Clinical Practice Guideline: **Stuttering Devices and Altered Auditory Feedback (AAF) Devices**

Date of Implementation: **June 22, 2017**

Product: **Specialty**

Related Policies:
CPG 165: Autism Spectrum Disorders
CPG 166: Speech-Language Pathology/Speech Therapy Guidelines
CPG 257: Developmental Delay Screening and Testing

GUIDELINES

American Specialty Health– Specialty (ASH) considers altered auditory feedback (AAF) devices as unproven for the treatment of stuttering.

HCPCS Codes and Descriptions

HCPCS Code	HCPCS Code Description
E1399	Durable medical equipment, miscellaneous

BACKGROUND

Stuttering impacts speech fluency. It is a disturbance in the normal fluency and time patterning of speech and is characterized by disruptions in the production of speech sounds (e.g., frequent repetitions or prolongations of speech sounds, syllables, or words, or by an individual's inability to start a word), which are called disfluencies. Normal disfluencies characterized by occasional whole word repetitions are not problematic, but if they occur often within a single sentence, they can be disruptive to communication. Developmental stuttering is the most common form, and it begins between the age of 2 and 5 years. Preschool children may often have a period of normal disfluencies; however it is transient, and most children recover with or without therapy before 7 years of age. Persistent developmental stuttering is developmental stuttering that has not undergone spontaneous or therapy-related remission. Acquired stuttering in a previously fluent individual is less common than developmental stuttering and may be neurogenic resulting from brain damage associated with conditions such as traumatic brain injury, Alzheimer's disease, and Parkinson's disease. Psychogenic stuttering is also recognized following emotional trauma.

The exact cause of stuttering is unknown. Proposed etiologies include abnormal cerebral dominance with differences in regional brain activation patterns in regions of the brain that modulate verbalization. A genetic component has also been reported. It has been noted that those individuals who stutter inherit traits that increase their risk of developing a disfluency of speech. But these traits are yet to be determined. Impairment of muscle coordination to string together words fluently may also be present. The growing consensus is that many factors influence stuttering. Current theories suggest that it arises due to a combination of several genetic and environmental influences. Some elements currently being examined include motor skills, language skills, and temperament. It is presumed that a child experiences disruptions in speech production due to an interaction among these (and presumably other) factors (Yaruss, 2024). Presently there is no cure for stuttering. Standard treatments involve speech therapy with variable interventional approaches. Many programs for persistent stuttering focus on relearning how to speak or behavior modification, such as breathing through the words, changing the timing of speech (e.g., slowing down, stretching out sounds) or reducing physical tension during speaking (e.g., gentle onsets of speech movement). Comprehensive treatment approaches focus on improving the speaker's attitudes toward communication and diminishing the negative impact of stuttering on the individual's life. In this case, for children, treatment often includes educating parents about restructuring the child's environment to reduce episodes of stuttering. In some cases, medications are used. A speech evaluation is recommended for children who stutter longer than three to six months (NIDCD, 2017). For older children and adults, treatment options include training to change speech patterns, counseling to minimize negative reactions, pharmaceutical interventions, and electronic devices that enhance fluency. Self-help and support groups also play a prominent role in recovery for many people who stutter (Yaruss, 2024).

In most cases, stuttering has an impact on at least some daily activities, which will vary by individual. In certain cases, these difficulties may only happen during specific activities, like speaking in front of large audiences. For most others, however, communication difficulties occur across a number of activities at home, school, or work. Given this, often individuals will limit their participation in certain activities due to embarrassment or concern for reactions to their stuttering, including teasing. Other maladaptive behaviors include hiding their disfluent speech from others by rearranging the words in their sentence (circumlocution), pretending to forget what they wanted to say, or declining to speak. Other people may find that they are excluded from participating in certain activities because of stuttering. The impact of stuttering on daily life can be enormous based on how the affected person and others react to the disorder.

