# Behavioral Voice Interventions for Persons with Parkinson's Disease

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Presenter: Kelly Richardson, PhD, CCC-SLP

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- - [Amy] Once again, welcome to our webinar today, Behavioral Voice Interventions for Persons with Parkinson's Disease. Our presenter's Dr. Kelly Richardson, and she is an assistant professor at the University of Massachusetts. Her research program focuses on clinical outcomes associated with behavioral voice interventions for persons with Parkinson's, and further investigates non-sensory changes associated with Parkinson's disease. So I'm going to turn over the floor to Kelly. Kelly, welcome.

- [Kelly] Thank you very much, Amy, for that introduction. As a speech language pathologist and a clinical researcher, I'm really excited to present evidence-based voice treatments for individuals with Parkinson's disease, this has been a long-standing area of interest for me. At the end of this webinar, you will be able to list and describe the various voice features associated with Parkinson's disease, describe the speech and voice features associated with hypokinetic dysarthria, secondary to Parkinson's disease, and describe the current evidence-based voice treatment approaches for managing these speech and voice symptoms. Throughout this presentation, Parkinson's disease will be referred to more simply as PD. In addition, I would also like to note that the symptoms and treatment programs described in this webinar, excuse me, are for later onset idiopathic PD, which is the most common type of parkinsonism. Later onset refers to a diagnosis after 60 years of age. Young onset PD and other neurodegenerative diseases, such as progressive supranuclear palsy, and multiple system atrophy, will not be covered in today's talk.

Before we get started, though, I'd like to take a quick poll to ascertain the audience's level of experience with voice treatment for persons with PD. Wonderful, thank you. I can see there are varying levels of experience in today's talk. I'm going to move forward to the next slide. In recent years, there has been a concerted effort to project the healthcare burden for diseases associated with an aging population, such as Alzheimer's disease and PD, and this is partially driven by the demographic shift towards older individuals in Western nations. A PD is considered the second most common age-related neurodegenerative disorder after Alzheimer's. It is currently estimated that one million Americans and seven to 10 million people worldwide live with PD. The incidence and prevalence data reported on this slide, however, is based on those with the current diagnosis. But these data may actually underestimate the number of people afflicted by the disease due to challenges in accurately diagnosing the disorder. At present, there is no specific test to diagnose idiopathic PD, rather, a diagnosis is based on the patient's medical history, a review of their clinical signs and symptoms, and a comprehensive neurological and physical examination. If the results of these assessments, collectively, are suggestive of PD, a medication trial may be completed in a positive response to levodopa is thought to support the diagnosis. Before we discuss the voice treatment approaches, it's important to first understand the neuropathology of the disease process, because it has important implications for our therapeutic models.

For a long time, assessment of PD-related impairments has focused primarily on the motor symptoms associated with the loss of dopamine. We know that dopamine is an important neurotransmitter for executing smooth, and coordinated and controlled motor movements. In recent years, however, there has been growing interest in the sorry, non-dopaminergic change as associated with PD, which leads to alterations in non-motor function. And these can include sensory disturbances and changes in cognitive function. As clinicians, it's important that we consider both the motor and non-motor consequences of this multi-system disease. A loss of dopamine-producing cells in the substantial nigra is one of the main pathological features of PD, leading to a marked reduction in dopamine function along the nigrostriatal pathway. The nigrostriatal pathway connects the substantia nigra pars compacta to the caudate and putamen nuclei of the striatum. The nigrostriatal pathway is one of the four major dopaminergic pathways of the brain, and it is particularly involved in the production of movement because it forms part of the basal ganglia loop. The loss of dopamine along the nigrostriatal pathway leads to a number of motor symptoms including Tremor, Rigidity, Bradykinesia, or slowness of movement, and Postural instability. These movement-based symptoms can be remembered using the acronym TRAP. It is estimated that these pathological signs don't become apparent or evident until the nigrostriatal pathway has lost at least 80% of its dopamine capability. It's important to note that the motor symptoms of PD are highly variable, and not every patient will experience all of the symptoms listed in these slides. In clinical practice, we see patients with different clusters of symptoms as well as different levels of severity.

The progression of the disease state is also highly variable across individuals. As such, it's important that our voice treatment approaches are individualized to the specific needs of our clients. In addition to these primary motor symptoms, secondary motor characteristics are often present and may include a slow shuffling gait, micrographia, or abnormally small handwriting, differential dysfunction, leading to hyper-nasal resonance, a mask-like facial expression, speech difficulties, and reduced respiratory function due to rigidity and/or incoordination of the respiratory musculature coupled with a more open glottal configuration. To accommodate the changes, sorry, the challenges with gait and postural stability, it's important that we follow fall-prevention protocols, and when possible, I use checklists to accommodate the patient's writing challenges. For a long time, the main clinical focus in PD has been on the motor symptoms. However, there's increasing recognition that the clinical spectrum of PD is much more extensive and this also includes the non-motor symptoms.

