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Grand Rounds: Auditory Processing Disorders,
presented in partnership with Salus University
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Presenters: James W. Hall III, PhD; Ghada Said A. A. Ahmed, MS
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- [Christy] It's my pleasure to introduce our guest presenters today. First we have Dr. Hall who is an internationally recognized audiologist with over 40 years of clinical teaching, research and administrative experience. Throughout his career, Dr. Hall has held clinical and academic audiology positions at major medical centers and leadership roles in the American Academy of Audiology. Dr. Hall now holds academic appointments as professor at Salus University and also the University of Hawaii. We also welcome Ghada Said Ahmed, who is currently a student in the international doctor of audiology program at Salus University. Throughout her career, Dr. Ahmed has had more than 15 years of experience in providing audiology services in the Audiovestibular clinic in Egypt and currently in Jeddah, Saudi Arabia. Welcome, and at this time-

- [James] Thank you very much for that introduction, and we'll get started here. I know that I would presume that most of you are audiologist, if not all. There may be a few speech pathologists in the group, perhaps a few non-audiologist and non-speech pathologist. But as you will learn today in this very practical two-hour Grand Rounds presentation, auditory processing disorders are common, are quite prevalent, their management and their assessment is well within the scope of audiology practices. And some of you may already be providing these services. Others may be interested in providing services to this very important population of patients, both children and adults. And for those of you who are not yet providing services, I hope this presentation, this Grand Rounds will inspire you to at least identify patients who are likely to have auditory processing disorders, and perhaps even go to the next step of diagnosing the disorder, and perhaps even managing it. Now, we have a full two hours, but of course you will have access to this presentation after the fact it's being recorded, and you'll have access to the slide materials. At the very end, you will see some references that will also give you more information on the topic.

Now I'm gonna start things off with a introduction of roughly 20 minutes, and then I'm going to turn the microphone over to Ghada, who will be presenting a pediatric case. At the end of this presentation, you certainly will have learned this information. You will be able to identify risk factors for APD in children and adults. There are numerous risk factors and you'll probably be able to identify at least two or three for children and another two or three for adults. You'll also be able to list four test procedures that are evidence-based for the assessment of APD. Now, there are many, many more than four, but for your learning, outcome is only four tests. And then finally, you will be able to describe three evidence-based options for the management of APD. And again, there are more than three evidence-based options for management but we're only asking you to identify three of them.

Now, we always are obligated to disclose any conflicts of interest. In this case, it says I received an honorarium for the course, but I have made an agreement to donate my honorarium to Salus University for student scholarships, so I will not be receiving the money. And I have no relationships to disclose and neither does Ghada. In other words, there's no conflict in what we are saying and in some financial relationship we have with some other entity. We're not gonna be talking about any specific product or service, but I do want to clarify the last disclosure that I am affiliated with Salus University. Ghada is a student at Salus University and of course they are in partnership with AudiologyOnline in presenting this Grand Rounds. Now, I've never done this before, but for this presentation I was asked to identify the question in the questions that you will need to answer for CEUs, in the slide where that material is covered. So when we get to a slide that shows a little number on the bottom as identified by this arrow, that will alert you that the material on that slide is asked in one of the questions, and not only that, it's gonna actually tell you which question that material pertains to. So that's a very blatant hint, and I think it's a good way for you to focus on information that we thought was important, because we're asking a question about it.

Now, these are the topics that we're going to work through in this two-hour Grand Rounds. I've given many Grand Rounds over the years and I've attended many more. I definitely remember my first Grand Rounds, which was back in 1973, the fall of 1973. I had just earned my master's degree at Northwestern University in speech pathology, I was not yet an audiologist. And I attended some Grand Rounds, pediatric Grand Rounds, neurology otolaryngology, at Baylor College of Medicine, where I was working and also where I went on for my PhD. And so I'm very familiar with the format, I've been giving Grand Rounds ever since and attending them. And typically the cases that are presented in a Grand Rounds in a traditional Grand Rounds, are used as a springboard or a stepping off point for discussing a topic. And that's the format we're gonna use here. Rounds in a hospital or usually when the physician for patients walks around the hospital, goes on around and around through the hospital with a group of sometimes other students or residents or fellows or other physicians. And they basically meet with every patient, and they discuss the patient's management, and what they know about the patient. A Grand Rounds is different. A Grand Rounds is where a bunch of healthcare providers are sitting in a big room, usually a conference room where now they're very often virtual Grand Rounds, and discussing still a case, but without that case actually being there typically.

Okay, so let's start out with introduction to auditory processing disorder so we're all on the same page. Then I'm going to, in about 20 minutes or maybe 15 minutes, turn the mic again over to Ghada, who will present a child. Then when Ghada wraps up, I'm going to review how we assess children for APD and how we manage children based on what you learned from that first case. Then we'll reach the, approximately the halfway point, about one hour into the two-hour presentation. And then we, there'll be no break though, we're gonna go straight on through. And then I'll present a second case and my case will be an adult with APD, and I think you'll find that the patient quite interesting. It certainly was interesting to me. And then I will go through the same process that we did earlier but now I'll talk about assessment of APD in adults, and

management of APD in adults. And obviously those sections will be a little less detailed because much of the assessment strategy that we would use in the procedures and many of the management strategies and techniques that we use with children are also used with adults. I promise you, we will have time for questions and answers at the end. So you are able to write your questions out in the text box, press enter, and they will pop up under Q and A, which is in the upper right hand corner of the screen, and then at the very end, we will begin to answer as many questions as possible within the timeframe that we have.

All right, now I've broken down the agenda into times, it's a time-order to agenda, just so you'll have an idea of roughly how long everything's gonna take. When you put these kinds of presentations together, there's no way to accurately predict exactly how much time you're gonna spend on everything. And as I ran through the presentation and has Ghada took a look at her case, it's quite clear that we may not take 20 minutes for the actual case, which will leave us more time for some of the other materials. So don't be concerned if we're not strictly adhering to this time-ordered agenda. We will finish on time and we will have time for questions at the end.

So I'm gonna start out with my introduction to APD, just so that everybody understands what we mean by the term. First of all, I wanna stress, this is not a new concept. The concept of evaluating central auditory function in patients who have hearing complaints goes back more than 65 years to the mid 1950s. So we're gonna cover that. I'm gonna define APD, there are multiple definitions, but I'm gonna give you several of them, so you'll have a pretty good idea of what we mean when we refer to APD. And then I'm gonna just quickly comment on how rapidly the research literature's expanding. There's tremendous amount of evidence in support of APD and how to assess it and manage it. I'll introduce you to some of the clinical practice guidelines, which now exist for APD, not just in the United States but in other countries. And at that time, I'm also going to be sure to alert you to some concerns that have been

raised about APD and some skepticism and some very negative thoughts really about APD, we'll get to that a little bit later. And we're gonna wrap up the introduction by identifying risk factors for APD in children and adults.

So every audiologist, in my opinion, no matter who they are, no matter where they practice in the world, no matter whether they see children or adults, every audiologist should at least know who is at risk for APD, which patients, and make referrals of those patients to either another audiologist or as you'll see, there's a multidisciplinary group that sometimes is involved in assessment and management of APD. So very quickly, I don't wanna spend a lot of time on the historical perspective, but this is one of the major concerns that people have expressed about APD. We don't know much about it, it's new, it's still experimental. None of that's true. The very first study, it's a fascinating study, I've read it, I've got it on my computer. I have my students in classes that I teach on APD, including at Salus University read this article. It was written by three otolaryngologists who were in Italy in the mid 1950s. They were seeing patients who had definite hearing problems. They were complaining about them, yet these patients had normal audiograms. And we see this all the time, patients with serious listening problems, auditory processing problems, but normal audiograms. And so, these clever otolaryngologists developed the very first formal test for APD. They filtered out high frequencies in the words. And when I did that and they presented words to people that had no problem with hearing and no problem with their brain, they could repeat the words back with 100% accuracy. But these patients who were complaining about hearing, who had normal audiograms, they had real trouble repeating back these filtered words. And they found that these patients actually had temporal lobe tumors affecting the auditory regions of the brain, and they were detecting this problem with this filtered word test, which is a degraded speech test. So that was 1954.

Ironically, in the same year, 1954, this fellow, Helmer Myklebust, who was at Northwestern University, I actually met him when I was there and I took a course in

learning disabilities, that he co-taught back in the early '70s. He published a textbook, and I have this in my office, this textbook, where he talks about how important it is for audiologists, 'cause he didn't use the term audiologist because that term didn't exist then. But he said, people who evaluate hearing really need to think about the central auditory system as well as the ear. Now, interestingly James Jerger, my mentor, and everybody recognizes that name, he took courses from the same person, Helmer Myklebust, and also went to Helmer Myklebust's clinics. Now, he was a psychologist Dr. Myklebust, but he would see patients with learning disabilities and some who had auditory processing problems, even though that wasn't the term used at the time. And Dr. Jerger was very impressed that patients were coming in, children to the clinic, who had perfectly normal audiograms and yet they couldn't communicate effectively at all with their hearing. And so, that led to Dr. Jerger emphasis throughout his career on APD, which in turn led to my emphasis on APD throughout my career.

Now, also in the 1950s, this is where it all started, we had a a British experimental psychologist, Donald Broadbent, who developed a very clever and rather unique way of evaluating auditory memory and auditory processing. And it's called the dichotic listening paradigm, which you're all familiar with. Now, he really was interested in auditory memory from a psychological point of view, but to others, Doreen Kimura, in the early 1960s, and Jack Katz, everybody's familiar with Jack Katz, in the 1960s, developed clinical versions of these dichotic listening test. And that's when audiology really started to focus on auditory processing disorders in 1960s. Because now we had two or three different tests for evaluating central auditory functioning. But that wasn't the end of of the developments, the historical developments, James Jerger, who I've just mentioned, he was following all of this closely. Of course, he was very interested in auditory processing disorders and central auditory functioning. And at Baylor College of Medicine, he had great relationships with neurology, neuropsychology, neurosurgery and of course, otolaryngology. And so he developed a battery of tests, which some of which we still use and we'll talk about today, to evaluate auditory processing and

central auditory function. And he validated those tests. In other words, he used those tests in people who had known central nervous system dysfunction, tumor, cyst, strokes, head injury, et cetera, and proved that these tests really were evaluating central auditory functioning.

