Biofeedback

Number: 0132

(Replaces CPB 138)

Policy

*Please see amendment for Pennsylvania Medicaid at the end of this CPB.

Note: Some Aetna plans exclude coverage of biofeedback. Please check benefit plan descriptions for details.

Aetna considers biofeedback medically necessary for the following conditions:

■ Cancer pain
■ Chronic constipation
■ Fecal incontinence
■ Irritable bowel syndrome
■ Levator ani syndrome (also known as anorectal pain syndrome)
■ Migraine and tension headaches (muscle (EMG), skin or thermal biofeedback; EEG biofeedback is considered experimental and investigational for this indication because its effectiveness for this indication has not been established)
■ Neuromuscular rehabilitation of stroke and traumatic brain injury (TBI) (see "Note" below)
■ Refractory severe subjective tinnitus
■ Temporomandibular joint (TMJ) syndrome

Policy History

Last Review 03/30/2018
Effective: 05/31/1996
Next Review: 01/24/2019

Definitions

Additional Information

Clinical Policy Bulletin Notes
Urinary incontinence

**Note:** Aetna considers AutoMove AM800 experimental and investigational for neuromuscular rehabilitation of post-stroke patients because its effectiveness for this indication has not been established. Although triggered by EMG, AutoMove AM800 is a neuromuscular electrical stimulator (see [CPB 0677 - Functional Electrical Stimulation and Neuromuscular Electrical Stimulation](../600_699/0677.html)); it is not biofeedback. Furthermore, available evidence does not support the effectiveness of this modality in treating post-stroke patients.

Aetna considers biofeedback for the following conditions (not an all-inclusive list) experimental and investigational because there is insufficient evidence in the medical literature documenting the effectiveness of this approach for these conditions:

- Addictions
- Allergy
- Anger management
- Anterior shoulder instability or pain
- Anxiety disorders
- As a rehabilitation modality for spasmodic torticollis, spinal cord injury, or following knee surgeries
- Attention deficit hyperactivity disorder (ADHD)
- Autism
- Balance training (with tongue-placed electrotactile biofeedback or visual interactive biofeedback)
- Bell's palsy (idiopathic facial paralysis)
- Cardiovascular diseases (e.g., heart failure)
- Chemotherapy-induced peripheral neuropathy
- Childhood apraxia of speech
- Chronic abacterial prostatitis
- Chronic fatigue syndrome
- Chronic pain (e.g., back pain, fibromyalgia, neck pain) other than migraine and tension headache
- Cleft palate speech (nasopharyngoscopic biofeedback)
- Daytime syndrome of urinary frequency
- Depression
- Diabetes
- Epilepsy
- Essential hypertension (e.g., by means of the RESPeRATE Device)
- Facial pain
- Functional dysphonia
- Home biofeedback (for any indication)
- Improvement of anorectal/bowel functions after sphincter-saving surgery for rectal cancer
- Insomnia
- Labor pain
- Neurogenic bladder
- Non-neuropathic voiding disorders
- Ordinary muscle tension states
- Pain associated with multiple sclerosis
- Panic disorders (e.g., FreeSpira breathing system)
- Pelvic floor dysfunction
- Peripheral arterial disease (e.g., intermittent claudication)
- Pre-term labor
- Prophylaxis of medication overuse headache and pediatric migraine
- Post-trauma stress disorder
- Psychosis
- Psychosomatic conditions
- Raynaud's disease/phenomenon
- Sleep bruxism
- Spasticity secondary to cerebral palsy
- Toe-out gait modification/retraining in people with knee osteoarthritis
- Tourette’s syndrome
- Tremor
- Type 2 diabetes
- Urinary retention
- Vaginal tear
- Vaginismus
- Vertigo/disequilibrium
- Visual disorders
- Vulvodynia.
Note: Postural strapping retraining biofeedback is considered experimental and investigational because its effectiveness has not been established.

