you.

The question is what role do factors like speed of bycross adaptation, patient age and pre existing cognitive conditions play in the success with such interventions? And we know from pediatric literature

that audiologists often hold off on cross or by cross fittings because they presume a lot of things that aren't necessarily there in the literature. I think that's an excellent question. And one of the things I would probably say is just like any kind of amplification, the sooner the better, you know, I think. And if Erin, if you want to jump in, Aaron's case is a perfect demonstration of somebody who had a lot going on but really could benefit from any kind of cross intervention and certainly a by cross.

Erin, do you want to address that at all? My preparation for this didn't really cover these particular aspects, but I think patient motivation is probably a bigger factor than anything if they're willing to adjust and if their expectations are realistic. That's all I have to say. Thank you.

Thank you. That was. Thanks for your comment.

Anybody else with questions? I know we're coming up to the bottom of the hour and some of you who are not in the Eastern time zone are probably chomping at the bit to get to lunch. And those of you who are in the Eastern time zone probably need to get back to work. But we really appreciate you joining us today. And you know, if you have any questions, you're welcome to reach out to any of us that will be in the materials that you're provided.

Well, thank you. Thank you very much, Dr. Whitelow and all of our presenters from Ohio State University. We really appreciate you sharing your time and expertise with us today. I'd also like to thank everyone for participating in today's webinar. We look forward to getting your feedback on the course evaluations and hope to see you in future courses on audiology online.

So this concludes today's course and please have a great rest of your day. Thanks.