You're all familiar with the name, Bob Keith, during the same timeframe, late 1970s, early 1980s, he started to also become interested in APD and developed numerous tests for evaluating APD, even some other tests that we use with APD patients. And finally, there are many others we could cite. I'll mention Frank Musiek. Frank Musiek probably knows more about the central auditory nervous system than any audiologist certainly in the United States, maybe in the world. And he began to also develop new tests, new dichotic tests, new tests for sequencing, the gap detection test, and he also started to apply cortical auditory evoke responses in studying APD. So this really sets the stage for where we are now. We know a lot about APD we know how to evaluate it and we know how to manage it. During the 1990s is when a lot of the research was done and that was called the decade of the brain. We don't have time to get into it, but in my opinion, it was the 1990s, that timeframe when APD was really validated. Where people began to show with functional imaging, with evoked responses. That some patients had auditory systems that didn't just work normally. Sometimes they were children, sometimes they were adults, that wasn't a language problem, it wasn't a psychological problem, it wasn't an attention problem, it was an auditory problem, and it could be proven using objective techniques. During the 1990s, people also began to appreciate neural or brain plasticity. In other words, the brain can change.

So when you find a problem with auditory processing disorders in a patient, with the right treatment, you can actually improve their status tremendously. In fact, sometimes you can't even find any evidence of the auditory processing disorder after treatment. Now, we can't do that with the ear but we could do that with the brain because of brain plasticity, it can change. Here speaking of functional MRI, this is actually a one of my

patients, and this just proves a lot of points. This young man, teenager, he had horrible problems on dichotic listening task but they were very different than typical problem. Normally there's a left ear deficit and strong right ear performance on dichotic test. He had just the opposite. He had a right ear deficit, sometimes very poor scores, and very good scores on the left ear. So I won't go into all the details, but he ended up getting functional MRI at a major medical center, not where I was, but somewhere else. And during that imaging of the brain, of brain metabolism, he was listening to and repeating words.

Now, if you listen to and repeat words, you should have a lot of activity in your auditory regions of your brain. And sure enough, as you can see in this slide, his activity, the bright spots were all on the right side instead of the left. We know that the left brain, the left hemisphere is dominant for language and auditory processing of verbal material in almost everybody, but not for him. So this is a classic example of how our clinical tests are very, very sensitive to what's actually happening in the brain and they are being validated, the clinical tests, by imaging and other techniques that don't require any real participation by the patient. Okay, moving right on quickly to definitions of APD. Well, there are as many definitions for APD as there are people who are talking about APD in some respects, but we have a pretty good feeling for what it is. We know it's a deficit in processing information, and we know it's gotta be specific to the auditory modality. In other words, it can't be just a memory problem, it can't be just an attention problem, it can't be a language problem, it's gotta be an auditory problem.

Now, as you'll learn, many of these patients have other problems. They have coexisting disorders in addition to their auditory. But the auditory modality must be involved. The other thing that you must keep in mind is that patients may have normal hearing sensitivity, and most of the time in very simple listening environments, they have no problems. But they're inefficient in processing information and ineffective. So when you get into a noisy setting, or if they're listening to somebody speak with another accent,

or if they're trying to process information quickly or maybe they're distracted, or maybe their attention is on something else, then they have major problems. So auditory processing involves efficiency and effectiveness in processing information, not just the ability to process it in ideal conditions. And then the third component, and these are all from different sources that I've cited, the third definition focuses on what kind of patients might present with APD. And it can be children and adults, it can be people who have had no problems with their nervous system, it's a developmental delay or disorder, and other patients who have had head injury or other insults to the central nervous system, which may have led to the development of APD well after birth.

Now, in the United States, for those of the United States, you are familiar with the International Classification of Diseases is now in the 10th version, so it's the ICD-10. And for every disorder, there is a code and there is a descriptor. And there is now since in the last five years or so, a code and a descriptor for APD, and here's the definition. So again, different definitions, but we all are always talking about auditory problems, we're always talking about problems that involve the ear and the brain, and we're talking about problems that can be diagnosed by audiologist. Now, the British Society of Audiology in recent years has really started to focus on APD and so I'm not gonna read all of this, but I would encourage you to, wherever you are in the world, check out the BSA website, and they've got all kinds of clinical practice guidelines including guidelines on APD. The British Society of Audiology makes some nice classifications which actually are very useful for our discussion. And they talk about two types of APD basically, one is developmental, where for example, a child with no, maybe premature, maybe not, maybe somebody, child has had ear infections in preschool years, maybe not. But everything seems to be fine in their development, but they've got APD. And of course, when they're an adult, they still have it unless it's been diagnosed and treated. And then they make that distinction between that and acquired APD, which is what we've already discussed. Something happened to the brain after it was once normal. Then they also mentioned a secondary APD where there's an original problem, might

be a hearing loss, it might be just a conductive loss, but it's chronic, not transient, and over time, the auditory processing is disrupted, but secondarily because of the peripheral problem.

Okay, now I'm not gonna go through all of the next two slides in detail, in the interest of time, but I strongly recommend that you check out this reference by Gail Chermak Mac and Frank Musiek, published in 2011, the references at the very end of the study, I mean at the presentation. They talk about all the different neurological disorders and diseases that can be associated with APD. And this is one of the main reasons we need to be evaluating APD. Some of these patients that we see actually have neurological problems that must be dealt with. They also talk about neuro developmental delay or disorder. And as a rule, we want to identify the delay and intervene immediately. We don't wanna wait around to see if the child works through that neurodevelopmental problem. They also talk about neuro anatomical abnormalities, which can be documented with imaging or even with an autopsy. So this is all proof that APD does exist. There's evidence, both biological as well as clinical evidence, that APD is a real problem. Now in adults, the etiologies are somewhat different. Obviously, anyone can have a head injury, anyone can have any kind of brain injury, anybody can have a stroke or an aneurysm in the brain or a tumor, but with adults that's more common. Whereas with children, of course, neurodevelopmental problems are more common. And we're gonna get into these in much more detail when we talk about risk factors.

Okay, now in the interest of time, we can't talk much about the research, but there's plenty of it. Here's a graph that I created from a pub med search. So this is the National Institute of Health website. And you can see from that arrow pointing to the number, that over 6,000 publications pop up when you type in auditory processing disorders. And you can see the rapid increase in those bars over the years. So there's a huge literature on APD, and we have a lot of evidence in support of its assessment

and management. Okay, clinical practice guidelines do exist, and they've been around now for a good solid 10 years. In the United States, the clinical guidelines, well, first of all, this is all APD assessment and management is well within the scope of practice for audiology. All scopes of practice for audiology in countries that have them, clearly identify APD as within the scope, assessment and management. So every audiologists are the professionals that should be evaluating APD and managing it with other health professionals helping out.

Okay, so in the United States, the clinical practice guidelines were developed in the late well, around 2008, 2009, and they were published and peer reviewed and published in 2010. And I strongly recommend that you go to the AAA website and download them. To the right is a photograph of the task force that put them together. I was on the task force, had this picture taken on my iPhone, in fact. And these guidelines are very detailed. They provide you with information you need to apply the assessment and management techniques that we're gonna be talking about in APD. The British society as already mentioned, they have guidelines. And then I wanna direct your attention to the New Zealand Guidelines. They're the latest, 2019. They are incredibly comprehensive, and I strongly recommend that you go to them. We'll be making reference to them throughout this presentation. There are so many details in the New Zealand Guidelines on APD that you'll find very helpful, including where to find tests and how to, what age range the tests are useful in, et cetera.

Okay, now very quickly expressed concerns and questions. Over the years, people have expressed doubt about ABD. And some of the concerns like those expressed by Larry Humes, the first author, who was a very well respected audiologist, said, "Well, is this really an auditory problem or is it some type of reflection of a peripheral hearing loss, or perhaps even a cognitive or memory type problem?" So some of the concerns, and the second author, Andy Tony, Anthony Cacace has the same concerns. Is this really an auditory problem? Can we specify that it's auditory? And those are natural

concerns because many of these patients with APD also have language problems or attention problems which actually might be more prominent. And then other people, most of them audiologists, but not all, some speech pathologists, have also said, "Well, we need more information on this particular aspect of APD. We need a better definition, we need more rigorous tests, we need more evidence in support of management." And these kinds of articles and concerns have been very good because they've pushed forward the state of the art in APD, and they've led to more research, and they've contributed more to our evidence in support of APD. And then I'm gonna cite this very last concern, which is probably the strongest. And I'm not gonna read through this. But David Moore was a very well-respected hearing scientist. He's not an audiologist, he has a psychology background, and he's really very critical about whether we should even be evaluating APD. And as mentioned in this little slide, he actually said, they're not even gonna accept, he and the board, Editorial Board of Ear and Hearing won't accept anymore papers, manuscripts, unless APD is more carefully defined. That you can't just assume that APD is a single diagnostic type problem. So these are all concerns, but in fact, many of these specific concerns are not supported by the literature. It's not a language problem, we know that, and there's plenty of evidence in support of that. It's not an attention problem, it's more than just a learning disability. So I mentioned this just because you will encounter people who have some real serious doubts about APD, and you need to be prepared to respond to the doubts.

Okay, now APD, some people say it's so confusing, I don't know how to evaluate it, we don't have this, we don't have that, I feel uncomfortable evaluating it. And I put together this table just to reassure you that what we know about the peripheral hearing loss, peripheral auditory system and peripheral hearing loss that we evaluate all the time, is really not much different than APD. Now again, I won't go down the whole list, but when we have concerns about APD, usually we have the same concerns about the peripheral hearing loss. And when we are assessing APD or assessing peripheral loss, we're using very similar strategies, and we're using a team approach. And we don't

always know that our manage, it's gonna be 100% successful. So there's really not much difference in evaluating APD versus peripheral hearing loss. We're evaluating hearing, we're evaluating auditory function.

Okay, we're gonna finish up this first part with just a quick review of risk factors for children and adults. Here are some risk factors for children. We've already talked about some of them. Neurological difficulties around birth, peri natal problem. Something we should always ask about. Prematurity, head injury, seizure disorders. Chronic otitis media through the preschool years, where the brain is being deprived of a consistent, constant, normal auditory stimulation. That can lead to APD or contribute to it.