Background

Biofeedback (BFB) can be defined as a training technique that utilizes monitoring instruments to detect and amplify internal physiological processes, and presents this ordinarily unavailable information by audio and / or visual means to patients. This information is usually displayed in a quantitative manner and used by the patients to learn specific tasks.

Urinary Incontinence

Urinary incontinence (UI) affects people of all ages especially elderly women. Among adults, there are 4 prevalent types of UI: (i) stress incontinence (closure problem), (ii) urge incontinence (storage problem), (iii) overflow incontinence, and (iv) mixed stress and urge incontinence. In women, stress incontinence is generally caused by an incompetent urethral mechanism which arises from damage to the sphincter(s) or weakening of the bladder neck support that typically occurred during childbirth. Some women develop stress incontinence as a consequence of multiple anti-incontinence procedures resulting in a condition known as intrinsic urethral sphincter deficiency. In man, stress incontinence is usually a consequence of operations for benign prostatic hypertrophy or prostatic carcinoma. Urge incontinence is usually associated with an over-activity of the detrusor muscle. When the involuntary contraction of the detrusor muscle is associated with a neurological deficit, it is known as detrusor hyperreflexia. On the other hand, when detrusor over-activity is not associated with any neurological deficit, it is labeled as detrusor instability (unstable bladder). Overflow incontinence may be due to an underactive detrusor muscle or obstruction of the urethra. In men, overflow incontinence associated with obstruction is usually due to prostatic hyperplasia. Urethral obstruction in women may occur as a consequence of anti-incontinence operation or severe prolapse of the uterus or
relaxation of the anterior vaginal wall with cystocele or cystourethrocele.

It is now generally accepted that behavioral techniques, because of their relatively non-invasive and low risk approaches, have become the first line treatment for UI. Other techniques that may be used in combination with behavioral therapies include biofeedback, vaginal cone retention and electrostimulation even though the effectiveness of the latter in the treatment of certain types of UI is still unproven. The next step of treatment for UI is drug therapy followed by surgical interventions which include periurethral bulking injection of collagen.

Pelvic muscle exercises can aid in strengthening the voluntary periurethral and pelvic muscles needed to maintain urinary continence since contractions of these muscles raise the urethral pressure. Indeed, this form of exercise is indicated for women with stress incontinence, men with incontinence following prostatic surgery, and patients with urge incontinence. Depending on the type of UI, patients are taught to contract the pelvic floor muscles, relax the detrusor and the abdominal muscles, and/or contract the sphincters. Biofeedback has been suggested to be useful in teaching patients with UI pelvic muscle exercises because it relays to them whether they are contracting the right muscle(s) and provides positive reinforcements as they acquire the skill during training sessions.

There is sufficient evidence that biofeedback-assisted pelvic muscle exercise (e.g. Kegel's exercise) is a safe and effective method for the treatment of stress incontinence, urge incontinence, and mixed stress and urge incontinence. The Agency for Health Care Policy and Research (AHCPR)'s clinical practice guideline on urinary incontinence in adults states that biofeedback used in combination with other behavioral treatments such as pelvic muscle exercises and bladder training, can be useful in the reduction of symptoms associated with urinary incontinence.
Chronic Constipation