There is growing evidence that the degeneration of non-dopaminergic neurons occurs well before the loss of dopamine in the nigrostriatal pathway. As a result, the non-motor symptoms that results become apparent in individuals with PD long before the onset of these motor symptoms. These early non-motor symptoms can include sleep disturbances and loss of sense of smell. The non-motor symptoms comprise a variety of cognitive, neuropsychiatric sleep, autonomic, and other sensory impairments. Some of these non-motor symptoms are shown on the screen, but this list is by no means exhaustive. The non-motor symptoms can really alter the quality of life of our patients. I can tell you from my clinical experience, they are often reported to be more debilitating than the motor symptoms. As clinicians, we frequently account for the motor-based impairments in our therapy programs. We cue our patients to adjust their body position, the cue them to take a deeper breath before speaking, but it's important that we're also mindful of the non-motor symptoms in our clinical practice. Most often, I encounter challenges imposed by physical fatigue and decreased intrinsic motivation due to apathy.

To address the issues with fatigue, I do my best to time the treatment sessions with the patient's optimal time in their medication schedule. Given scheduling constraints, however, this is not always possible. When a patient presents with apathy, I find clinical education and caregiver involvement to be important components of the therapeutic process. When patients understand the rationale behind the voice exercises and the potential benefits of enhanced communication, I find that intrinsic motivation can often be heightened. In addition, since many patients with PD have difficulty recognizing that their speech is soft, caregivers can provide direct and positive feedback when their loved ones speak at a louder volume.

This only serves to reinforce the skills that they're being trained or taught in the therapy room. There are a number of non-motor impairments associated with PD, but I'm going to highlight a few for you. Changes in executive function is one of the most common cognitive impairments found or reported in individuals with PD. The prefrontal cortex and the dopamine system, both play an important role in executive functioning. So as the disease process damages these areas of the brain, we see changes in the patient's ability to process, organize and remember information. As a result, memory aids can be a helpful tool in therapy, such as providing written instructions or homework plans, I often put together a binder for patients to take home, which outlines the task instructions, and also includes a record sheet that they can use to document their home progress. This helps create a sense of accountability and also guide their at-home-therapy activities. Patients also have difficulty with attention and we can think of this in the realm of sustained, alternating and divided attention. So it's important that we minimize cognitive demands in therapy by simplifying our cuing and task instructions. In addition, we know that patients with PD have difficulty filtering out irrelevant stimuli. This is a process we call sensory gating. So it's important that we minimize environmental distractions, when possible, and this can involve visual and/or auditory distractions. And lastly, patients may present with slow thinking and difficulty with word-retrieval, so allowing them time to process and respond to information is important. We often engage in caregiver education around this topic. To circumvent these challenges, it's really important that our voice-treatment programs are designed to mentor cognitive load and focus on simplified task instructions because the research shows that attention and memory disturbances, apathy and fatigue can impact our treatment outcomes.

So, we know there are a cluster of speech and voice symptoms that describe the cardinal features of hypokinetic dysarthria associated with this underlying basal ganglia dysfunction. The presentation of these symptoms is heterogeneous across individuals, but the primary voice complaint is reduced speaking volume. A number of studies have shown that individuals with PD speak, on average, two to four decibels lower than neurologically intact speakers. Other speech and voice symptoms can include reduced fluctuation in pitch and loudness. We refer to these perceptual qualities as mono pitch and mono loudness. These fluctuations are important for producing intoned speech and conveying emotion. So as a result of these flattened frequency and intensity contours, people with PD are often misinterpreted as being uninterested or lacking enthusiasm. A number of therapeutic approaches can be employed here, including having the patient read children's books aloud, which often demand intoned speech, and the use of biofeedback tools so that speakers can view and manipulate their fundamental frequency and intensity contours in real time. In addition, vocal quality is often described as horse, harsh and/or breathy, due to underlying issues with respiratory function in laryngeal valving. as clinicians we may also observe faster rates of speech or short rushes of speech, which can further degrade speech naturalness and speech intelligibility. Pausing at non-syntactic boundaries may also be observed due to cognitive and/or respiratory issues. Hypokinetic dysarthria can emerge at any stage of the disease process and often leads to progressive sense of alienation and social isolation.

So we can think of therapeutic options as occurring in three domains, pharmacological, surgical, and behavioral. Many patients with PD are receiving pharmacological management for the motor and non-motor-based disturbances that I previously described. It's important that we're mindful of the patient's medication schedule, as motor fluctuations during what we call medication, oftentimes can present challenges during voice therapy. As previously mentioned, I try to coordinate voice therapy to occur during their optimal medication cycle. In recent years, I have worked with an increased number of patients who have opted for surgical management of their motor symptoms. And surgical management can include deep brain stimulation to the subcortical structures of the brain. At present, the effects of deep brain stimulation on speech are inconsistent.