Researchers have suggested that stuttering is caused by an auditory dysfunction. There is strong evidence that dysfunctions in auditory cortical brain regions may contribute to stuttering. Therefore, altered auditory feedback (AAF) devices have been proposed and investigated as a treatment method. The underlying mechanisms that enhance fluency under AAF have not been identified. Many theories have been proposed such as distraction, auditory malfunctioning, or modified vocalization. The rationale for AAF comes from the observation that individuals who stutter tend to become more fluent when speaking in unison with others – the so-called "choral effect." AAF attempts to emulate the choral effect by allowing the user to hear one's own voice with a slight time delay or a pitch shift which is said to create the illusion of another individual speaking at the same time. These types of auditory feedback enable vocal awareness and control, immediately reduce stuttering, with no training or mental effort. The user's voice sounds natural. A person will don headphones/earpieces and talk. These devices use auditory feedback via an earpiece worn in or behind the ear, and utilize, alone or in combination, the following techniques: Delayed auditory feedback (DAF) delays the user's voice to their headphones a fraction of a second (adjustable and in the 25-250 millisecond range); Frequency-shifted auditory feedback (FAF) alters the pitch of the user's voice in his or her ears via headphones; and/or Laryngeal auditory feedback (LAF) or masking auditory feedback (MAF) synthesizes a sine wave that imitates vocal fold vibration which facilitates the fluency of speech. The masking sound is triggered by a laryngeal microphone and played back to the user via an earpiece. The device then electronically alters the signal into a buzzing sound, to sound more like the individual's actual vocal fold vibration.

Stuttering Devices

There are several stuttering devices on the market. Herein briefly describes a sampling of devices. The SpeechEasy device utilizes DAF and FAF to recreate and optimize the choral effect. The device is worn like a traditional hearing aid. When wearing a SpeechEasy device the user's words are digitally replayed in their ear with a very slight delay and frequency modification, which creates the illusion of speaking in unison with another person. This reportedly reduces stuttering in some individuals. Auditory feedback provided by the Fluency Master anti-stuttering device involves the use of a small microphone placed near the larynx of the user. The microphone detects vocal tone vibrations which are amplified and sent to the user's earpiece. It is proposed that the amplification of vocal tone by the Fluency Master helps to control stuttering and improve fluency. The Pocket Speech Lab utilizes all three types of AAF. In addition, vocal tension biofeedback analyzes the voice frequencies and amplitudes of the user. A green light indicates vocal relaxation and changes to red with increased vocal tension. This technique aims to train the user to speak with relaxed breathing and control of the muscles involved in speech. The Basic Fluency System uses DAF and FAF. SmallTalk uses DAF and FAF as well.

EVIDENCE REVIEW

Lincoln et al. (2006) reviewed journal papers from the previous 10 years that investigated the effect of AAF during different speaking conditions, tasks, and situations. A review of research indicates that literature exists on the effect of AAF on the speech of people who stutter; however, critical knowledge about the effect of AAF during conversational speech and in everyday speaking situations is missing. Knowledge about how to determine the correct levels of AAF for individuals, and the characteristics of those likely to benefit from AAF, also needs to be established. Authors conclude that there is no reason to accept a suggestion that AAF devices would be a defensible clinical option for children. In general, device development and availability has occurred at a faster pace than clinical trials research. Armson et al. (2006) studied the effect of SpeechEasy on stuttering frequency during speech produced in a laboratory setting. Thirteen adults who stutter participated. Stuttering frequencies in two baseline conditions were compared to stuttering frequencies with the device fitted according to the manufacturer's protocol. Examination of individual response profiles revealed that although stuttering reduced in the device compared to the baseline conditions during at least one of three speech tasks for most participants, degree and pattern of benefit varied greatly across participants.