Constipation is one of the most common gastrointestinal complaints in the United States affecting at least 10% of the general population, and 25% of the elderly. It is not a disease, but a symptom of various diseases/disorders of mixed etiologies and mechanisms. According to the report of an international workshop on the subject, constipation is defined as the occurrence of 2 or more of the following symptoms in the previous 12 months (without the use of laxatives): (i) fewer than 3 bowel movements per week, (ii) excessive straining during at least 25% of bowel movements, (iii) a feeling of incomplete evacuation after at least 25% of bowel movements, and (iv) passage of hard or pellet-like stool during at least 25% of bowel movements (Whitehead et al, 1991). Causes for constipation may be colorectal (e.g., malignancy, diverticular disease, pelvic floor dysfunction, and anal fissure), drug-induced (e.g., opiate analgesics, calcium and aluminum-containing antacids, anti-diarrheal agents, anti-depressants, and anti-histamines), metabolic/endocrine (diabetes mellitus, hypothyroidism, hypercalcemia, and pregnancy), and neurogenic (multiple sclerosis, Parkinson's disease, cerebral tumors, and Hirschsprung's disease). Other possible causes include irritable bowel syndrome, inadequate dietary fiber, and psychosocial problems. There are 2 major causes for chronic constipation: (i) colonic inertia, and (ii) pelvic floor outlet obstruction (PFOO). The former is known as slow-transit constipation, and is characterized by a delay in the movement of food residues through the colon. It is usually treated with total abdominal colectomy with ileorectal anastomosis. The latter is also known as anismus, pelvic floor dyssynergia, paradoxical puborectalis contraction, pelvic outlet syndrome, and spastic pelvic floor syndrome, and is characterized by inability or difficulty to expel stool from the rectosigmoid region. Pelvic floor outlet obstruction is a functional disorder of evacuation involving the external anal sphincter and pelvic floor voluntary musculature in which the muscles contract, rather than relax. This results in the anal canal being kept tightly closed during straining at attempted defecation. Symptoms of
PFOO include incomplete rectal evacuation, prolonged straining at defecation, digital manipulation of the rectum, and constipation. The diagnosis of PFOO is often established by means of anorectal and pelvic floor function tests such as balloon expulsion test (simulated defecation), evacuation proctography (defecography), anorectal manometry, scintigraphic expulsion of artificial stool, sphincter/puborectalis electromyogram, as well as measurement of rectoanal angle. Biofeedback has been used successfully to teach patients with this disorder to relax the sphincteric and pelvic floor musculature.

An UpToDate review on “Management of chronic constipation in adults” (Ward, 2014) states that “Biofeedback is not widely available, has not been well standardized, and results may vary at different centers. However, where available, it is an attractive alternative for patients with pelvic floor dysfunction and severe constipation as it provides the potential for treatment without laxatives”.