Academic failure is definitely a risk factor. Any child who has normal hearing, but no other obvious explanation for poor performance in school is at risk for APD. There's definitely a family history in some patients. Co-existing disorders actually put a child at more risk. Child with language impairment's a greater risk, for example, than a child without language impairment. And finally, the last bullet point here, if you've got a child who's already been evaluated, or you've evaluated the child, and if they've had a normal audiogram, and maybe they've had three or four normal audiograms, and yet their teacher and their parents, everybody, still thinks they have a hearing loss, that child is at great risk for APD.

Okay, so there are many consequences to not identifying children with APD. So these risk factors are so important for you to keep in mind. And every patient who has a risk factor, every child, really needs to go, undergo a diagnostic assessment, either by you or someone else. Okay, now how about the coexisting disorders? Well, there's a long list of them. These are children who don't just have auditory problems, but they do have an auditory problem in addition to the others. So we're gonna talk more about these and you're going to see that part of the challenge in evaluating and managing APD, is that you must have a multidisciplinary team, because it's not just an auditory problem in each child.

Okay, now risk factors in adults, and then I'm going to turn the microphone over to Ghada. In adults obviously, you could have an adult who has an auditory processing disorder that is leftover, you might say from childhood. In other words, nobody ever diagnosed them when they were children, they didn't do well in school, they're still having the same problems that they had as a child. So that's one possibility. But then you have others. Any patient over the age of 65 years old is at much greater risk for APD than younger patients. So age alone is a risk factor. Complaints of hearing problems and yet the audiogram's normal or there's not much of a hearing loss, that's automatically should tip you off, think about APD. Referral from selected sources. So if you get a patient from neurology or psychiatry, they're more likely to have APD than a patient coming from motor oncology, or walking in off the street. And then obviously, the medical disorders and diseases that can affect the nervous system, can also affect auditory processing and the central auditory nervous system. And of course, traumatic brain injury automatically is a risk factor, whether or not the patient lost consciousness, that patient should be evaluated for APD.

Okay, so we're now going to switch gears. I'm going to turn off my microphone, and I'm going to turn the microphone over to Ghada. Ghada is a student in one of, we have several international audiology programs, educational programs at Salus University, and she kindly agreed to present a case. She's a brave woman who said, "Yes, I don't mind presenting a case in front of many, many people."

- Thank you Dr. Hall

- So here you are Ghada.

- [Ghada] Okay, hello everyone. I am glad to be with you today to just present my child case- I'm glad to be with you today to just present my child case study. So first I will

begin with the complaint. So it's a seven-year-old boy presented to our clinic, complaining of hearing difficulty in noisy environment, including classroom, recess time and while watching TV with family. He didn't complain about hearing difficulty in quiet environment. There was no history of delayed language development. The mother reported normal prenatal, neonatal and postnatal history. The patient was a full-term healthy baby who was discharged from a well baby nursery. The patient passed the distortion-product otoacoustic emissions screening test before hospital discharge. There was no history of NICU admission, no jaundice, cyanosis, no middle ear infection, no history of trauma. There is a reported one relative with Attention-deficit/hyperactivity disorder.

We started doing the peripheral audiological assessment, otoscopic examination, normal mobile intact tympanic membrane, a pure tone audiometry was done, relieved normal hearing. This is a bilateral excellent speech discrimination. As you see, what this condition scored was excellent, 96% in both ear. A distortion-product otoacoustic emissions was done within normal limits bilaterally. The Aural immittance measures were also done, which detect the bilateral type A tympanogram, normal ipsilateral and contralateral acoustic reflex threshold for stimulus frequency, 500, 1000, 2000 and 4000 Hertz. Then we start our central auditory test battery to evaluate the cortical integration and interhemispheric transduction. We start by the dichotic digit test for both ear. With presentation level at 50 dB sensation level. Child instructed that he will hear two numbers in each ear, to listen carefully and repeat all the number he will hear. The order doesn't matter. Always we start a few numbers for just practice. So as you see for the right ear, it's 78%, left ear is 55%. This relieved bilateral decrease in the score, which is more in the left ear, which is 50%.

Then we do the frequency pattern test. This test used to assess the cortical integrity. It's contains of three tone burst, made up of low frequency tone, 88 Hertz, and high frequency tone of 1122 Hertz. With an inter stimulus interval of about 200 milliseconds.

In each sequence, two of the tone burst have the same frequency, whereas a third one is of different frequency. Like low, low, high, high, high, low, low, high, low, high, low, high, low, high, high, high, low, low. The test is done twice, once with verbal response from the patient, as he's supposed to say high, low, high, for example, or then repeated again with a humming response, just to try to imitate the sounds that he will hear. As you see here the right ear is 50%, left ear is 43%. So it's both are decreased, and this is for the verbal response. We repeated his here, as you see for the humming response, we see that right ear is 70%, left ear is 63%, which is for us, within normal range for the humming response.

After that, we did the duration patterns sequence, is similar to the pitch pattern, but he's supposed to comment on the duration of the stimulus. Like, the length of the stimulus, it's long, long, short, short, short, long, long, short, long. And of course, Dr. Hall is describe everything in more detail later on the webinar. For the right ear, it's 66%, for the left ear, it's 46%. Which is also low for both ears. Then we did the gap in noise test. This is a child supposed to detect a brief silent gap between two pairs of the sound, with variable inter-stimulus interval from two milliseconds up to 20 milliseconds. Here there is a bilateral normal score of 80%. This light show how the language is processed in the cortical hemisphere. So sound from the right ear is going directly to the left hemisphere, due to the dominant contralateral pathway, and the left hemisphere is the one which is responsible for the language processing. Whereas the left ear is going to the right hemisphere, and then it's supposed to travel across the interhemispheric transfer, through corpus callosum to reach the left hemisphere to be processed.

Summary of the finding for this case. Test findings are consistent with diagnosis of APD. There is abnormal score for at least one ear, for two different auditory processing test. Dichotic digit test abnormally decrease the score bilaterally, more in the left ear, as we saw earlier. Duration pattern test abnormally decreased score bilaterally more in

the left ear with verbal response, but normal with humming response, as we mentioned before. Pitch pattern test abnormally decrease the score bilaterally more in the left ear. Findings are consistent with an auditory processing delayed maturation or disorder involving either right hemisphere or interhemispheric transfer, via corpus callosum to left hemisphere. We made the following referral to MRI to exclude any auditory nerve or brain anomalies, speech pathologist for language evaluation, psychologist for assessment, cognitive and attention ability. For the management, we try to improve the environmental, acoustic environment around the child. So we use a personal FM system to improve auditory processing. Use formal and informal auditory training technique to enhance temporal auditory processing, and follow up is a very important issue that we have to monitoring the auditory status. Thank you very much. I hope you all benefit from this short case. Now to Dr. Hall again. Thank you, Dr. Hall.

- [James] Okay, thank you very much for that a pediatric case. And we're going to build on what you've just heard from Ghada, because we're gonna be talking about more of the tests that, more about the test that she mentioned, and also more about the management. So let's begin our general review of APD assessment in children. First of all, we're gonna talk about how to administer the test. Now, obviously in a brief Grand Rounds like this, we can't cover all the details. But there are plenty of resources that you can consult, and I've listed some of them at the end, in the references at the end of this presentation. Well, first of all, the assessment is multidisciplinary. So audiologists played a primary role, but we need other professionals that will help out, and this is consistent with clinical practice guidelines, such as those of the American Academy of Audiology. So if you go to that document, you will learn more about the multidisciplinary team and the same for other clinical practice guidelines. And you'll realize that you need to have psychologists, speech pathologists, sometimes different types of physicians and maybe other health professionals, that will help you not only in the assessment but also the management of APD.

A very important first step in the assessment process is a good case history. Now, the case history that you use for APD patients is not the same case history you would use for most other patients in the clinic. So I encourage you again, to go to the guidelines and you can put together your own specific history form that will supplement, or that you will use in addition to your typical history. You're focusing on some other things in the history than you might with the traditional history. The traditional patient history for audiology focuses on an ear and on peripheral auditory functioning. Here we're more interested in central auditory functioning. Now as we get into the actual assessment itself, getting beyond the history, we also have guidelines that we can turn to. And one of the most important principles of administration of tests to evaluate APD is the crosscheck principle, which you're all familiar with. So here, the concept is we use independent test, that is two or more tests that are totally independent, and we look at the pattern of findings among these multiple tasks, rather than relying on a single type of test in a single test. And for APD assessment, a basic premise is we need to use verbal and nonverbal tests. Not just verbal, but also nonverbal. We need to use objective as well as behavioral tests. And of course, we need to use tests that give us information on the entire auditory system. From the ear to the auditory cortex.

Now, real quickly, you don't need a sound-treated room necessarily to evaluate APD after you get past threshold assessment, but most of the time we will conduct our assessment in a sound-treated room. But for speech audiometry at 40 or 50 decibels, any quiet room would be adequate. We try to use recorded materials always with normative data, because in children in particular, the values that you get will change with age. And so the younger child, for example, Ghada's seven-year-old boy, we would expect poor performance for seven-year-old and a 10-year-old or a 12-year-old. And even for older adults, there are sometimes normative data that changed with age. We want verbal and nonverbal, and we always need to take into account, the possible effect of factors like attention, motivation, et cetera. And we're gonna cover those more when we talk about listener variables. And the definition for APD, I'm gonna stress that

again, the scores for two different procedures are below normal limits. That's lower than two-standard deviations below the mean, for at least one year. In many cases, multiple tests, five or six tests will be abnormal, sometimes on both ears, sometimes on one ear.

Okay, test battery. Well, this will take not much time. Test battery for evaluating peripheral auditory function. A sensitive test battery that allows us to get the information we need very, very quickly. Basically, the test battery is just a good routine, comprehensive audiological assessment. Pure tone audiometry, I only do bone conduction when necessary. Most of these patients have normal hearing sensitivity. They have normal tympanograms, maybe normal reflexes, normal OAEs, so bone conduction is really not needed. Speech audiometry, here we want to focus very quickly on just getting word recognition in quiet. Don't spend much time on it. In fact, in some cases I didn't even do it because I'm gonna be evaluating speech audiometry, pardon me, speech perception with many, many other tests during the whole test battery. Immittance measures, the only difference here is always do ipsi and contralateral reflexes. And a pattern which you might find in APD is an abnormality only in the contralateral reflexes, and I'll show you that in a moment in a slide. OAEs, I think are critical. OAEs are important, and you'll remember that Ghada evaluated OAEs in her patient, even though the patient passed hearing screening. We wanna rule out peripheral loss or confirm it as quickly as possible, and OAEs are a great way to do that, even in very young children.