There was a recent meta analysis of 921 patients with PD who've reported dysarthria as an adverse event under deep brain stimulation to the subthalamic nucleus in 9.3% of patients. The most common speech symptoms that were exacerbated by the DBS procedure include slurred speech, rapid speech rates and festinating speech. Other studies however, have reported either no change in speech function or improvement. So the effects of deep brain stimulation on speech function appears to be related to several factors including the anatomical target, the frequency and the amplitude stimulation, so we really do need additional research to better understand the potential effects of deep brain stimulation on speech. As speech language pathologists, we are trained to provide skilled intervention in the behavioral management of speech and voice symptoms. It's important for us to be aware of the pharmacological and surgical management of motor-based disturbances however, because it may impact indirectly the communication system that we are addressing in therapy. Clinically, the two speech and voice symptoms that are often targeted in therapy are hypophonia, or soft-speaking volume, and we work to normalize speech rate. These therapeutic targets are most likely to improve communication and positively impact listeners perception of speech intelligibility, and speech naturalness. In our clinical management of hypophonia, one of the most important steps in therapy is having patients learn to independently monitor and evaluate their voice production in real time, and then apply the appropriate communication strategy when they perceive that their voice is soft. This act of monitoring changes and speaking volume, however, requires acute sensory and cognitive processes.

The patient must be able to extract, encode, store and process intensity information embedded in the speech signal and then cue themselves to speak at a louder volume. As we have just discussed, however, there was mounting evidence to suggest that individuals with PD have a variety of sensory and cognitive-based disturbances, which include abnormal perception of their own speaking volume. When patients with PD are asked to comment on their speaking volume, they often report that they feel like they're shouting, despite the clinician's observation that they are speaking at a normal volume, or a softer volume. So as we navigate through the various approaches to voice intervention, it's important to keep in mind that our patients will not only present with motor disturbances, but also sensory and cognitive challenges, mental and physical fatigue, and different levels of intrinsic motivation. Some of the treatment programs that we will discuss require access to specially trained clinicians, and this can act as a geographical barrier for some patients. Telepractice rehabilitation models now allow us to reach a broader audience, but this does require some level of technological proficiency on behalf of our clients. Lastly, when designing a voice treatment program, it's important to be mindful of the principles of neural plasticity. So first, we want to be cognizant of the number of trials provided to our patients. We know from research that a high number of repetitions is required to increase synaptic strength, increase the number of synapses and reorganize pathways in the brain. Second, it's important to incorporate emotionally salient tasks because practicing rewarding tasks has been shown to activate basal ganglia circuitry. So we want our clients to be motivated and engaged throughout the therapeutic process. Third is the principle we're all familiar with, use it or lose it. Failure to drive specific brain functions can lead to functional degradation.

And lastly, specificity matters, we want to train the deficits. Now that we have a foundation for the motor, sensory and cognitive challenges associated with PD, we will review some of the behavioral voice interventions for hypophonia, or this decreased speaking volume, that is so common in this clinical population. The approaches discussed, however, do not represent the full breadth of treatment approaches used in clinical practice. So we're gonna begin by talking about the Lee Silverman Voice Treatment program, also known as LSVT LOUD. LSVT LOUD has over 25 years of efficacy data to support its use. LSVT LOUD is an intensive voice treatment program that focuses on a single therapeutic target, and that is louder speaking volume. This approach is most effective when patients have a high level of motivation, a supportive care partner and intact cognition.

The therapy techniques are intended to increase vocal loudness and improve communication effectiveness and speech intelligibility. While initially designed for patients with PD, LSVT LOUD has also shown efficacy with other disorder groups. The LSVT LOUD program is intensive in nature and involves one hour of voice therapy, four days a week for four weeks. It is typically delivered via in-person sessions, but there is an option for LSVT e-LOUD where treatment is delivered using real-time video conferencing. And research has shown that it is as effective as doing all 16 sessions in person at a clinic. Delivery of LSVT LOUD services require certification and maintenance through the parent company LSVT Global. Some of the practical considerations include access to an LSVT-certified clinician, certainly financial resources, in our area, insurance co-pays can range from $20 to $90 per session, and of course, technological proficiency and behalf of our clients for participation in the e-LOUD program. We also want to think about the patient's level of physical and mental fatigue and intrinsic level of motivation, given the intensive nature of the program. So as previously mentioned, LSVT LOUD focuses on production of a louder voice.

The program's mantra is, "Think loud". It's important to note, however, that we don't want our patients to hyper-function, but rather increase vocal loudness so it's at a level that is perceived by others to be within normal limits. LSVT LOUD also focuses on high physical effort to override the muscles' diminished movement and slowness of movement. Early in the course of therapy, the clinician provides direct feedback to help the patient scale the effort needed to perform the tasks during therapy. As treatment progresses, patients are asked to begin to monitor the level of effort they're using to produce louder speech.

This is the sensory calibration piece, and this is particularly important given the sensory challenges associated with PD. In the first half of each treatment session, patients focus on producing a louder volume during a variety of tasks, including sustained vowel formation, production of high and low-pitch glides, and while reading aloud a list of self-generated functional phrases. The second half of each therapy session follows a speech hierarchy, starting early in the course of therapy with phrase and sentence-level stimuli and progressing over the weeks to reading and conversation, maybe its tasks. During therapy, the clinician models appropriate posture, a nice open oral cavity, but he or she does not provide explicit cuing in these areas, and this is done to reduce the cognitive load in the patient. Instead, the clinician provides a simple cue, "Watch me, do what I do." In addition to intensive one-on-one therapy, the patients also complete homework on therapy days and non-therapy days. This is designed to maintain a certain level of motivation and accountability, it also provides adequate time for the skills to be learned and transferred to other environments such as home or work. In addition, LSVT LOUD individualizes treatment exercises to each person's interests and personal goals for improving communication. So in a moment, we're gonna watch a video that shows a patient before and after LSVT LOUD. As you watch the video, pay attention to the client's speech and voice quality before and after therapy, as well as the communication challenges, sorry, described by the patient. Okay, we'll now watch the video.