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Armson and Kiefte (2008) studied the effect of SpeechEasy on stuttering frequency, speech rate, and speech naturalness. Thirty-one subjects participated in the study. Speech measures were compared for samples obtained with and without the device in place in a dispensing setting. Mean stuttering frequencies were reduced by 79% and 61% for the device compared to the control conditions on reading and monologue tasks, respectively. Despite dramatic reductions in stuttering frequency, mean global speech rates in the device condition increased by only 8% in the reading task and 15% for the monologue task, and were well below normal. Further, complete elimination of stuttering was not associated with normalized speech rates. Nevertheless, mean ratings of speech naturalness improved markedly in the device compared to the control. Authors conclude that these results show that SpeechEasy produced improved speech outcomes in an assessment setting. However, findings raise the issue of a possible contribution of slowed speech rate to the stuttering reduction effect, especially given participants' instructions to speak chorally with the delayed signal as part of the active listening instructions of the device protocol. Study of device effects in situations of daily living over the long term is necessary to fully explore its treatment potential, especially with respect to long-term stability. O'Donnell et al. (2008) examined the effects of SpeechEasy on stuttering frequency in the laboratory and in longitudinal samples of speech produced in situations of daily living (SDL). Only 7 adults who stutter participated in the study. For each participant, speech samples recorded in the laboratory and SDL during device use were compared to samples obtained in those settings without the device. All seven participants exhibited reduced stuttering in self-formulated speech in the Device compared to No-device condition during the first laboratory assessment. In the second laboratory assessment, four participants exhibited less stuttering and three exhibited more stuttering with the device than without. In SDL, five of seven participants exhibited some instances of reduced stuttering when wearing the device and three of these exhibited relatively stable amounts of stuttering reduction during long-term use. Five participants reported positive changes in speaking-related attitudes and perceptions of stuttering. Further investigation into the short- and long-term effectiveness of SpeechEasy in SDL is warranted.

Saltuklaroglu et al. (2009) examined how AAF and choral speech differentially enhance fluency during speech initiation and in subsequent portions of utterances. Ten participants who stuttered read passages without altered feedback (NAF), under four AAF conditions and under a true choral speech condition. Results showed that on average, AAF reduced stuttering by approximately 68% relative to the NAF condition. Stuttering frequencies on the initial syllables were considerably higher than on the other syllables analyzed (0.45 and 0.34 for NAF and AAF conditions, respectively). After the first syllable was produced, stuttering frequencies dropped precipitously and remained stable. However, this drop in stuttering frequency was significantly greater (approximately 84%) in the AAF conditions than in the NAF condition (approximately 66%) with frequencies on the last nine syllables analyzed averaging 0.15 and 0.05 for NAF and AAF conditions, respectively. In the true choral speech condition, stuttering was virtually (approximately 98%) eliminated across all utterances and all syllable positions. Authors concluded that altered auditory feedback effectively inhibits stuttering immediately after speech has been initiated. However, AAF requires speech to be initiated by the user and 'fed back' before it can directly inhibit stuttering. It is suggested that AAF can be a viable clinical option for those who stutter and should often be used in combination with therapeutic techniques, particularly those that aid speech initiation. Small sample size is a weakness of the study.

Lincoln et. al (2010) investigated the impact on percentage of syllables stuttered of various durations of delayed auditory feedback (DAF), levels of frequency-altered feedback (FAF), and masking auditory feedback (MAF) during conversational speech. Eleven adults who stuttered produced 10-min conversational speech samples during a control condition and under 4 different combinations of DAF, FAF, and MAF participated. Participants also read aloud in a control condition with DAF and FAF. Authors concluded that participants' varying responses to differing AAF settings likely accounted for the failure to find group differences between conditions. These results suggest that studies that use standard DAF and FAF settings for all participants are likely to underestimate any AAF effect. It is not yet possible to predict who will benefit from AAF devices in everyday situations and the extent of those benefits. The results are somewhat mixed and there is minimal data on its effect on everyday social fluency.

Unger et al. (2012) investigated the immediate effects of altered auditory feedback (AAF) and on Inactive Condition (AAF parameters set to 0) on clinical attributes of stuttering during scripted and spontaneous speech. Two commercially available, portable AAF devices were used to create the combined delayed auditory feedback (DAF) and frequency altered feedback (FAF) effects. Thirty adults, who stutter, aged 18-68 years (M=36.5; SD=15.2), participated in this investigation. Each subject produced four sets of 5-min of oral reading, three sets of 5-min monologs as well as 10-min dialogs. These speech samples were analyzed to detect changes in descriptive features of stuttering (frequency, duration, speech/articulatory rate, core behaviors) across the various speech samples. A statistically significant difference was found in the frequency of stuttered syllables during both Active Device conditions for all speech samples, with the greatest reduction occurring with scripted speech. During the Inactive Condition those participants within the moderate-severe group showed a statistically significant reduction in overall disfluencies. This result indicates that active AAF parameters alone may not be the sole cause of a fluency-enhancement when using a technical speech aid.