Now, auditory evoked responses, both brainstem and cortical can be used to evaluate APD. But we're typically not gonna go straight to that point unless we have to. But if the behavioral findings are inconclusive and incomplete, the crosscheck principle tells us we must go on to objective tests such as auditory evoke responses. Now, I mentioned the cross versus uncross reflexes. There are some excellent references on this very topic, some quite recent. This is a strong pattern of auditory problems in the

brainstem. The ipsilateral reflexes are perfectly normal, and the contralateral reflexes are either very elevated threshold or there's no reflex whatsoever in the contralateral conditions. And it could be both contralateral or even one contralateral condition. This almost always indicates a central auditory problem, even before you get to the behavioral tests.

Okay, so now we're gonna move on to other tests that we need to use to evaluate central auditory function and processing. Well, we have guidance also from clinical guidelines on how to put together our central auditory test battery. So there are numerous recommendations, both from the American Academy of Audiology and also the British Society of Audiology, New Zealand Guidelines, et cetera. So it's not a question of you just making up a test battery based on what you have available, there are clinical guidelines on which test should be used. I encourage you to check out these guidelines. Here are some examples about auditory processing tests, to evaluate the six auditory processes that we typically are concerned about. The first auditory process is temporal auditory processing, and there are multiple tests we can use to evaluate temporal auditory processing.

For example, in Ghada's case, she used the gaps in noise test which is a good choice. That's probably the best of the temporal auditory processing, but she also did some temporal sequencing tests, the pitch pattern, and duration pattern with her seven-year-old patient. Those were all measures of temporal auditory processing, which is probably the most common deficit you will find in APD. Dichotic listening test, should be a routine part of any APD test battery, gotta use the dichotic digits. Another good choice because it's not linguistically very demanding, but it is from an auditory point of view. But there are many other dichotic tests that we could use. Then there are the tests of monaural low-redundancy speech perception, and these include the filtered-word test. There's plenty of those. Remember, that's the test that was first used back in 1954, developed in '54, by the Italian otolaryngologists. We have time

compressed speech tests where a lot of the gaps, a lot of the non-speech in a word are compressed in time, so it's demanding very rapid processing. We have numerous speech in noise tests. We also have tests to evaluate localization and lateralization. Not a lot of them, but the listening in specialized noise test with sentences, the LISN-S, is an excellent example of a test which taps into this very important auditory process. And then we have the auditory discrimination tests. They can be very simple, like frequency or intensity discrimination, or they can be more complex like discriminating among similar sounding words. Now there are also test batteries that you can buy, purchase, for use in the clinic, that have multiple tests already combined into one test battery, such as the SCAN-3, which was developed by Bob Keith, first back in 1984.

So you're all probably familiar with it but it has multiple tests of different auditory processes. I've keep mentioning the New Zealand Guidelines. Very new, just came out this past year in the fall. I highly recommend them. You do a Google search and you'll easily find them, and read them through. No matter where you're located, you don't have to be in New Zealand. And they cover all these topics and more. Background, a lot of information that I've discussed, assessment and this part, the assessment section is incredibly detailed. As I mentioned in my last bullet here, in these guidelines, there are wonderful tables that give you the list of the diagnostic test but also the research articles that support them, the age range for which the tests are appropriate, and even other information like where you can get the test. So I encourage you to check out these guidelines.

Okay, now in addition to auditory processing in some of our patients, we need to go beyond the tests that I just mentioned, to evaluate whether or not attention might be affecting the test results, or whether the patient might have difficulties with phonological awareness, maybe at risk for dyslexia or a reading problem. So I must just at least mention these additional tests as we talk about the assessment of APD. The Auditory Continuous Performance Test was developed by Bob Keith. It's a

fantastic test for children who, either someone is concerned about attention deficit, or you suspect it based on their performance on the test battery. They're unable to be vigilant and focus on the task at hand throughout the test period. And it's a very easy test to administer and there are good normative data. We can also screen as audiologists for phonological awareness, which is the ability to detect and recognize speech sounds when they're all together in a word, and to be able to even extract a speech sound and then put that word back together without the sound that was removed. And this is a very basic reading skill. It's the number one out of the five reading skills. This is the most basic and fundamental. Anybody who is having difficulty reading and who has not responded to reading intervention, should undergo phonological awareness screening, and perhaps diagnostic testing. And there are tests like the test of auditory analysis skills test, which you can easily administer. You can find it online, I'd be happy to provide it to you. And it can be done in about two minutes, and it will pick up children who are likely to have phonological awareness difficulties. And then they could be further evaluated usually by a speech pathologist to diagnose the problem.

Now what about young children? There is a misconception, or sometimes you might say a myth, that young children can't be evaluated for APD. And there are some actual audiologists that will say, don't even bother analyzing children under the age of seven years. I do not agree with that. In fact, I hardly disagree with it. The younger the child, the earlier the identification of APD, the more effective the management, and the more we can prevent secondary problems, psychosocial problems. So it is possible to evaluate children under seven years. You can evaluate pretty much any child of any age, but the older the child, the more tests you can use, but we don't ignore the younger children. So let's just quickly talk about how we evaluate a child under the age of seven. Well, first of all, there are children with APD under seven. In fact, most of the children we see, no matter what the age, will have APD when they're younger. So the earlier we identify it, the better. We use the risk factors we've talked about, of course

our complete history, and then we do the best we can to evaluate them whenever they come into the clinic.

So let's say they're five years old when they come to the clinic. Well, we certainly can evaluate auditory processing at age five. We can't do as many tests as we will later, but we can sort out whether they have auditory processing disorder or not. And we can usually implement some intervention, implement some other assessments that will tap in to problems that might coexist with the APD, and therefore get the management started much earlier. We have behavioral tests and this is, these are just some of them that can be used. All of these tests can go down to age four or five. And of course, we always have the option of using auditory electrophysiology. Not only acoustic reflexes as we've discussed, but speech evoked ABR or traditional click evoked ABR, plus the cortical evoke responses. Now, coming back to the New Zealand Guidelines, there is a very detailed section on what tests are available for the very young child, so I encourage you to check it out. There's no excuse for not evaluating a child at age five or six, and even age four. In fact, some of these tests go down to age three, as you can see.

Okay finally, we're gonna talk about factors influencing the assessment. So let's just say we've already, either conducted the assessment or we're trying to make our decision about what test that we want to use in the assessment. Well, first of all, one of the factors, the listener variables, is attention. The child or the adult has to be focusing and attending to the task, and some patients can't do that. And so that's a factor we must always take into consideration. Another is fatigue. If a child has, or an adult has an auditory processing disorder, going through the test battery that we're administering can be very grueling, can be very tiring. It can really wear them out. And so, I always would recommend evaluating patients in the morning, particularly children. Don't let them go through a full school day, and then come into your clinic. Give them plenty of rest, and sometimes, not very often, but sometimes you may sense that

they're just too tired to continue, and you'll need to bring them back for a second session. Another listener variable is hearing sensitivity. We're gonna talk much more about that when we get to adults, and the factors influencing adult assessment. But here the bottom line is we can evaluate patients with hearing loss. There's nothing saying we can't, we can even evaluate patients with unilateral hearing loss. We just need to make some, adapt our tests and make some adjustments in how we perform the assessment.

Medications are sometimes a factor, and with children, if they're taking medications that they always take for whatever their problem, maybe it's attention, maybe it's an emotional problem, whatever it is, maybe an infection, let the patient take whatever medication they take on a routine basis. We want them in their typical state.

Motivation's a big factor, but with children, it's almost never a concern. Parents get their child all ready for the assessment. The child's usually realize how important it is for them to do well. And so they're usually quite motivated to perform well. And with adults, there's absolutely no question. They're almost always motivated because they're the ones that brought themselves into the clinic to find out what their problem is and what to do about it. Motor skills, we won't get into that, but very often if a child has real serious articulation problems, dysarthria, maybe in apraxia of speech, we need to use more picture pointing tests because we can't really clearly understand what they're saying. So we can't determine whether they heard what they were hearing properly.

And then finally, native language or first language, language experience, and language age, particularly in children, are all factors that can influence our test. They don't mean we cannot evaluate APD, they just are factors that must be taken into account in determining how to evaluate the patient and how to analyze the test results.

Okay, management in children. And I wanna assure you that I'm keeping a close eye on the clock, and when we get to the case two, which is coming up real soon, we will pick up some time so we're right on schedule. Okay, management is a very critical topic. It does us no good, or does very little good to simply say to a patient, oh, or a parent, your child has APD. Management is the real payoff. That's why we're going through the assessment, because we wanna help the child. We wanna improve their outcome. And typically, that's going to be done through their management. So let's define what we mean by management and what other terms we might also use. Well, this is from the AAA guidelines, which are the 2010 guidelines, which talk about intervention as the over encompassing, the umbrella term. Intervention's everything we might do for the child to improve their status, improve their auditory functioning, improve their communication and improve their quality of life.

Treatment is a specific procedure that might be used as part of intervention. We're gonna talk about some treatments. Which are basically auditory training-type programs. And then management, we often use the term management and intervention interchangeably. I often do, and I do in this lecture, but management technically refers to compensatory approaches like strategies or technologies, such as an FM system that Ghada recommended for her child. Now, I wanna point out that research is now showing that management strategies, which were maybe selected to help a child just function when that management was being used, in other words, if they use an FM system, the idea as well, when they're using the FM system, their signal to noise ratio will be improved and they'll do better in noisy settings. But my research and others' research has shown that sometimes the management actually changes the way the brain's processing sound. In other words, it contributes to neuroplasticity. And so the management may end up turning into being treatment and intervention in some cases. This is from the British Society of Audiology Guidelines, and these are all good suggestions. Management should be very individualized, tailor made for your patient. Should be cost effective. You don't do everything you possibly can, be as efficient as

possible. And of course, time effective. And it should always consider everything we know about that child.

Okay, now intervention options are multiple and they're highly varied. This is just a short list of some of the intervention options for APD in children, and we're gonna talk more about those for adults. Counseling is so critical. In fact, with many patients, parents of children and the patients themselves, if they're adults or teenagers, they will tell you pointblank, they'll look you in the eye and they'll say, you know, I think the most important thing that I learned from coming to your clinic today was what my problem is. I now know what my problem is. I know other people have it. I know there's a name for it. And I know that there's been a lot of research on this problem, and that makes me feel good already. So counseling is critical. And we're gonna talk much more about that when we get further on to management. Counseling can actually improve quality of life and improve the patient's outcome all by itself.