- [Woman] Have you noticed any changes in your speech or your voice, that you would associate with Parkinson's?

- Yes, I don't speak loud enough a lot of times.

- [Woman] Hmm, anything else?

- Hoarse.

- Uh-huh, anything else?

- I stutter, and which I never did before.

- [Woman] Do this for me, if you would, take a deep breath and say, "Ah," for as long as you can.

- Ah.

- [Woman] Good for you, okay. Would you say Parkinson's disease has caused you to talk less?

- Yes.

- Because?

- Because I stutter and I can't be heard. If there's noise in the house, like when the kids come over, nobody pays attention to me 'cause they can't hear me, till I get mad and then yell.

- [Woman] Take a deep breath and say, "Ah," for as long as you can.

- Ah.

- [Woman] Have you noticed changes in your speech or your voice as a result of the speech therapy?

- Oh, yes.

- What have you noticed?

- I talk louder, I think louder. I'm going to sing with the Sons of the Pioneers one of these days with my voice.

- [Woman] Good for you, that's excellent. What practicing do you do at home?

- My ahs, my highs and my lows, and I read out the mail out loud.

- [Woman] Excellent. Do you feel like practicing helps?

- Oh, yes.

- Okay. Do you feel as though people can understand you all of the time now?

- Majority of the time, unless it's my husband and he says, "What, I can't hear you."

- Good for you.

- But I think he does that just to be cute.

- I think he does, too. Has anyone commented that it's easier to understand you now?

- Oh, yes, I set some of our friends back when we went to their house and I talked loud, Louis says, "What the hell happened to you?" My daughter said, "Oh, Ma, that's you?"

- [Woman] Isn't that good, don't you feel wonderful?

- Oh, yeah because now she can't say, "I didn't understand what you said."

- [Woman] Right, no excuses, right?

- Yeah, no excuses.

- All right, all right. So what do you do when you want to be as easy to understand as possible?

- Think loud.

- [Kelly] Okay, so now let's take a moment to talk about this video. Before treatment, the patient presented with vocal hoarseness and I timed her maximum phonation during the sustained vowel task and it was about seven to eight seconds, which is indicative of two things, reduced breath support, and/or problem with laryngeal valving. In the interview, the patient complains of difficulty being heard, especially when speaking in a noisy environment. This is a challenge commonly reported by persons with PD. She also recognizes her hoarse voice quality and the onset of a neurogenic stutter. She further reports that she talks less due to these communication challenges, she says, "Nobody pays attention to me "'cause they can't hear me." After participating in these 16 individualized LSVT sessions over a four-week period, her maximum phonation time was considerably longer at about 22 seconds.

Her sustained ahs were also produced with a nice open oral cavity which allowed for maximum resonance and it was produced at a louder volume with a really nice clear tonal quality. During conversation, the patient speaks at a louder volume, some of you may need to reach and adjust the volume on your headset, and she also notes that her communication has improved, which is really what we wanna hear at the end of therapy. She reports that she can be more easily heard the majority of the time. She also notes that she continues to practice at home, which is a really important component of any exercise-based therapy program. Okay, now we will return to the slides. So research has shown that a single therapeutic target if increased vocal loudness, can elicit system-wide changes in respiration, phonation and articulation, and we have also seen changes in swallowing function and facial expression. Now, these findings have been replicated across a number of studies, but I've highlighted just a few on the slide and the references for these studies has been provided at the end of the presentation. LSVT LOUD provides several important tools to help patients maintain the benefits that they derive from their individual therapy. Patients can participate in tune-up sessions to reinforce the skills they previously learned in therapy. These are often completed every six months following completion of the LSVT LOUD program. Patients can also purchase the LSVT Companion software, which supports continued home practice and provides immediate feedback on their performance for vocal intensity and pitch range. The Homework Helper videos are also available on DVD, they can also be downloaded, and these promote continued home practice and they provide really nice visual and auditory models of the different exercises that they learn in therapy.

More recently, LSVT has established what's called the LOUD for Life program, which is a community-based exercise class. I just wanna take a moment to note, however, that this maintenance program does not involve skilled service delivery and cannot be submitted for insurance reimbursement. The LOUD for Life program is designed to allow people who have completed the LSVT LOUD program to continue practicing their exercises and louder voices, not just at home by themselves, but also in a group setting with other LSVT LOUD graduates. The LOUD for Life program requires additional clinician certification. Another treatment approach for patients with Hypophonia is the SpeechVive.