In a Cochrane review, Woodward et al (2014) examined the safety and effectiveness of BFB for the treatment of chronic idiopathic (functional) constipation in adults. These investigators searched the following databases from inception to December 16, 2013: CENTRAL, the Cochrane Complementary Medicine Field, the Cochrane IBD/FBD Review Group Specialized Register, MEDLINE, EMBASE, CINAHL, British Nursing Index, and PsychINFO. Hand-searching of conference proceedings and the reference lists of relevant articles were also undertaken. All randomized trials evaluating BFB in adults with chronic idiopathic constipation were considered for inclusion. The primary outcome was global or clinical improvement as defined by the included studies. Secondary outcomes included quality of life, and adverse events as defined by the included studies. Where possible, these researchers calculated the risk ratio (RR) and corresponding 95 % CI for dichotomous outcomes and the mean difference (MD) and 95 % CI for continuous outcomes. They assessed the methodological quality of included studies using the Cochrane...
risk of bias tool. The overall quality of the evidence supporting each outcome was assessed using the GRADE criteria. A total of 17 eligible studies were identified with a total of 931 participants. Most participants had chronic constipation and dyssynergic defecation; 16 of the trials were at high-risk of bias for blinding. Attrition bias (4 trials) and other potential bias (5 trials) was also noted. Due to differences between study populations, the heterogeneity of the different samples and large range of different outcome measures, meta-analysis was not possible. Different effect sizes were reported ranging from 40 to 100 % of patients who received BFB improving following the intervention. While electromyographic (EMG) biofeedback was the most commonly used, there is a lack of evidence as to whether any one method of BFB is more effective than any other method of BFB. These researchers found low or very low quality evidence that BFB is superior to oral diazepam, sham BFB and laxatives. One study (n = 60) found EMG biofeedback to be superior to oral diazepam. Seventy per cent (21/30) of BFB patients had improved constipation at 3-month follow-up compared to 23 % (7/30) of diazepam patients (RR 3.00, 95 % CI: 1.51 to 5.98). One study compared manometry BFB to sham BFB or standard therapy consisting of diet, exercise and laxatives. The mean number of complete spontaneous bowel movements (CSBM) per week at 3 months was 4.6 in the BFB group compared to 2.8 in the sham BFB group (MD 1.80, 95 % CI: 1.25 to 2.35; 52 patients). The mean number of CSBM per week at 3 months was 4.6 in the BFB group compared to 1.9 in the standard care group (MD 2.70, 95 % CI: 1.99 to 3.41; 49 patients). Another study (n = 109) compared EMG BFB to conventional treatment with laxatives and dietary and lifestyle advice. This study found that at both 6 and 12 months 80 % (43/54) of BFB patients reported clinical improvement compared to 22 % (12/55) laxative-treated patients (RR 3.65, 95 % CI: 2.17 to 6.13). Some surgical procedures (partial division of pubo-rectalis and stapled trans-anal rectal resection (STARR)) were reported to be superior to BFB, although with a high risk of adverse events in the surgical groups (wound infection, fecal incontinence, pain, and bleeding that required further surgical intervention). Successful treatment, defined as a decrease in
the obstructed defecation score of greater than 50% at 1 year was reported in 33% (3/39) of EMG BFB patients compared to 82% (44/54) of STARR patients (RR 0.41, 95% CI: 0.26 to 0.65). For the other study the mean constipation score at 1 year was 16.1 in the balloon sensory BFB group compared to 10.5 in the partial division of pubo-rectalis surgery group (MD 5.60, 95% CI: 4.67 to 6.53; 40 patients). Another study (n = 60) found no significant difference in efficacy did not demonstrate the superiority of a surgical intervention (posterior myomectomy of internal anal sphincter and pubo-rectalis) over BFB. Conflicting results were found regarding the comparative effectiveness of BFB and botulinum toxin-A. One small study (48 participants) suggested that botulinum toxin-A injection may have short-term benefits over BFB, but the relative effects of treatments were uncertain at 1 year follow-up. No adverse events were reported for BFB, although this was not specifically reported in the majority of studies. The results of all of these studies need to be interpreted with caution as GRADE analyses rated the overall quality of the evidence for the primary outcomes (i.e., clinical or global improvement as defined by the studies) as low or very low due to high risk of bias (i.e., open label studies, self-selection bias, incomplete outcome data, and baseline imbalance) and imprecision (i.e., sparse data). The authors concluded that currently there is insufficient evidence to allow any firm conclusions regarding the safety and effectiveness of BFB for the management of people with chronic constipation. They found low or very low quality evidence from single studies to support the effectiveness of BFB for the management of people with chronic constipation and dyssynergic defecation. However, the majority of trials were of poor methodological quality and subject to bias. They stated that further well-designed randomized controlled trials (RCTs) with adequate sample sizes, validated outcome measures (especially patient reported outcome measures) and long-term follow-up are needed to allow definitive conclusions to be drawn.

**Fecal Incontinence**

Fecal incontinence (FI) is relatively common in the elderly and
children. There are many causes for FI including injuries or diseases of the spinal cord, congenital anorectal malformations, accidental injuries to the rectum and anus, aging, diabetes mellitus, tumors, post obstetrical injuries, and post anorectal surgeries. Fecal continence relies on several factors: (i) mental function, (ii) stool volume and consistency, (iii) colonic transit, (iv) rectal distensibility, (v) anal sphincter function, (vi) anorectal sensation, and (vii) anorectal reflexes. Dysfunction/abnormality of any of these factors, alone or in combination, can result in FI. Normal anal sphincter activity depends on a functional sphincter mechanism consisting of the internal anal sphincter (IAS), the external anal sphincter (EAS), and the puborectalis muscles. The passage of stool into the rectum causes rectal distention resulting in reflex relaxation of the IAS. During this relaxation, FI will ensue unless the EAS is simultaneously contracted voluntarily.