Advocacy, what do I mean by that? When I take on a patient and when I get to my case in a moment, my adult case, you'll see what I mean. When I take on a patient I'm committed to that patient. Once they walk through the door to my clinic or sometimes before that, when they send me an email, and they express their concerns and they ask my help, I'm gonna do everything I can for them from then. From then on, I'm their advocate. I'm their cheerleader, and I'm almost like their lawyer. I'm going to represent them, so that they can get all that they need to improve. FM technology, we'll talk about that, computer-based training, very, very valuable, many options available now. Then there's a variation of auditory training called direct auditory remediation, we'll discuss that. There are numerous programs to improve phonological awareness which is an auditory type skill that's necessary, as I said, for reading. There are language-based options and multidisciplinary options.

So let's just talk about counseling a little bit more. Counseling is critical because number one, no one, patients and parents typically don't know much about APD. So information counseling is essential. You gotta explain what is APD, and how do we know you have it, or how do we know you don't have it. Explain the test findings. And then give the patient really solid information on how we can help them, and stress that it's all evidence-based. Now, you'll see in a moment that children with APD tend to have some serious psychosocial problems. APD really affects this child's quality of life, so personal adjustment counseling is often needed, both for the child and the parents. And we've talked about advocacy, and of course referral to anyone, I mean, to a professional counselor or a psychologist for any patient, or even a parent who has serious problems, perhaps depression due to the APD.

Now, how do I know that children with APD have psychosocial problems? Well, it's because we conducted a study and I was one of several researchers, several of my students and the late Carl Crandell, actually the students or Carl Crandell's students. And then when he died in 2004, I believe, five it was, then I inherited his students at the University of Florida. And we conducted this study, Carl and I actually developed the study but then when he died, we finished it up. And we basically showed that if you use a formal measure of psychosocial functioning that would be used by psychologists, kids with APD are either at great risk for psychological problems, or they actually have clinically significant psychological problems. And Carl and I had long discussions about, is this really because of their auditory processing disorder that they have these psychological problems? Or are they coexisting? And you'll see in a bit that we found that the psychological problems in these children, and this is the parent report, this is what the parents thought about the child. Here's the same kind of psychological or psychosocial assessment. And you can see the different categories or domains down below, anxiety, stress, depression, et cetera. This is the children commenting on their own problems. And in both cases, they're real serious. And what we found was that managing a child's APD effectively, basically makes these problems

go away. They don't have any psychosexual problems anymore. And we're gonna get to that when we talk about the FM system. So that proves that the psychosocial problems are secondary to the APD. And with management of APD, this is the one of the most important things you can do for the child, these psychosocial problems disappear.

Auditory training. There didn't used to be any methods for auditory training 10 to 15 years ago. Now there are multiple methods and they're evidence-based. I encourage you to check out, again, the New Zealand Guidelines for APD, 'cause they really get into this in great detail. They list the training techniques and they provide the evidence in their support. Now, all of these strategies, auditory training, FM systems or direct auditory skill remediation, it's all put into the category of so-called bottom up approaches. Bottom up approaches are what audiologists are most familiar with and most interested in, and which audiologists utilize most often. They're called stimulus driven because they're all based on improving the way sound is being processed and perceived by the auditory system. So it's dealing with the process of auditory, dealing with auditory processing on a way up from the ear to the brain. There's auditory training techniques like earobics, and there's a number down there, Q nine, so we must be asking a question about that. Earobics is a very popular auditory training program for children. We're gonna talk later about LACE that's used with adults. There is dichotic training techniques, which are extremely effective, and then of course, there's enhancing the listening environment and the best way to do that is a personal FM system.

So let me just comment on that for a moment. Personal FM systems, you're all familiar with them, involve a receiver, the best type of receivers actually into the ear canal, and a transmitter. The transmitter's used by whoever's doing the talking, so usually the teacher in a classroom setting. But it could be a friend, if the child's wearing an FM system outside of school, it could be a parent, it could be a coach. It could be anyone

that's speaking to the patient. And our study, which was published in 2009 focused on one of the FM systems that was very popular at the time. Now, there's still our personal FM systems and Phonak in fact still has them, but the names have slightly changed. That is one of the references at the end. If you have trouble finding that article, just contact me, I'll be happy to provide it. What we found, and this was amazing, I'm just gonna quickly summarize this study. Very often when you conduct a study, you end up with results that you never anticipated. And with psychosocial difficulties that these kids had, we didn't know what to expect with management. I thought that the problems might still exist but maybe not be quite so serious. But what we found was at the end of the study of one school year of consistent use of a personal FM system in school or at home, wherever they were, that the psychosocial problems went away. They literally went away. In fact, by the end of this study, we were amazed. The kids with APD when compared to our control group, they were more psychosocially intact than the control group. And I think it's because they had started out with such problems they're now quite happy, quite satisfied that they no longer had these problems that they once had. The psychosocial problems went away. And this is based on the parent report of what they thought their child was doing now at the end of the study. And this table shows what the students thought. So most of the time the parents actually thought the child's psychosocial status was actually improved more than the child fought. But still, you can see those hundreds over on the right. They don't have anxiety anymore. They don't have social stress anymore. This was amazing. We changed their psychosocial functioning.

And then, the other thing I'm gonna mention very quickly, so I don't forget it. We found that at the end of this study, which was obviously the FM systems were attempting to improve the ability of the child to hearing background noise, we found that at the end of the study, when we, again, formally evaluated speech perception in noise for these children and compared that to a control group, we found that even without the FM system, the child was performing much better with speech perception in noise. So we

had changed the way the brain was processing sound permanently. And I've seen this in other cases, FM systems are not just management to compensate while they're using the system, help the child compensate. FM systems can actually change the way the brain processes sound permanently.

Okay, now we're now gonna just in passing, mention the top down approaches and then we'll move right onto case two. Top down approaches are not typically implemented by audiologist. More often by psychologist or most particularly by speech pathologists. And this is how the brain influences, controls, enhances what is being heard by the ear. So before we're talking about bottom up approaches affect how sound is being processed by the auditory system as we go from the ear to the brain, but this is how the brain is controlling what the lower levels of the auditory system are actually doing. And they can be very, very effective, so the best approach is to combine bottom up and top down approaches. Now, this is all evidence-based and this is a relatively recent article, 2012, within the last 10 years. One of just many, I should point out, this is from New Zealand, showing that when you compare different intervention strategies, auditory training, FM, bottom up, bottom down, you can show benefit in school as children with APD. So there is evidence in support of the management of APD.

Okay, that brings us to case two, and I will be presenting case two. This is an adult. As you know, the first case was a child. This was one of the most interesting patients I've ever seen in many respects, thank you. And I think you'll pick up on that right away. In fact, what happened with this patient and me has never happened with any of my other patients. And I've literally seen thousands and thousands of patients over my four-year career. When I first saw her, I was on the faculty at the Vanderbilt University, and I had an APD clinic, a very busy one, we always had a waiting list. And this patient was referred to me by a lawyer, by an attorney. So she didn't come in, it wasn't a typical referral, she was being referred by her attorney. She was a 37-year-old female at the

time. She was a speech pathologist, so she knew quite a bit about auditory processing. And she had been working with some children with severe emotional and behavioral issues in a classroom setting, and one of the children, one of the young men, actually, got very upset, not because of anything she did, but that was the nature of his problems, and he beat her up, he assaulted her. She ended up with a head injury. And her lawyer was referring her to me to evaluate auditory processing. The insurance company which was, the school had an insurance company, was saying that she had no problem, that she was essentially making this up. And she wanted to go back to work but she was unable to, and so I was asked to evaluate her.

So I started out with the basic peripheral auditory assessment we've already discussed, including OAEs. And her audiogram was essentially within normal limits in both ears, as you can see here. No evidence of a hearing loss peripherally, normal tympanograms, reflexes, ipsi and contra were normal. Grab my little arrow here. The ipsilateral reflexes are indicated by the open square, the contralateral by the crossed square, cross reflexes, so I plot it right on the audiogram form. That's a big advantage of separate ear audiograms. Got a lot more room, everything's very simple. Same symbols are used on both sides 'cause we know which is the left and which is the right. And so, all of that was normal temperament and even word recognition was normal. So if you stopped here, after a basic assessment, you would have said she has no problem. Well, that would have been a big mistake. In fact, I would say that that would have been unprofessional to stop at this point. Her OAEs are shown here. It's a little worry, these were old findings, but basically her DPOEs were well within normal limits, well above zero dB in both years, normal cochlea. So then we get into the central auditory assessment, and Staggered Spondaic Word test was well below normal limits for the left ear, but normal for the right.

So this tells me, she's not malingering. She's really trying her best. This is a typical pattern. If she were malingering, I would expect very poor findings on both ears and

that would have been a little unusual for an APD, so I would have been suspicious, but that's not what I found. Dichotic digits, horrible scores on the left, normal on the right. The SSI-ICM, I'm gonna talk more about that in a bit, it's the synthetic sentence identification with an ipsilateral competing message. And at a very easy signal to noise ratio, plus 10 dB, normal, normal. But when I got down to zero, where the sentences that she's listening to in the background story are the same level, she's now having some trouble at the age of 37. Normal pitch pattern sequence and abnormal duration pattern sequence, and my policy was to use both ears in doing those tests rather than monetarily. So we're having evidence. We've got evidence clearly of APD. So I made these recommendations. Now, remember this patient came to me from an attorney, so I'm a little bit more limited in what I recommend. She's not yet really my patient. I'm performing the service at the recommendation of the attorney.

So I counseled her, which was very, very reassuring for her, that you really do have a problem, your complaints are legitimate, I understand these difficulties you're having, and I will convey that to your attorney and to anyone else who needs to know. I talked about the importance of a good signal to noise ratio, I suggest that she get a language assessment 'cause she's a speech pathologist. She recognized she needed that. And I said, "But I really need to use one other set of test, auditory evoked responses, to confirm that you have these problems 'cause that's probably what the other legal team is gonna ask about. They're gonna say, well, how do you really know she has an auditory processing disorder? So she came back at the request of the attorney or the referral of the attorney, for the auditory evoke response assessment. And I found very abnormal middle latency response, when I recorded it, tried to record it over the left hemisphere, which was exactly what I would predict. If she had an APD, I would expect the left hemisphere to be involved, or the auditory regions, and that's what we confirmed, I confirmed, with the middle latency.