The SpeechVive, which is shown here on the screen, is a prosthetic device that is worn in a fashion similar to a behind-the-ear hearing aid. The SpeechVive play sounds in the patient's ear when they're speaking, and when they stopped speaking, the sound turns off. So in this way, the device does not interfere with the person's ability to listen to their communication partner. The SpeechVive uses a built-in accelerometer to detect vibration in the ear canal. Once vibration is detected, the sound will play. To mimic how the accelerometer works in a very rudimentary way, you can place your index finger in your ear canal and count aloud and you will feel the vibration. The SpeechVive is designed to elicit the lumbar effect, which is the phenomenon of automatically speaking louder when talking in a noisy environment. So the SpeechVive mitigates the impact of cognitive decline and voice treatment because the patient is not required to respond in a volitional way. Patients are often instructed to wear the device daily during communication, I also advise patients to read out loud daily for 30 minutes in order to further train the respiratory and laryngeal muscles. At the initial device-fitting, the SLP adjusts the sensitivity of the device so that the sound triggers only when the patient is talking. The amplitude of the sound is also adjusted at this time, so that it elicits the targeted increase in vocal intensity, which is three to five decibels above their baseline speaking volume.

The target increase of three to five decibels is comparable to the treatment gains observed in conversational speech after patients have completed the LSVT LOUD and the SPEAK OUT programs. The process of calibrating the device takes approximately five to 10 minutes using SpeechVive's proprietary software. This leaves time in your therapy session to focus on other areas of impairments, such as cognition. The calibration software also serves as an important tool for tracking the patient's speaking volume over time to ensure continued maintenance. Patients are seen on a as-needed basis for device adjustments, but this is highly individualized and really depends on the needs of your clients.

The SpeechVive can be worn in any environment, and it is appropriate for patients with hearing impairment. I have fit the SpeechVive on bilateral hearing aid users, the patient simply removes their amplification from one ear and wears the SpeechVive device. So LSVT LOUD and the SpeechVive share similar therapeutic goals of increased speaking volume and improved communication. The two voice programs show similar therapeutic outcomes of a three-to-five decibel change in speaking volume during conversation, post treatment. The fundamental difference between the programs is in the form or the type of cuing used in therapy. LSVT LOUD uses implicit cuing where the patient learns to monitor their speech in real time and apply the treatment strategy, Think Loud, independently. The SpeechVive, in contrast, uses an external cue, that noise, to automatically elicit increased speaking volume, thereby circumventing the need for conscious control of vocal intensity. We are now gonna watch a video of a patient wearing the SpeechVive device for the first time.

- [Woman] What bothers you about your speech or your voice?

- I kinda can't no volume. It's because of the the person in the room is not, and my speaking is not clear, it's getting worse. When sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch with its path high above.

- [Woman] Okay, Leo, so I am recording you again, this time with the SpeechVive. Can you just turn your head all the way that way for a moment just I can capture that in your ear? Yep, okay. And I'm gonna have you just read that top paragraph of the "Rainbow" passage, and you can begin.

- When sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of light, white light, into many beautiful colors. These take the shape of a long round arch with its path high above.

- [Kelly] So let's just take a moment to talk about the video. At the beginning of the interview, the patient describes his low speech volume and lack of speech clarity, and once he's fitted with the SpeechVive, there is an immediate noticeable increase in his speaking volume, which, personally for me, greatly enhanced his speech intelligibility. Now we'll return to the slides. So the first SpeechVive study of 39 people with Parkinson's disease demonstrated that 90% of the participants spoke at a louder volume, used more efficient respiratory patterns to support this louder speech volume, and showed improved speech intelligibility and speech rate after wearing the device for eight weeks. These findings have been replicated in several follow-up studies shown on this slide. A recent study examined the long-term effects of the SpeechVive on respiratory and the laryngeal function during speech tasks for individuals with PD. The results indicated that clinical benefits were maintained 24 weeks after completing the eight-week treatment program. In particular, the speakers continue to use a louder volume while talking, they took advantage of higher recoil forces, demonstrating more efficient speech breathing, they also showed a more normalized speech rate and improved laryngeal valving.

The third intervention that we're going to discuss today is SPEAK OUT and The LOUD Crowd. Similar to other voice therapies, this program requires clinician training on individual therapy techniques, this is the SPEAK OUT program, and through a group therapy approach, which is called The LOUD Crowd. Prior to starting SPEAK OUT, patients and their families attend a Parkinson's information session. This is essential for the family to understand basic information about Parkinson's disease, and how speech and swallowing can be impacted. The session highlights the use of speaking with intention to improve communication. The goal of the intense instruction is to activate voluntary effort for verbal communication.

The basic format of the speaker program includes 12 one-on-one sessions administered by a certified speech language pathologist over four weeks. The program takes a criteria-based approach to achieve the desired intelligibility basing the number of sessions on each person's individual progress throughout the program. To facilitate maintenance and establish a home practice routine, patients are seen for a six-week follow-up. Since Parkinson's disease is progressive and degenerative in nature, daily home practice and continuous follow-up is crucial for maintaining the improvements achieved in any kind of therapy. After completing the SPEAK OUT program, each participant is assigned to a weekly group therapy program called The LOUD Crowd. The LOUD Crowd intends to provide social opportunity, as well as an opportunity to maintain the improved speech and voice quality achieved by the SPEAK OUT sessions.