There are various methods for the treatment of FI including behavioral therapies, drug therapies, as well as surgical intervention. For the past 3 decades, various biofeedback techniques have been used in the management of FI. In particular, EAS biofeedback training has been shown to be effective in treating FI. This technique teaches patients to increase the strength of contraction of their EAS in response to rectal distention. The major outcome measures deemed important in assessing the usefulness of biofeedback for the management of patients with FI are restoration of continence or reductions in the frequency of incontinence, and long term results.

There is evidence that biofeedback techniques are safe and effective in the treatment of patients with fecal incontinence, especially those who have some degree of rectal sensation and ability to contract the sphincter voluntarily. Biofeedback training has been demonstrated to restore continence or reduce the frequency of incontinence in patients with fecal incontinence with satisfactory long term results.

Terra et al (2006) evaluated the outcome of pelvic floor
rehabilitation in a large series of consecutive patients with FI caused by different etiologies. A total of 281 patients (252 females) were included. Data about medical history, anal manometry, rectal capacity measurement, and endo-anal sonography were collected. Subgroups of patients were defined by anal sphincter complex integrity, and nature and possible underlying causes of FI. Subsequently patients were referred for pelvic floor rehabilitation, comprising 9 sessions of electric stimulation and pelvic floor muscle training with biofeedback. Pelvic floor rehabilitation outcome was documented with Vaizey score, anal manometry, and rectal capacity measurement findings. Vaizey score improved from baseline in 143 of 239 patients (60%), remained unchanged in 56 patients (23%), and deteriorated in 40 patients (17%). Mean Vaizey score reduced with 3.2 points (p < 0.001). A Vaizey score reduction of greater than or equal to 50% was observed in 32 patients (13%). Mean squeeze pressure (+5.1 mm Hg; p = 0.04) and maximal tolerated volume (+11 ml; p = 0.01) improved from baseline. Resting pressure (p = 0.22), sensory threshold (p = 0.52), and urge sensation (p = 0.06) remained unchanged. Subgroup analyses did not show substantial differences in effects of pelvic floor rehabilitation between subgroups. The authors concluded that pelvic floor rehabilitation leads overall to a modest improvement in severity of FI, squeeze pressure, and maximal tolerated volume. However, only in a few patients, a substantial improvement of the baseline Vaizey score was observed. They noted that further studies are needed to identify patients who most likely will benefit from pelvic floor rehabilitation.

A Cochrane review on biofeedback and/or sphincter exercises for the treatment of FI in adults, Norton and colleagues (2006) concluded that the limited number of identified trials together with their methodological weaknesses do not allow a definitive assessment of the possible role of anal sphincter exercises and biofeedback therapy in the management of people with FI. These researchers found no evidence of biofeedback or exercises enhancing the outcome of treatment compared to other conservative management methods. While there is a
suggestion that some elements of biofeedback therapy and sphincter exercises may have a therapeutic effect, this is not certain. They stated that larger well-designed trials are needed to enable safe conclusions.

Suitable candidates for this treatment modality are patients who have some degree of rectal sensation and ability to contract the sphincter voluntarily. First line approaches including behavior modification (e.g., dietary manipulations and/or changes in bowel habit, and prevention of fecal impaction/constipation by regular use of laxatives and/or enemas) and pharmacotherapies (e.g., loperamide/Imodium, or diphenoxylate with atropine/Lomotil, Diarsed, and Reasec) should have been tried and failed. Children with fecal incontinence secondary to myelomeningocele are not good candidates for the use of biofeedback in treating their incontinence.