Well later, now this is the interesting part. Later, 13 years later, I was speaking at a convention and I was speaking about APD. It was the same part of the country, but not in the same town. And during a break, a woman came up to me, I didn't recognize her, and it was this patient. She was a speech pathologist attending the convention, and she said, "I don't know if you remember me. But I was the person you saw." And as soon as she explained her situation, I remembered distinctly, and she asked if I would evaluate her again. She was still having problems. But here's what she put in a written letter to me. Telling me how much she appreciated what I had done. This is the advocacy, just describing APD to a person, and telling them you'll stick with them and you'll help them as much as you possibly can in dealing with this problem can be very, very therapeutic all by itself.

So she came back, now she's 50 years old, normal audiogram still, reflexes still normal, normal temp, nothing's changed peripherally. Here are her OAEs is a different piece of equipment, but still showing perfectly normal OAEs 13 years later, when she's 50 years old. So then I get into the APD assessment. I didn't know what to expect, but notice, very poor scores on the left ear for a dichotic test compared to the right. That's the classic left ear deficit. The synthetic sentence identification with an ipsilateral competing message, now not just borderline, she's very abnormal. I'm gonna show you the graph in a moment. So she's deteriorated on her speech perception in noise over the 13-year period. And that confirms what she's saying. She says, "I'm having more and more problems now than I ever did." I did to SCAN-A, she was at the ninth percentile for filter words, which is technically normal, and yet that means 91% of 50-year-olds would do better than she did. And she was clearly abnormal on auditory figure ground, and only at the first percent, 0.1 percentile. At 0.1 percentile, not even 1% for competing words, which goes along with these two dichotic tests. So she clearly has auditory processing disorders now, which I would expect. I wouldn't expect them to go away after a head injury.

So now I'm recommending more detailed intervention because she's my patient. I'm advocating for her. So I said, "You really need an FM system." She's back at work, she's 50 years old, she's having a horrible time in a classroom setting, but she can wear an FM system just like the children in the classroom. I said, "You've gotta complete an auditory training program and LACE, is an adult auditory training program." So that was very easy for her to implement it. It's available online. And now, as opposed to 13 years earlier, we have some dichotic training programs. So I recommended dichotic intensity increment difference, or DIID, and I gave her materials and we walked, I helped her go through the process. And I said, "I'd like to follow you up in one year." Now at this point, I was leaving the University of Florida, so I never did follow up on her after some correspondence following the second assessment so I honestly don't know how she's doing now, but I do know that when she got to the point where she was using an FM system, she'd completed LACE, and she'd completed the DIID program, the auditory training program, this is an auditory specific program. She said, "I'm doing better than I've ever done before." But I have no data to support that a statement of hers.

Okay, so now we're going to talk about assessment and management of APD in adults, building on what we just discussed in that case. And I know that we've taken a little more time for some topics, a little less for others, but actually, we are right on schedule, as I look at my calendar here, my agenda. So we're gonna stay right on schedule. And obviously, when we talk about assessment of APD, there are some general concepts, general procedures and principles that apply to both children and adults. So we're not gonna review again what we've already discussed with children. First of all, we talked about children, mostly being developmental. Out of 100 children coming to you for an APD assessment, the majority will be a developmental problem. There'll be no head injury, there'll be no tumor in their brain, they won't have any seizures. They'll just have problems with auditory processing that seemed to be, have been present since birth. But with adults, it's very different. With adults as I mentioned,

age is a factor. Now age is a factor before you get to old age. And the older I get, the later the definition for old age, 'cause many people my age are running for president, I'm not quite that old. But at any event, older is just all relative. It's a physiologic rather than a chronological. But once you get to age 50 and beyond for patients, you should always consider age as a factor. And I think part of the change in my patient that I presented, the adult, part of the changes she's experiencing literally, are the aging of her auditory system after a pretty serious head injury.

Older patients are also much more likely to have cognitive impairment and even dementia. And so, anytime you suspect cognitive impairment or maybe it's in a history, or maybe you have the results of a psychological assessment showing the patient does have dementia, then that's a very, very important risk factor for a adult APD. So that's another profile. An older patient comes in, nobody knows what's wrong with them but they've got cognitive problems. Or of course, as I've mentioned, you may have younger adults, 20-year-old, 30, 40-year-old adults who really have APD that they've had all their life and it was never diagnosed. Now, why do they come to your clinic at the age of say 30 or 35? Well, here are three reasons, and I've had a lot of experience with patients like this. Let's say it's a female patient, a woman, and she graduated from high school, but then she got married and had children. She was a worked inside the home, very hard with her children, raising her children with her husband, perhaps. And then now she's, the children are growing and she's getting employment outside the house, or maybe she needs to financially, and she's struggling. Can't do it. Having real problems with the job that involves communication. Or maybe she is very hard worker, very reliable, she's been promoted to being a supervisor, or to be a manager and now she's in noisier environments. She has to communicate more often with people and now she's noticing the problem. Or the patient is going back to school, or maybe for training, maybe community college, maybe college, and now they're relying on their hearing in a way they've never had to before. And now they're noticing a problem.

Of course, with adults, you also may have an acquired APD. And this is probably the most common. An adult with TBI, maybe a veteran who had a combat injury, or maybe somebody would have a motor vehicle accident or a stroke. Or now they're 60, 70, 80 years old and they clearly have dementia, it's been diagnosed, they are very likely to have APD. So how do you evaluate adults for APD assessment, what peripheral assessment, same way you do children, same test battery. Now, when we get into a central audiological assessment, auditory processing assessment with adults, it's actually quite easier, much easier in some respects because there are so many more tests. Because the average pediatric APD test has normative data up to age 12. But by the time they get to age 11 or 12, the corpus callosum that Ghada mentioned earlier has matured. And so you don't see any real changes in auditory processing performance in adulthood, at least up through age 55 or 60.

So all of these tests that are available for children are also available for adults, but then many more tests are available for adults and you don't need to have age-referenced normative data. So we're not gonna talk about all of them obviously, but if we look at the New Zealand Guidelines, which I've mentioned numerous times, and we look at the different types of auditory processing that we really like to assess, discrimination, binaural interaction, dichotic listening, speech in noise, et cetera, temporal processing, you can see there's multiple tests out there that are all evidence-based, they've been described in the literature. Some of them have been used for 50 or more years. Now, I'm not, don't work for any company, I don't promote any company, I'm totally independent, academically independent. But if you want to buy or purchase auditory tests, you have to get them from some vendor. And one option is Auto Tech. It's been a company that's been around since the 1970s, 1960s, perhaps. And it's got new management 'cause the person who first founded the company, Bill Carver, was getting very, very old. Turned it over to some people who are now running the company, and it's a wonderful source of APD tests. So all the tests that we've talked about, many versions of the same tests, like dichotic digits, many versions of dichotic

digits, all available from the same resource. And this is something of interest to this group that I'm talking to right now. There are tests available from Auto Tech in so many languages. These are the languages I could find on the website. So no matter where you are in the world, you can purchase tests in the language of the people coming into your clinic, that you can administer for APD.

Now these are the speech tests. You can also of course, administer non-speech, non-verbal tests in addition to these speech tests, and you can put together a really nice test battery. So for an international audiological APD assessment, I would always start with as many speech tests as I can get, but then get the nonverbal test. Gaps in noise is a great one, pitch pattern, duration pattern that Ghada talked about that I used in my case, those are non-verbal. You can use those in any languages. You could use frequency discrimination, intensity discrimination, temporal discrimination tests which are non-verbal. And of course you have all the objective tests. The auditory evoke responses, OAEs, acoustic reflexes, contra reflexes, including acoustic reflex amplitude and acoustic reflex latency with some pieces of equipment. So anywhere in the world you might find yourself, you can put together good test battery.

Okay, here are some speech in noise to every routine test auditory assessment. Not an APD assessment, just on a routine assessment. You should always include speech in noise. And if you don't do it on every patient, adult or child, certainly, perform a speech in perception in noise test on every patient who says, I can hear you just fine here where it's quiet. But you put me in a noisy setting, we go out in the waiting room or out on the street, I couldn't understand a word you're saying. You are not performing an adequate assessment for that patient unless you've evaluated speech perception in noise, and there's plenty of options for that. Both in English language and in other languages. And by the way, any patient who speaks English, they don't have to be a native English speaker. They don't have to have English as their first language, can usually perform these tests. So don't hesitate to use these tests in someone who's not

a native English speaker. And if they do well, then you know for sure, they don't have an auditory processing problem. If they don't score within normal limits, then you know at least when they're listening to English, they have a problem processing it. Now the auditory evoke responses that we use most often when we're evaluating APD are the cortical evoke responses. The auditory middle latency response, the auditory late response and the P 300. But when you've got the patient hooked up with the electrodes, I recommend you always record the ABR as well. At least for And with some devices, you actually can use speech stimuli for the ABR, as well as the cortical. If you have that option, it's better to use speech, than non-speech, or both. And Nina Kraus, who's at Northwestern University has done a lot of work on speech evoked ABR in patients with APD, children and adults. And shown that even at the brainstem level, auditory processing is less than efficient and is not very effective in patients with APD. And so this argues against this problem being language or attention, or some non-auditory problem. Clearly if the ABR is abnormal, it's an auditory problem.

Okay, now the guidelines, we're gonna move on to assessment, the guidelines for, or I should say move on to management in a moment, but the guidelines that AAA have produced and the New Zealand Guidelines clearly define who is a candidate for auditory evoked responses. And in my experience, I supplement the behavioral testing with auditory evoked responses. And I'll start with auditory evoked responses unless the child's very, very young and I can't do any behavioral tests. So in most cases I'm only using auditory evoked responses when the patient meets one of these criteria. Now in the patient I presented today, my case two, clearly, one reason that I performed auditory evoked responses is because a patient was referred from an attorney, by an attorney, and I wanted to make sure that I had objective electrophysiologic confirmation of an auditory processing problem. Okay. So we won't get into this in detail in the interest of time but the justification and the explanation for why you need to use auditory evoke responses is all in the guidelines. They talk about auditory evoked responses in general, and then they talk about ABR. And these are the AAA

guidelines, then they talk about the middle latency. Of course, all of these statements are supported by research articles, and even the level of evidence is mentioned. So the higher the level of evidence, the better. So a level one is the top, two is next best and then you work your way down. So there's plenty of justification for using auditory evoke responses in these patients as needed.