Participation in The LOUD Crowd involves weekly group sessions where the individuals practice SPEAK OUT exercises. Participation in group-based exercises helps to facilitate maintenance of the therapeutic gains in a supportive environment. In addition, patients can continue to meet with trained clinicians every six months to evaluate their progress. There is growing evidence base that cites a number of clinical improvements following participation in the SPEAK OUT program. The post-treatment benefits include increased vocal intensity or increased speaking volume, an increase in pitch range and sustained vowel duration, improvements in reading intelligibility, and patient reports of voice-related quality of life have also been documented. Studies have also shown improvements in dysphonia severity.

The authors had used a relatively new metric called the Acoustic Voice Quality Index, also known as the AVQI, which is a multi-variant method to measure or assess dysphonia severity. The AVQI is unique in that it uses both continuous speech tasks and sustained vowel phonation in order to drive an estimate of overall voice quality. We are seeing the AVQI increasingly being utilized in clinical and research practices to determine overall voice severity. Long-term data show treatment gains of increased speaking volume were maintained at six-month and 12-month follow-ups. Although these current evidence-based treatment approaches have been shown to foster significant improvements in functional communication for many patients with PD, not all patients respond favorably to treatment.

There are several important barriers to treatment that warrant consideration, and these include disease severity, the financial cost of the proposed treatment program, the intensity of service delivery due to issues with physical and mental fatigue, and access to a clinician certified in the proposed therapy technique. Having a breadth of treatment programs available to patients is important because our clinical practice necessitates the use of customized treatment plans that meet the complex communication needs of patients and their families. There has been growing interest in the use of choral singing programs to help reduce the speech and voice symptoms associated with PD and to reduce the psychosocial effects of the disease, 'cause we have learned that a lot of individuals with Parkinson's disease report social isolation. Support for the use of choral singing has been shown in brain-imaging studies, which have documented overlapping neural networks for the physical acts of speaking and singing.

The shared neural networks include the inferior pre and postcentral gyrus, the superior temporal gyrus, and the superior temporal sulcus, which provides evidence of shared neural systems for sensory motor control and feedback during speech and singing. Although the precise neuroanatomical changes associated with choral singing intervention are not well-understood, researchers have speculated that the rhythmic-based cues associated with singing improve the timing and the output of the motor system. So, for example, the use of rhythmic auditory cues, such as a metronome, have been shown to immediately improve gait performance in some persons with PD.

So in Parkinson's disease, the dysfunctional basal ganglia cortical circuitry that we've just talked about earlier in this webinar is associated with timing distortions in the perception and the production of rhythmic events. So providing an external rhythmic cue may compensate for the impaired internal generation of rhythm. There are several other additional benefits to singing which I wanna take a moment to highlight. During the act of singing, we tend to sit more upright, we naturally project our voices at a louder volume, the act of singing also involves a lot of modulation or fluctuations in pitch, and we also focus quite heavily on breath control. The act of singing involves relative strong and fast inspirations, followed by extended regulated expirations. So singing requires breathing to be regulated in order to help sustain the notes. Singing also indirectly works on attention and memory processes, because patients learn the lyrics with repetition over time. It's also provides a important social outlet for a group of patients who are known to report social isolation as a result of the disease. The use of choral singing as a speech rehabilitation tool has been reported in treatment studies involving patients with nonfluent aphasia, traumatic brain injury, autism spectrum disorder, apraxia speech, and fluency impairment. To date, however, few studies have examined the clinical benefit of choral singing for persons with PD. The few studies available include a variety of therapeutic singing protocols, treatment durations and outcome measures, which makes it difficult to support or generalize their findings. In 2001, Haneishi developed a Music Therapy Voice Protocol, referred to as MTVP, which consists of vocal warm-ups and singing exercises.

And he studied this technique in a relatively small group of patients with PD. After 12 to 14 choral singing sessions, he found that the patients with PD showed significant increases in speech intelligibility, and vocal intensity. And more recently developed singing protocol used singing chants with piano accompaniment, to enhance auditory rhythmic stimulation. Their protocol also involved a series of prosodic, respiratory and laryngeal-based exercises. After 13 sessions of choral singing, the authors reported that the patients with PD showed improvements in vowel phonation and reading. Despite the relatively small sample sizes and the uncontrolled nature of the studies, the results indicate that singing may help reduce some of the speech and voice problems associated with Parkinson's disease.

Future research though, we should really focus on dose effects, we don't know the optimal number of sessions that would be beneficial for our patients, and we really need to have randomized control trials to determine the efficacy of these interventions. A review of the choral singing literature shows several clinical outcomes for persons with PD which I'm gonna take a moment to highlight. These include increased vocal intensity during singing, reading and conversational speech, he also showed increased pitch accuracy and vocal range, and greater tongue excursion during vowel articulation, as reflected by an increased vowel-space area post treatment. In addition, patients reported improvements in speech intelligibility. As an emerging area of study, however, the reported data on therapeutic singing are still highly variable. Despite the reported benefits that I just outlined, other studies have reported no treatment-related changes in vocal intensity, pitch range, maximum phonation time, maximum loudness, or voice-relate quality of life after participating in 12 90-minute choral singing sessions. For the last three years, my colleagues and I have been running a choral singing group in our community in western Massachusetts for patients with neurological impairment.