Gallop and Runyan (2012) examined long-term effectiveness by examining whether effects of the SpeechEasy were maintained for longer periods, from 13 to 59 months. All participants were interviewed via telephone for approximately 30 minutes (15 minutes wearing the device and 15 minutes without the device). The authors found that time did not have a significant effect on stuttering frequency. Results indicated no significant change for the seven device users from post-fitting to the time of the study; however, findings varied greatly on a case-by-case basis. There was no significant difference in stuttering frequency when users were wearing versus not wearing the device currently. This study was limited by the lack of a control group and the small sample size. Ratyńska et al. (2012) assessed the immediate dysfluency reduction after use of the Digital Speech Aid (DSA). The DSA is a pocket-sized device used for speech correction in stutterers which modifies the patient's auditory feedback with the use of Delayed Auditory Feedback (DAF) and Frequency-shifted Auditory Feedback (FAF). The study included 335 patients aged 6-64 years with speech disfluency. For all speaking situations, statistically significant improvement was achieved. Immediate fluency improvement was observed in 82.1% of patients during reading, in 84.5% during dialogue, and in 81.2% during monologue. Values different from placebo (reliable improvement) were obtained in 66.9% of patients during reading, in 66.6% during dialogue, and in 63.9% during monologue. Authors concluded that the DSA is an effective tool for immediate dysfluency reduction in stutterers. No long-term evidence was noted, and methodologic limitations existed, so results should be interpreted with caution.

A study by Foundas and colleagues (2013) reported on 14 individuals who stutter and used the SpeechEasy® device and compared them to a control group of 10 individuals. The SpeechEasy is an electronic device designed to alleviate stuttering by manipulating auditory feedback via time delays and frequency shifts. Device settings (control, default, custom), ear-placement (left, right), speaking task, and cognitive variables were examined in people who stutter (PWS) (*n*=14) compared to controls (*n*=10). Among the PWS there was a significantly greater reduction in stuttering (compared to baseline) with custom device settings compared to the non-altered feedback (control) condition. Stuttering was reduced the most during reading, followed by narrative and conversation. For the conversation task, stuttering was reduced more when the device was worn in the left ear. Those individuals with a more severe stuttering rate at baseline had a greater benefit from the use of the device compared to individuals with less severe stuttering. Authors conclude that their results support the view that overt stuttering is associated with defective speech-language monitoring that can be influenced by manipulating auditory feedback. However, study groups remain small and there is little to no data on the long-term use of these devices, and no data to support that fluency would persist following discontinuation of the device. Larger prospective randomized controlled studies are required to demonstrate the effectiveness of AAF for everyday communication and fluency compared both to no treatment and to other forms of established therapy.

Ritto et al. (2016) studied the effectiveness of a device delivering AAF (SpeechEasy®) was compared with behavioral techniques in the treatment of stuttering in a randomized clinical trial. Two groups of adults who stutter participated. Participants in group 1 were fit with a SpeechEasy® device and were not given any additional training (i.e., supplementary fluency enhancing techniques). Participants used the device daily for 6 months. Participants in group 2 received treatment in the form of a 12-week fluency promotion protocol with techniques based on both fluency shaping and stuttering modification. Results noted that there were no statistically significant differences ($p > .05$) between groups in participants' stuttered syllables following treatment. That is, both therapeutic protocols achieved approximately 40% reduction in number of stuttered syllables from baseline measures, with no significant relapse after 3- or 6-months post-treatment. Authors conclude that results suggest that the SpeechEasy® device can be a viable option for the treatment of stuttering.

Johnson et al. (2020) aimed to address the extent to which integrative deficits occur outside of conduction aphasia and how this manifests behaviorally in areas other than speech repetition by examining the behavioral correlates of speech sensorimotor impairment under altered auditory feedback (AAF) and their relationship with the impaired ability to independently correct for online errors during picture naming in people with aphasia. Authors found that people with aphasia generate slower vocal compensation response to pitch-shift AAF stimuli compared with controls. However, when the timing of responses was controlled for, no significant difference in the magnitude of vocal pitch compensation was observed between aphasia and control groups. Moreover, no relationship was found between self-correction of naming errors and the timing and magnitude of vocal compensation responses to AAF. These findings suggest that slowed compensation is a potential behavioral marker of impaired sensorimotor integration in aphasia.