Okay, now what about evaluating a auditory processing in an adult with a hearing loss? And there are some audiologists, as soon as they see the hearing loss they say, oh, there's a hearing loss here, peripheral hearing loss, we don't need to worry about APD. But there's absolutely no, nothing saying, there's no distinction in the terms of auditory dysfunction between the ear and the brain. You can have etiologies like head injury that affect both the ear and the brain. You can have aging that affects the ear and the brain. So any time you have a patient, you should always evaluate peripheral auditory function and whenever needed, central auditory function. And the question then is, well, if they have a peripheral hearing loss, if they have a high frequency presbycusis type hearing loss, for example, can we evaluate auditory processing? The answer is yes. We make some changes, we adapt a bit and then we go right ahead and we evaluate auditory processing even though the patient's got a hearing loss. We can increase the level of the intensity. Of course, if they have a medically manageable peripheral hearing loss, we do that first. So otosclerosis otitis media, whatever it might be. We don't rely only on single syllable word test because there are a lot of high frequency sounds in single syllable words, which might make it difficult for the patient to perform the task, even though their auditory processing is normal. And then we go on to tests that do not involve, or not influenced by peripheral loss. So there are many sentence tests, like the synthetic sentence identification that we've already talked about, which really aren't effected by high frequency loss at all. And the research is in our favor. Research clearly shows that a hearing loss, mild, moderate hearing loss, will not have any negative effect on the test that we're performing for central auditory assessment. Okay, and again, the New Zealand Guidelines also confirm that we can

evaluate patients with peripheral loss and they also provide some suggestions for how to do that.

Okay, what about a patient who has an asymmetric loss, more hearing in one ear than the other, or even a unilateral hearing loss? Can we evaluate those patients? And the answer is yes. Now, how do you change your approach for a patient with unilateral or asymmetric hearing loss? Now, remember if they have an asymmetric or unilateral hearing loss, before we get to the APD assessment, we're gonna make appropriate referrals. We're gonna make sure that we've referred the patient to a probably an otologist, to rule out a neural auditory problem. So this is assuming that the asymmetric or unilateral hearing loss is permanent and it's not retrocochlear. It's a cochlear unilateral hearing loss. Well, the only thing we do differently in evaluating auditory processing, is we don't perform dichotic tests. You can't perform a dichotic listening test in a patient hearing only in one ear. But other than that, we can do everything. We can certainly evaluate speech perception in noise 'cause that's done typically monorally. We can evaluate temporal auditory processing. We can evaluate most everything. The other tests in addition to dichotic that we can't do is we can't do a test like the listen test, listening in spatialized noise when we're actually trying to look at spatial processing of sound, because the patient is not even hearing from one ear. But for the most part, we can at the end of an assessment, say this person clearly has no problem with auditory processing. They have a peripheral loss but no auditory processing problem due to a central deficit, or they do have an auditory processing problem. And that of course will influence management.

Okay, the factors that we talked about earlier. Listener variables, are just as important for adults. So fatigue, hearing sensitivity, motivation. Now, as I mentioned earlier, motivation is typically not a question or concern for adults. Adult comes to your clinic wanting to know why they can't hear at work, for example, or struggling in the classroom, they're motivated. But you may get some patients who are motivated to

show they have more of a problem than they really have, particularly if there's a medical legal case involved. So always consider motivation, but as a rule, it's not an issue in adults. Native language clearly can be and of course visual acuity, if they're needing to use a picture pointing test or use their eyes during the hearing test, obviously that could be more likely to be abnormal in older adults. Okay, now real quickly, one of the factors that's probably most important, listener variable that's most important with adults is cognitive functioning. Whereas the average child coming into a clinic, at least my clinics, has had normal cognitive functioning. And that's even proven by a normal IQ test or psychoeducational assessment in the school. With an older adult, they're much more likely to have cognitive decline. In fact, that may be why they're coming into your clinic. Somebody thinks they're having problems with auditory processing, but they won't say that. They'll get referred for it because they're not following what people are saying, they're not remembering what people are saying, they're not listening to what people are saying. And in those patients, always keep cognitive function in the back of your mind. And the research clearly shows that there's a direct correlation and connection between cognitive performance and the ability to perform auditory processing test, including speech in noise.

Okay, so let's wrap up our discussion on adults. We're talking about management, and again, we're pretty much right on schedule, and then we'll have time to for questions and answers. So if you do have questions, start thinking about them and I know there's quite a few of them already and we'll just work our way down the list. Well, what we talked about for management of APD in children, for the most part, also applies to adults. Now, in my experience, the emphasis with adults is often quite different. Very often we're trying to compensate for them so they can, or help them compensate, manage their APD so they can function in challenging listening settings. So we're not worried about academic performance typically, or we're not focusing on trying to change the auditory processing permanently, as we do with a child so that they don't need therapy anymore and they can do well in school and go on with their life. With

adults very often, I'll tell the patient, what we're doing now, you're gonna have to do this whenever you're in a listening setting. We're gonna have some changes that are permanent in your brain, but you're always gonna be having to take responsibility for doing the best you can to improve your auditory processing. So the management strategies are somewhat different for children and adults. Remember I mentioned the LACE, it's an auditory training program, that's one different option for adults than children.

Another is adults who need to wear hearing aids. If your assessment of peripheral auditory function leads you to a conclusion that this patient needs improvement with audibility, they need to hear faint sounds better, they have a peripheral hearing loss, start your management there. Because auditory processing is totally dependent on audibility. You can't process something if you're not it. So always begin with peripheral management, get the very best hearing aid fitting, binaural that you possibly can. Then if the patient's complaining of difficulties in background noise, and now they're wearing the hearing aid but they're still having problems in background noise and your APD assessment showed that they had problems with speech perception in noise, then consider a hearing aid fitting, for example with directional microphones, or coupling an FM system, a remote microphone, with a hearing aid in certain settings. So if they're driving in a car or riding in a car, the person they're with is got the microphone. If they're in a business meeting, the speaker has a microphone, or there's an FM system wherever they are, coupled with their amplification.

So that's a big difference between children and adults. Also with adults, when you get into management, don't forget the multidisciplinary approach. Now, you are more often with adults to be in charge of management. Whereas with children, there may be a psychologist involved or a speech pathologist. But with adults very often, you're pretty much controlling the management because their problem is primarily auditory. But don't forget the psychologist or the neuropsychologist. Because as you get into older

adults, with cognitive impairment, cognitive decline is closely related to auditory processing disorders. And I started studying this back in the mid 1970s. In fact, the first study I performed, I was shocked. I was with a student at Vanderbilt University, a PhD student, and she was focusing on patients with Alzheimer's dementia. And there were 10 subjects with very mild Alzheimer's dementia. We had another group of control subjects, same age, these were all '60s and '70s patients, subjects, and age and gender. So we had two groups, all older adults, but one had been diagnosed with early Alzheimer's dementia. Auditory processing was normal in the normal group, the control group, and I couldn't believe the deficits in auditory processing the folks in the other group that Alzheimer's dementia was showing. And then right after that, that was the mid 1990s other people started to show that if you want to detect Alzheimer's dementia at the earliest possible stage, actually use an auditory processing test, use a speech in noise test, use a dichotic test. They're extremely sensitive to auditory cognitive deficits.

So management of adults, you start where you would with children but then there are some strategies that would be most useful with adults that you might not use with children. Okay, well, we're getting toward the end. Oh, I should point out that the auditory training programs that we talked about earlier, earobics, for example, which is excellent, I've used that in literally hundreds and hundreds of patients, that is totally appropriate for adults as well as children. And we already discussed the DIID, the Dichotic Intensity Increment Difference test and there's another version of that called ARIA, A-R-I-A, very effective with adults, and they can implement the management themselves. That's another difference between management in children and in adults. With children it's often the management's being coordinated with their parents, with the school system, with other professionals. With adults very often, my patient was an excellent example, they pretty much are motivated to continue or initiate and continue the management of them themselves, so they're coordinating their own management. And then don't hesitate with an adult who has clear pattern of auditory processing

disorders, to refer that patient to appropriate professionals. If my patient that came in that I presented, even if she hadn't come in upon the referral of an attorney, if she'd come in on her own, I still would've sent her to a speech pathologist for evaluating language to a psychologist to evaluate cognitive function. And if she came straight in to see me, I certainly would've sent her to a neurologist for an MRI, or back then it was a CT scan, and also to make sure that she didn't have any other neurological deficits that we were overlooking.

Okay, we have time for questions and I did have a summary slide, but we've pretty much covered that material. Let me just quickly tick through the summary points. Number one, APD does exist. There's ample evidence that it exists. It's an auditory problem. There's neurophysiologic evidence. There's radiological imaging evidence from FMI, there's plenty of clinical evidence over the last 60 plus years. Literally tens of thousands of patients with APD have been diagnosed and management. The fact that management for a patient with a diagnosis of APD actually helps them, proves that it's an auditory problem. If you use auditory training in a patient with auditory processing disorders, and they no longer have any problem with their auditory functioning, then they must've had auditory processing disorders to begin with. We also, another point in the summary, is we have clinical practice guidelines. Evidence-based, peer-reviewed clinical practice guidelines. So that's all you need to develop your test battery and your clinical protocol for the evaluation and management of APD. We have plenty of evidence in support of the management or the intervention. And that didn't exist years ago. I must admit, even into the 1990s, very often when we got to the point where we diagnosed APD, we didn't know quite what to do next. Because there were no auditory training programs. Earobics for example, was one of the first, it was developed in the early 1990s. We didn't have the kind of personal FM systems that we have now. The personal FM systems back then were not acceptable. They were more like headsets and very cumbersome and not very user-friendly. But now we have that.

And then the last point I'll make is that every audiologist, you can't ignore auditory processing disorders as an audiologist. You've gotta make one of three decisions. Do I evaluate it, do I identify these patients, do I diagnose their problem and do I manage them? That's one option. Do I identify them and do I diagnose them, but do I refer to someone else for the management? Or the third option, do I simply find patients who are at risk for APD and refer them? But those are your only three choices, you can't ignore it. When I see an audiologist who says, well, I'm in private practice and I dispense a lot of hearing aids and I never see patients with APD, my standard response to that audiologist is, well, you have seen patients with APD, you've seen lots of them. Particularly if they're seeing an older population, you just don't know it. You just don't know who they are. So patients where the APD come into every clinic, and it's your obligation as an audiologist with the very least, identify them.