And at present, about 50% of our group consists of patients with PD. Many of these patients have completed individualized voice therapy programs, and they use the choral singing group to continue exercising their voice in what they perceive to be a safe space. One of the greatest benefits reported by our choral members is improved quality of life. And that is a metric that is not fully captured in these reported studies. They also report a strong sense of community and a safe space to practice using their voice among people with similar challenges.

The speech of P, sorry, the speech of people who have Parkinson's disease is often difficult to understand because the individual speech sounds are not made very clearly or precisely. Thus, clear speech is another treatment approach for patients with hyperkinetic dysarthria. Common instructions for eliciting clear speech include speak clearly, hyper-articulate, speak to someone as if they have a hearing impairment and speak to someone who has difficulty understanding you. These various instructions all aim to emphasize articulatory placement and increased precision. Other methods of clear speech instruction are shown on the slide and they may include things like instruction to say all sounds clearly and firmly to make firm lip contact for those oral and nasal bilabial plosives, to explode the T, D and K, G sounds and to pause between words, and remember to keep your vocal loudness up. With clear speech, initial practice is encouraged at the word level before progressing to short phrases, sentences, of course, and paragraphs and conversational speech. I just want you to be mindful of the attention and memory challenges that we've talked about, it's important that the length and complexity of the clear speech instructions is considered in that context. The initial studies of clear speech benefit have been studied in healthy adults. When healthy individuals were cued to speak clearly, they showed a slower rate of speech an increase in the frequency and duration of pauses, increased pitch, increased speaking volume, and greater tongue movement during production of vowels, as reflected by expansion of vowel space area.

These studies of clear speech on healthy individuals provides important baseline metrics for comparison against other groups. Many studies have been devoted to looking at the clear speech benefit for hearing-impaired speakers with reduced speech clarity. This line of research suggests that the instruction to speak more clearly can increase speech intelligibility by 17 to 26% in hearing-impaired speakers, this is what we call the clear speech benefit. Similar clinical outcomes have been reported for persons with PD.

Clear speech strategies have yielded decreases in speaking rate, an increase in fundamental frequency during speaking, improve speech intelligibility, and increased speaking volume, which is always one of our prime therapeutic targets. So, again, we are seeing the system-wide changes in respiration, phonation, and articulation with delivery of a simplified cue to speak clearly. The final therapy approach that I will highlight is the use of altered auditory feedback. This is the process of manipulating the sound of a speaker's voice before they hear it. Altered auditory feedback can fall under two domains, there's delayed auditory feedback, and frequency-shifted feedback. With delayed auditory feedback, the speech signal is processed and amplified with a very subtle or short time delay, often ranging from 50 milliseconds to 200 milliseconds. When a person hears his or her speech played back with a short time delay, they tend to naturally slow down their rate of speech. So this can be a useful clinical tool for patients with cognitive decline, who are unable to accurately self-monitor and self-regulate their speech. And it's also been shown to have some clinical benefit for patients with a neurogenic stutter, such as people with Parkinson's disease. With frequency-altered feedback, the person hears his or her speech played back with a slight shift up or shift down in fundamental frequency. This creates a choral speaking condition, which can elicit more fluent speech. So again, it can be a therapeutic technique you use for somebody with a neurogenic stutter. SpeechEasy is one tool to help speakers with PD speak at a slower rate and increase their fluency. There are also a number of free or low-cost apps that can simulate delayed and frequency-shifted feedback conditions. So before exploring a device with patients, I often have them wear headphones and I manipulate their speech by introducing a time delay or frequency shift, to see how their speech responds. I'd like to thank you for participating in today's webinar, and I welcome any questions that you have at this time.

- [Amy] Thank you, Kelly. I'm taking a look at the Q&A pod right now, and Marsha is asking, "Is there a correlation "between dopaminergic versus non-dopaminergic involvement "and the development of dementia in Parkinson's patients?"

- [Kelly] You know what, that is an excellent question and not one that I can answer 'cause there is Lewy body dementia, which was not covered in today's talk, and it has slightly different underlying pathological processes than the condition we talked about today, which is idiopathic PD.

- [Amy] Good job, okay, thank you. Here's another question asking if Medicare reimburses for LSVT LOUD for the 16 sessions that are recommended.

- [Kelly] Oh, because my research is done clinically in a lab, I usually have funding and we don't go through insurance agencies. I wish my colleague was here 'cause she'd be able to answer that question. I apologize, I'm not sure about insurance reimbursement or Medicaid funding for the LSVT program.

- [Amy] Okay. And here's somebody asking if these protocols are used only with adults, or might they be applicable for teens or younger? I know that this type of Parkinson's isn't typical in a younger person, but maybe for similar speech issues.

- [Kelly] Yeah, I know that the LSVT LOUD protocol has been tested and reported in the pediatric population, primarily children with cerebral palsy, and the researchers have noted significant clinical gains in the pediatric population, but you're right, a lot of the programs I presented today have been designed for later onset Parkinson's disease where we typically see a diagnosis after 60 years of age. So I don't know if any of the other protocols that I talked about, I don't believe the SpeechVive has been looked at, or explored in pediatric populations. I'm not sure about the SPEAK OUT protocol.

- [Amy] Okay. All right, we have somebody asking, "What apps are you using "for the delayed auditory feedback and frequency shifting?"