**Headache**

It is estimated that 50 million Americans suffer from headache. Headaches can be classified into 4 distinct categories -- vascular, tension, traction, and inflammatory. Vascular headaches include migraine and cluster which probably arise from the abnormal functioning of the vascular system or the brain's blood vessels. Tension (muscle contraction) headaches are caused by the tightening of muscles of the head, face and neck. Traction and inflammatory headaches refer to those that are caused by inflammation, traction and displacement of the pain sources of the head. Pathological conditions such as hematomas, aneurysm, brain tumors, or brain edema can lead to traction headaches; while diseases of the eye, ear and sinus can give rise to inflammatory headaches. The most prevalent type of vascular headache is migraine. It is now generally accepted that about 1 in 8 adults in the developed countries has migraine headaches. Women are affected 2 to 3 times more than men. This disorder predominantly affects young adults and the peak incidence is between the age of 25 and 34. There are 2 major types of migraine headaches: (i) migraine
with aura (classical migraine) which accounts for 15 to 18 % of all migraine episodes, and (ii) migraine without aura (common migraine) which accounts for 80 % of all migraine attacks. Some individuals suffer from both types of migraine at different times. The treatment of choice for frequent migraine sufferers is usually pharmacologic prophylaxis. Avoidance strategies (loud noises flashing lights, stress and certain foods) also constitute a very important first line approach in managing migraine. Biofeedback training with or without relaxation techniques have also been shown to be effective in treating migraine and tension headache.

In particular, thermal biofeedback training has been shown to be effective in treating migraine headache. This technique teaches patients to increase the temperature of their fingers. Supposedly, dilatation of the peripheral blood vessels in the hand is associated with reduced blood flow in the regions of the supra-orbital and superficial temporal arteries, although the exact mechanism by which thermal biofeedback improves migraine headaches is still unclear. For the management of tension headache, EMG feedback has been employed primarily. Moreover, it has been shown that the combination of thermal and EMG biofeedback has been effective in the control of migraine, tension, and mixed migraine and tension headache. Furthermore, it has been reported that relaxation techniques can produce improvements in headache.

Available evidence indicates that biofeedback techniques (thermal, EMG, and temporal blood volume pulse biofeedback), with or without other behavioral therapies (relaxation and cognitive training), are safe and effective methods for the treatment of migraine and tension headache. This therapeutic modality has no side effects and does not preclude other options. Unlike migraine and tension headache, there is a lack of published data concerning the safety and effectiveness of biofeedback in the management of cluster headache.

Before enrolling in a biofeedback program, patients should be examined by a physician to ensure that their headaches are not
due to pathological conditions such as hematomas, aneurysm, brain tumors, brain edema, or diseases of the eye, ear and sinus. They should also be willing and motivated to learn and practice the specific tasks needed to correct / improve their problems. First line approaches, including avoidance of precipitating stimuli and pharmacologic prophylaxis, should have been tried and failed.

Medication Overuse Headache:

In a pilot, randomized, controlled, single-blind trial, Rausa and associates (2016) evaluated the effects of BFB associated with traditional pharmacological therapy in the prophylactic treatment of medication overuse headache (MOH). A total of 27 subjects were randomized to frontal EMG-BFB associated with prophylactic pharmacological therapy (BFB Group) or to pharmacological treatment alone (Control Group). The primary outcome was to evaluate the number of patients that return episodic after treatment. These researchers also evaluated the effects of frontal EMG-BFB on frequency of headache and analgesic intake. Changes in coping strategies and in EMG frontalis tension were also evaluated; ANOVA was performed on all the variables of interest. At the end of treatment the number of patients that returned episodic in the BFB group was significantly higher than in the Control group. Patients in the BFB group differed from the Control group in headache frequency, amount of drug intake and active coping with pain. These outcomes were confirmed also after 4 months of follow-up. No significant effects were observed in EMG recordings. The authors concluded that BFB added to traditional pharmacological therapy in the treatment of MOH is a promising approach for reducing headache frequency and analgesic intake. They stated that modification of coping cognitions in the BFB group, as an adjunct mechanism of self-regulation, needs more evaluations to understand the role of BFB in changing maladaptive psychophysiological responses.