Okay, let's get on with the questions now. And I'm looking at the list here. So I'm just gonna work my way from the top down. Can we diagnose... And Ghada, you're welcome to jump in at any point with any of these questions and try to answer them. Can we diagnose cochlear dead regions in APD cases, CAPD cases?

Well, you certainly can have patients who have regions of the cochlea that aren't functioning. So-called cochlear dead regions, and patients with APD. And in fact, I've mentioned, there's nothing saying you can't have both them. Peripheral and a central auditory problem, in fact, if you have a peripheral auditory problem, you're more likely to have a central auditory problem, so there's an association. And if you have an etiology that's caused a central auditory problem like traumatic brain injury, that very well may have also affected the ear. So I would always evaluate the ear first, and then that would, of course include if you wanted to try to find cochlear dead regions. One reason I like OAEs, particularly DPOAEs with many frequencies proactive, is sometimes you will see regions between the octaves, a frequency region between the audiometric octave frequencies, where very abnormal OAEs, in fact none. And that information is

valuable because if a person's having problem with auditory processing and they're not getting all the auditory information into the auditory system to begin with, because of the cochlear dead region, they're gonna have a more of a deficit.

Okay, to what extent do you recommend educational audiologists get involved in testing for APD?

Okay, that's a great question to be honest. First of all, I would prefer the patient in the public school system or in school, to be evaluated for APD in the school system, not to go to another clinic. And I didn't have time to talk about a program I developed, today I didn't have time to talk about it but if you contact me, I'll send you information. It's called EARS, EARS, E-A-R-S, all capitals. It's an acronym, and it stands for Early Auditory Reading Success, EARS. And the whole concept is find the children with APD in kindergarten, in the public school, and provide all the remediation that they need in the public school, very inexpensively, very efficiently, in order to prevent them from ever falling behind in reading, and to help them always stay ahead academically. So every educational audiologist should, in my opinion, educate classroom teachers, speech pathologist, reading specialist, of course the principal, anyone else, even the nurse in the school, about APD, what the risk factors are. There are as you know, paper-pencil tests like SIFTER and CHAPS and others, which teachers could administer to try to sort out which of the 20 kids or 25 kids in the classroom might have APD, or use the risk factors that I've already listed. If a child's a graduate of the intensive care nursery when they were born, another is if the child has an older sibling who's already been diagnosed with APD, that's a strong risk factor. If they had a lot of ear infections as a child, maybe they still have some residual middle ear abnormalities, all those children are at risk. Children can be screened for APD in a matter of 15 to 20 minutes after the initial peripheral assessment. And the many of the recommendations for management can be done right in the school system. So every educational audiologist really should be involved.

Okay, Rebecca says, "I work solely with individuals with developmental disabilities, adults and children, and some demonstrate poor auditory processing and struggle with standardized test methods."

Well Rebecca, that's a challenge. People realize, everybody knows that cognitive functioning and developmental delay, developmental disabilities can be associated with auditory dysfunction, including auditory processing disorders. So the challenge is to sort out what problems are they having that are purely auditory, that might be found in any patient or anybody, and which problems that they're having are auditory but they're influenced by developmental delay or developmental disabilities? In a patient, for example, with the cerebral palsy, which is a motor problem, we wouldn't expect them to have auditory processing disorder. So if they have auditory processing disorders based on your tests, then that's clearly a auditory specific problem. It's not caused by their cerebral palsy. But with other cases, there may be a general delay in neurological development, that's influencing many functions, including hearing. You would definitely want to rely to a large extent, on objective tests, electrophysiologic tests, certainly OAEs for peripheral function, ipsi, contra reflexes for brainstem function, and if you have the option, auditory evoke responses. 'Cause you're gonna have more patients where the behavioral tests are gonna be inconclusive. Is it really just a reflection of their developmental disability or impairment or is it an auditory problem?

Okay, do you have any suggestions for the evaluation management of APD in adults with... Okay, that was part of the same question.

I would not be discouraged from trying, because anybody who has an intellectual disability, in my opinion, or even let's say they have a low normal IQ, their IQ is down around 82, 83, they need every bit of help they can get. They can't overcome their

auditory processing problem by developing these incredible strategies for compensation that somebody who has an IQ of 120 or 30 might. They don't have great memory that they can utilize to overcome an APD. So they need all the benefit that you can possibly provide them. Certainly a classroom FM system would be a very good beginning, but also auditory training would help traumatically.

Okay, Irene, what is the recommended frequency and intensity for participating in auditory training programs to see a therapeutic effect?

Okay, I'm glad that you mentioned that. The short answer is very intense for a short time. Auditory training programs, for example, the DIID, the dichotic training program, I've had some experience with that, we would see three days a week, the child or an adult would undergo the therapy, the training, auditory training, three days a week, or four at the most, for maybe 20 to 30 minutes per day. And the same is true for earobics. Usually three days a week, three or four days, 30 minutes a time. And within two to three weeks, we start seeing changes. With an FM system, that may take a little longer for you to start seeing some changes, but not years, usually within a year. And so that's one of the, this is the brain plasticity. This is one of the most exciting things why I love to work with people with APD. You can see benefits so quickly and they're permanent. And the maintenance, I always bring the child back. And sometimes you need a little refresher of the intervention, a little more auditory training at some point. But usually, once they start processing auditory information well and effectively, and they do that day in and day out, that's really part of the ongoing treatment, you might say.

We're completing testing at our clinic on iPads, probably 'cause of COVID-19, when taking the tracks... Oh, I see for pure tone audio, or for speech audiometry, from CDs that effect... No, it doesn't. The first thing we would do is we would get a master CD or all the CDs we needed, say from Auto Tech or some other person or vendor, and then

we would, you can do several things. With some audiometers like the GSI AudioStar or the GN Otometrics Astera, you can put all your speech stuff right on, all the speech materials on the audiometer. Or we would put them on iPods, or run it right from a tablet into an audiometer. So that doesn't affect, we'd looked at that, other people have, there's no distortion, there's no change in the materials.

Would you evaluate an older adult with the hearing aids on? Oh, that's a great question. I would first evaluate them without their hearing aids, just so I can get a pure measure of the very optimal, at a very high intensity optimal performance on auditory processing. But then, I would want to do speech in noise, certainly not dichotic test, but maybe some of the other, like the pitch pattern, with the hearing aids to mainly prove that with the hearing aids which is their normal, typical condition, they're doing as well as I showed they were doing, or as poorly without the hearing aid, just to make sure that we're not looking at a hearing aid specific problem. In other words, where the hearing aids are either not amplifying adequately or they're distorting information.

Briefly discuss billing. Okay, Eric, that's a good question. Aided and un-aided speech in noise, speech in quiet, that's all good. For years and years, I've ran APD clinics, and in terms of revenue, and I don't do it to make the revenue obviously. My goal is to help people. But I was always among the highest revenue generating audiologists. Every patient coming in was referred by a physician. We always knew in advance, that we're gonna get reimbursed. It's a lot of diagnostic assessments when you start totaling up the, you use CPT codes, Current Procedural Terminology codes for the different procedures, you're doing a lot of procedures, you can bill for them, I would always, in my one, two-hour slot, my single two-hour slot for an APD patient, I would be able to generate far more revenue than another audiologist working for two hours in the clinic. And there's this misconception that you can't get reimbursed for APD. That's not true at all. You need to make sure you're using proper CPT codes, proper diagnosis codes, but your reimbursement will follow, and just verify that you gonna talk to the insurance

companies or the health insurance companies that are involved, or wherever the money's coming. For an attorney, you're gonna get obviously, money from the attorney or the insurance company.

Very quickly, I know we're just about out of time here. It's two o'clock on the East Coast, although we're two minutes from the two hours, where we started, can I take the APD test in patients with severe hearing impairments, or is there a limit? Oh, that's a good point. There's two ways of looking at this, Victoria, and you're in Argentina. Your English is excellent, thank you. Far better than my Spanish, which is nonexistent.

My approach was always, if the patient's got a severe hearing loss or moderate hearing loss, whatever peripheral hearing loss, and I'm concerned, or they're concerned, or someone's concerned about auditory processing, I'm gonna administer the auditory processing test. If they're trying to listen to speech in noise, and they've got a severe hearing loss and they can't understand a thing that they're hearing, based on my test, then that's what's happening in their everyday environment. And I'm gonna be underestimating their problem if I don't do the APD test. I might just say, oh, with a severe loss, that even with a hearing aid they'll do well, and that'll help me counseling, it'll maybe help me with recommendations for FM systems. In fact, you can do the auditory training tests or procedures that we talked about in people with any degree of hearing loss. So I would definitely evaluate APD in anyone at risk for auditory processing disorders, even if they do have a peripheral loss.

And finally, advising older adults, not children, to see a neurologist, psychologist when many have limited.

Okay, I'm glad you asked that question. I don't over refer. And I'm very sensitive to the patient's financial or economic status and conditions and limitations. And so, I'm gonna do all that I can to help the patient without making a lot of referrals, just to see

what the results might be. So I'm gonna refer to a neurologist when I'm concerned about a neurological problem. I'm gonna refer to a psychologist in an adult when I'm really concerned they might have cognitive decline, and they really can't be managed effectively without it. Ultimately, it's the patient's decision, whether or not to follow through with those referrals. And I'll try to help them financially in every way I can. And even getting a hearing aid, if they need a hearing aid and they can't afford it, I'll find out, we always had a bank of hearing aids, sometimes they'd been returned and reconditioned. We weren't selling them as new, we weren't selling them at all. We were giving them to patients either on longterm loan or literally giving them to patients. So if a patient has limited economic resources, then we'll do everything we can to make sure they get the help they can, as economically as possible. Okay, and I would not classify severity of APD. I'd say any APD is a problem, and trying to classify or describe the severity implies that some problems are not as serious than others, but I've found that even just a problem with speech perception in noise, which might be considered a mild form of APD if you try to categorize it, can be devastating for a patient.

All right, folks. Well, thank you very, very much for your attention, assuming you were attending, I think you were. Don't hesitate to contact me with questions. I'm sure Ghada would accept questions too. You can find our email addresses, and definitely provide APD services of some sort in your clinical practice. That's my final plea. Thank you very much.