- [Kelly] That is a great question. I have in front of me, so I use, it's called DAF Professional. There is a free--

- I'm gonna put a little notes pod up on the screen. Would you mind to type the name in there?

- [Kelly] Absolutely.

- [Amy] And that way, it'll be sort of recorded for those who are interested. Thank you so much.

- [Kelly] I like because they have a free version and then they do have a version with few more features that you can elect to purchase. I use the free version and allows me to manipulate pitch, as well as introduce a temporal delay, and I can also record the speaker and play it back so that they can hear the change in their speech.

- [Amy] All right, so we have a comment here about the woman that you showed in the video, which was so great, about pre and post LSVT LOUD. And what a huge change she seemed to have in her affect in addition to her speech and the audience member is wondering if you see that often, that might be something of a reflection of the, gosh, just patients' perceived changes as opposed to just strictly intelligibility measures as well.

- Yes, I can say that I have seen it and a lot of patients will tell me at the end of LSVT LOUD therapy, that they're more in tune with their body and where their muscles or their organs are positioned in space. And so I often find that they are more expressive at the end of therapy 'cause we spend so much time working on that articulatory posture in that nice open oral cavity that we often do see those unintended changes.

- [Amy] All right. I was wondering, you kind of touched on this with the choral singing piece that you said you had looked at, I guess, like patient satisfaction and so forth, and I noticed that a lot of the studies that are mentioned, they're very much about vocal intensity or perceived speech intelligibility, or whatever, but I'm curious if very many researchers out there are looking at life-participation type aspects of outcomes.

- [Kelly] Yeah, that's a really important area to focus on. I find a lot of research studies involve a questionnaire focused on quality of life or communication effectiveness, but in my conversations with these patients, before and after therapy, they often feel that these inventories don't do a great job of capturing some of those psychosocial benefits that they've received in voice therapy.

- [Amy] Exactly. Excuse me. So we have somebody else here asking how you deal with a couple of issues that you might see in Parkinson's patients, festinating speech and neurogenic stuttering.

- [Kelly] Yeah, I find, in working with those two conditions, it can be very challenging to address it behaviorally. This is when I often pull up my phone and put headphones on the patient and use one of my delayed auditory or altered auditory feedback apps to see if it helps. I have worked with other clinicians that have used pacing as a strategy to slow their rate which can increase verbal fluency, but again, it really depends on the presentation of the symptoms. Some patients don't have the cognitive control or presence to make that voluntary manipulation in speech rate.

- [Amy] This is sort of a good segue. The next question is from somebody who's talking about how a lot of her patients are not very tech savvy, and they have trouble with small print, and have difficulty using just devices in general and have neurogenic stuttering so she was asking about rate control, and, pacing boards then, perhaps, might be an option or, you have any thoughts on that?

- [Kelly] Yeah, pacing boards. I've worked with a clinician in our community that put a red band, like elasticized band, around the patient's wrist, and that was to remind them to pace and he would tap his finger on the red band to count out the syllables or the words. The SpeechEasy device that I mentioned in my presentation also has different models available, so they do have a completely in the ear canal, which requires more manual dexterity, but they also do have larger devices that fit over the ear like a behind-the-ear hearing aid for people with any dexterity issues. I also like to involve caregivers or care partners in the therapeutic process and teach them how to use some of these strategies so they can provide that assistance, 'cause you're right, manual dexterity is something that we commonly see as an issue in therapy.

- [Amy] Great. Someone was asking what kind of songs you use in the choral singing program?

- [Kelly] Yeah, well, I leave it up to the choral director. She basis that on really, I'm gonna say the range of experience 'cause we don't require any singing experience to participate in our choir, so we have a wide range of abilities. So she starts with songs that are a little bit more familiar, like "Edelweiss" with simplified lyrics. We've learned a lot in the three years that we've been running the choral group. We initially would present the lyric, the sheet music, but the type was so small and patients had a hard time deciphering the notes or parsing of the notes from the text, so we started to type out the lyrics using a larger fonts, and really picking songs that don't impose a lot of cognitive load. So simplified songs, a lot of chants, things that they would be familiar with.

- [Amy] Sure. All right, I'm gonna throw one more question at you. We have had so many good ones, and then I think we're gonna need to wrap up, but someone was asking, they work in a facility where typically the person is gonna be there for, or has funding for four weeks, and is it okay to initiate LSVT or is it going to, I guess, compromise the efficacy if you're not able to complete the entire program?

- [Kelly] Yeah, LSVT is designed to be an intensive exercise-based voice therapy program so it's really important to get those four sessions in a week for four weeks. So it might be, given those constraints, look at other voice therapy alternatives.

- [Amy] Okay, right, good. Well, I'm afraid we're gonna have to wrap it up here everyone 'cause we're about five over and I know that people have time constraints. So I wanted to thank you so much, Kelly, for being here with us today and presenting this information, it's really very useful and I loved the videos because it's reason for hope for some positive outcomes, I think. And thanks to our audience as well, I appreciate you being here and asking a lot of really interesting and insightful questions. So I hope that everybody has a wonderful Thanksgiving. We hope to see you back again at a webinar before too long. And I will go ahead and wrap things up here. Thank you, everybody.

- [Kelly] Thank you, Amy.