Prophylaxis for Pediatric Migraine:
In a meta-analysis, Stubberud et al (2016) examined the pooled evidence for the effectiveness of using BFB for reduction of childhood migraine. These investigators performed a systematic search across the databases Medline, Embase, CENTRAL, CINAHL, and PsychINFO. Prospective, RCTs of BFB for migraine among children and adolescents were located in the search. Data on reduction of mean attack frequency and a series of secondary outcomes, including adverse events (AEs), were extracted. Risk of bias was also assessed. Forest plots were created by using a fixed effects model, and mean differences were reported. A total of 5 studies with a total of 137 participants met the inclusion criteria. Biofeedback reduced migraine frequency (MD, -1.97 [95 % CI: -2.72 to -1.21]; p < 0.00001), attack duration (MD, -3.94 [95 % CI: -5.57 to -2.31]; p < 0.00001), and headache intensity (MD, -1.77 [95 % CI: -2.42 to -1.11]; p < 0.00001) compared with a waiting-list control. Biofeedback demonstrated no adjuvant effect when combined with other behavioral treatment; neither did it have significant advantages over active treatment. Only 40 % of bias judgments were deemed as "low" risk. The authors concluded that BFB appeared to be an effective intervention for pediatric migraine, but in light of the limitations, further investigation is needed to increase the confidence in the estimate.

**Neuromuscular Rehabilitation**

Among patients who survive longer than 1 month following stroke, it has been estimated that 10 % of them experience almost complete spontaneous recovery, and another 10 % do not benefit from any type of therapy. It is the remaining 80 % of stroke survivors with significant neurological deficits and physical disabilities who may benefit from rehabilitation. The principal goal of stroke rehabilitation is to improve the functional abilities of these patients, thus affording them greater independence in activities of daily living and improving their quality of life. Conventional modalities of stroke rehabilitation comprise various combination of range of motion and muscle strengthening exercises, mobilization activities, and compensatory techniques. Other therapies include
neurophysiological/developmental based methods in which the therapeutic program incorporates neuromuscular re-education techniques. In this regard, biofeedback has been used for neuromuscular rehabilitation. Among biofeedback techniques employed in neuromuscular rehabilitation, EMG biofeedback is the most common one. It is often utilized by stroke patients for facilitation of contraction (strength) and relaxation of spasticity (inhibition). Electromyographic biofeedback has also been used to treat patients with spasmodic torticollis and patients with muscular atrophy resulting from surgery.

The goals of EMG biofeedback in neuromuscular rehabilitation is 2-fold: (i) relaxation of muscles, or (ii) recruitment of muscles. Relaxation of muscles is usually performed under one of two conditions -- either muscles are trained to relax as a consequence of hyperactivity that may be stress or work related, or they are trained to relax as a result of hyperactivity caused by central nervous system dysfunction (e.g., patients with spasticity due to stroke or traumatic brain injury). Recruitment of muscles is generally carried out under conditions requiring increased output for movement generation or strength. A typical application of muscle recruitment using EMG biofeedback is in the activation of muscles that have been weakened as a result of a variety of reasons (e.g., patients with joint/ligament repair or immobilization of limb segment). There is sufficient evidence that EMG biofeedback is safe and effective for (i) neuromuscular rehabilitation in patients who suffered from strokes and traumatic brain injury. In contrast, there is insufficient evidence that EMG biofeedback is effective as a rehabilitation modality for patients with spinal cord injury, and in patients with spasmodic torticollis. Additionally, although there is limited evidence that EMG biofeedback is effective in enhancing (i) the return to full active extension of the operated knee, and (ii) recovery peak torque of the quadriceps femoris muscle following knee surgeries, there is little data on how these physiological improvements translated into improved functional outcomes. Candidates for EMG biofeedback should be disabled and have not benefited from conventional forms of therapy. Patients should have some volitional motor activity,
but are unable to use it in any meaningful manner. Ideal candidates should have no receptive aphasia and should be motivated and committed to the therapy.