Almudhi (2021) reviewed three variables that impact stuttering treatment. The first section discussed the usage of technological devices in stuttering treatment, specifically the scan device suggested to facilitate and improve the pace of expression and reduce dysfluencies in conversation and structured tasks. DAF techniques have proven efficacy related to delayed time, intensity, and delivery mode. Metronome pacing was also reviewed and shown to be effective in-patient self-monitoring and control of dysfluencies. The second section discusses the benefits of telehealth as a means of providing services to people with stuttering. The third part of the analysis reviews the clinical benefits of apps. The research review concluded stuttering therapy has evolved with the use and benefit of telehealth and apps for increased self- control and flexibility promoting consistency. The use of devices noted to have been available and patient specific with variable success and carryover.

Fiorin et al. (2021) aimed to verify the impact of auditory feedback modifications on the spontaneous speech of individuals with stuttering. Sixteen individuals of both genders, aged 8-17 years and 11 months, with a diagnosis of persistent neurodevelopmental stuttering, were divided into two groups: Moderate Stuttering Group and Severe Stuttering Group. The testing procedures consisted of three stages: collection of identification data, audiological assessment, and fluency evaluation of spontaneous speech in four auditory feedback conditions (non-altered, delayed, masked, and amplified). The speech sample obtained in the non-altered feedback was considered the control; the others were considered as modified listening conditions. Regarding the stuttering-like disfluencies, a statistically significant difference was observed in the intragroup analysis of the Moderate Stuttering Group between non-altered and masked auditory feedback, as well as between non-altered and amplified. There was a statistically significant difference in the Severe Stuttering Group for all auditory feedback modifications in relation to the non-altered auditory feedback. There was also a reduction in flows of syllables and words-per-minute in the Moderate Stuttering Group for the delayed auditory feedback, as compared to non-altered. Authors concluded that the effect of delayed auditory feedback was favorable for the Severe Stuttering Group, promoting speech fluency. The conditions of masked and amplified auditory feedback resulted in speech benefits in both groups, decreasing the number of stuttering-like disfluencies. The speech rate was not impaired by any listening condition analyzed.

Chon et al. (2021) tested whether adults who stutter (AWS) display a different range of sensitivity to delayed auditory feedback (DAF). Two experiments were conducted to assess the fluency of AWS under long-latency DAF and to test the effect of short-latency DAF on speech kinematic variability in AWS. In experiment 1, 15 AWS performed a conversational speaking task under non-altered auditory feedback and 250-ms DAF. In experiment 2, 13 AWS and 15 adults who do not stutter (AWNS) read three utterances under four auditory feedback conditions: non-altered auditory feedback, amplified auditory feedback, 25-ms DAF, and 50-ms DAF. Across-utterance kinematic variability (spatiotemporal index) and within-utterance variability (percent determinism and stability) were compared between groups. In Experiment 1, under 250-ms DAF, the rate of stuttering-like disfluencies and speech errors increased significantly, while articulation rate decreased significantly in AWS. In Experiment 2, AWS exhibited higher kinematic variability than AWNS across the feedback conditions. Under 25-ms DAF, the spatiotemporal index of AWS decreased significantly compared to the other feedback conditions. AWS showed lower overall percent determinism than AWNS, but their percent determinism increased under 50-ms DAF to approximate that of AWNS. Authors concluded that auditory feedback manipulations can alter speech fluency and kinematic variability in AWS. Longer latency auditory feedback delays induce speech disruptions, while subtle auditory feedback manipulations potentially benefit speech motor control. Both AWS and AWNS are susceptible to auditory feedback during speech production, but AWS appear to exhibit a distinct continuum of sensitivity.

Frankford et al. (2022) aimed to identify whether external timing cues, which increase fluency, resolve auditory feedback processing disruptions. Literature has shown that adults who stutter (AWS) have reduced and delayed responses to auditory feedback perturbations. These studies suggest that during sensorimotor tasks like speech, AWS exhibit processing delays and/or reduced scaling of corrective movements in line with the sensorimotor theories. This study included 15 AWS and 16 adults who do not stutter (ANS) read aloud a multisyllabic sentence either with natural stress and timing or with each syllable paced at the rate of a metronome. On random trials, an auditory feedback formant perturbation was applied, and formant responses were compared between groups and pacing conditions. During normally paced speech, ANS showed a significant compensatory response to the perturbation by the end of the perturbed vowel, while AWS did not. In the metronome-paced condition, which significantly reduced the disfluency rate, the opposite was true: AWS showed a significant response by the end of the vowel, while ANS did not. These findings indicate a potential link between the reduction in stuttering found during metronome-paced speech and changes in auditory motor integration in AWS supporting the technique of controlled external timing to improve fluency.

Coughler et al. (2022) identified and described the full range of studies investigating responses to frequency altered auditory feedback in pediatric populations and their contributions to understanding of the development of auditory feedback control and sensorimotor learning in childhood and adolescence in a scoping review. Twenty-three articles met inclusion criteria. Across studies, there was a wide variety of designs, outcomes and measures used. Manipulations included fundamental frequency (9 studies), formant frequency (12), frequency centroid of fricatives (1), and both fundamental and formant frequencies (1). Study designs included contrasts across childhood, between children and adults, and between typical, pediatric clinical and adult populations. Measures primarily explored acoustic properties of speech responses (latency, magnitude, and variability). Some studies additionally examined the association of these acoustic responses with clinical measures (e.g., stuttering severity and reading ability), and neural measures using electrophysiology and magnetic resonance imaging. Findings indicated that children above 4 years generally compensated in the opposite direction of the manipulation, however, in several cases not as effectively as adults. Overall, results varied greatly due to the broad range of manipulations and designs used, making generalization challenging. Differences found between age groups in the features of the compensatory vocal responses, latency of responses, vocal variability, and perceptual abilities, suggest that maturational changes may be occurring in the speech motor control system, affecting the extent to which auditory feedback is used to modify internal sensorimotor representations. Varied findings suggest vocal control develops prior to articulatory control. Future studies with multiple outcome measures, manipulations, and more expansive age ranges are needed to elucidate findings.

In general, results of some studies have suggested that the use of these devices reduces stuttering frequency. However, the small sample sizes, short-term follow-up, and uncontrolled, nonrandomized design of these studies limit the generalizability of the results.

According to the American Speech-Language-Hearing Association (ASHA), early findings indicate that auditory feedback devices may be helpful for some people, but not for others. ASHA states that research is ongoing to identify (ASHA, 2018):

- Why some people benefit from the devices more than others
- Whether the devices can be made to be more effective
- How much improvement one might expect in fluency when a device is used either alone or with speech therapy whether the benefits last over time

The National Institute on Deafness and other Communication Disorders (NIDCD) states that some people who stutter use electronic devices to help control fluency. However, questions remain about how long such effects may last and whether people are able to easily use these devices in real-world situations. For these reasons, researchers are continuing to study the long-term effectiveness of these devices (NIDCD, 2017).

PRACTITIONER SCOPE AND TRAINING

Practitioners should practice only in the areas in which they are competent based on their education, training, and experience. Levels of education, experience, and proficiency may vary among individual practitioners. It is ethically and legally incumbent on a practitioner to determine where they have the knowledge and skills necessary to perform such services and whether the services are within their scope of practice.

It is best practice for the practitioner to appropriately render services to a member only if they are trained, equally skilled, and adequately competent to deliver a service compared to others trained to perform the same procedure. If the service would be most competently delivered by another health care practitioner who has more skill and training, it would be best practice to refer the member to the more expert practitioner.

Best practice can be defined as a clinical, scientific, or professional technique, method, or process that is typically evidence-based and consensus driven and is recognized by a majority of professionals in a particular field as more effective at delivering a particular outcome than any other practice (Joint Commission International Accreditation Standards for Hospitals, 2020).

Depending on the practitioner's scope of practice, training, and experience, a member's condition and/or symptoms during examination or the course of treatment may indicate the need for referral to another practitioner or even emergency care. In such cases it is prudent for the practitioner to refer the member for appropriate co-management (e.g., to their primary care physician) or if immediate emergency care is warranted, to contact 911 as appropriate. See the *Managing Medical Emergencies (CPG 159 – S)* clinical practice guideline for information.

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