**Raynaud's Disease/Phenomenon**

Raynaud's syndrome is a painful vasospastic disorder affecting most frequently the digits of the upper extremity, usually triggered by cold and/or emotional stress. When these symptoms are secondary to the presence of other causes such as vascular injury, and exposure to drugs and chemicals, or diseases, this disorder is known as Raynaud's phenomenon. On the other hand, when these symptoms occur without an associated disease, it is called Raynaud's disease (RD). Clinical manifestations of this disorder usually occur between the ages of 20 and 40 years. Moreover, women are more likely to be affected than men (approximately 4 to 1 ratio).

Treatments of RD include avoidance of precipitating factors, wearing of heavy clothing, protecting not only the hands and feet, but also the face and trunk to avoid reflex vasospasm, and drug therapy. For most patients with RD, the drug of choice is a calcium channel blocker. For patients with very severe RD, surgery may have immediate benefits, but long term results have been disappointing. Another approach for the management of RD is biofeedback. Thermal (finger temperature) biofeedback is the most commonly used biofeedback mode for the treatment of RD. Studies have shown that finger temperature biofeedback is effective in reducing the frequency and severity of vasospastic attacks in patients with RD. The major outcome measures deemed important in assessing the usefulness of thermal biofeedback for the management of patients with RD are reductions in frequency and intensity of attacks, and long-term results.

MEDLINE, EMBASE and AMED, 20 RCTs were found and divided into 9 treatment subcategories: acupuncture (n = 2 trials), antioxidants (n = 2), biofeedback (n = 5), essential fatty acids (n = 3), Ginkgo biloba (n = 1), L-arginine (n = 2), laser (n = 3), glucosaminoglycans (n = 1) and therapeutic gloves (n = 1). Trials in each subcategory were meta-analysed together. Several categories did not have enough trials to do a meta-analysis and most trials were negative, of poor quality and done prior to 1990. Biofeedback was negative for a change in frequency, duration and severity of RP attacks, and actually favored control (sham biofeedback; p < 0.02). The therapeutic glove favored active treatment (p < 0.00001). Laser resulted in one less RP attack on average over 2 weeks versus sham [weighted mean difference (WMD) 1.18; 95 % confidence interval (CI): 1.06 to 1.29], and a change in severity of attacks (WMD 1.98; 95 % CI: 1.57 to 2.39; p < 0.05). No significant differences were found in the nutritional supplements that were studied. The authors concluded that there is a need for well-designed trials of CAM in the treatment of RP. The literature is inconclusive except that biofeedback does not work for RP, therapeutic gloves may improve RP (but results may not be generalizable due to single trial site and no intent-to-treat analysis) and laser may be effective but the improvement may not be clinically relevant.

In an UpToDate review on non-pharmacological therapy for the RP, Wigley (2010) stated that the exact role of biofeedback and other behavioral methods in the treatment of primary RP are still in question. Furthermore, biofeedback is not helpful for the treatment of secondary RP, particularly in patients with a connective tissue disease.

**Tinnitus**

Tinnitus is defined as the aberrant perception of noise or sound without any external stimulation. Tinnitus presents as an aberrant and often disabling ringing, buzzing, clicking, or roaring sounds in the ears. Tinnitus may be unilateral or bilateral and has equal prevalence in women and men and is
most prevalent between the ages of 40 and 70. Occasionally, it can also occur in children. Periodic bouts of mild, high-pitched tinnitus lasting for several minutes are common in normal-hearing individuals. Severe and persistent tinnitus can interfere with sleep and the ability to concentrate, causing great psychological distress. In extreme cases, patients with severe chronic tinnitus may consider suicide. Tinnitus can be classified into 2 types: (i) subjective tinnitus, and (ii) objective tinnitus. Subjective tinnitus, which is more common, is only audible to the patient. It may arise from some types of electrophysiological disturbance anywhere in the auditory system -- the external ear canal, tympanic membrane, ossicles, cochlea, auditory nerve, brainstem or cerebral cortex. The underlying causes of subjective tinnitus include otological (presbycusis, noise-induced hearing loss, Meniere’s disease, or chronic otitis media), metabolic (diabetes, thyroid diseases, hyperlipidemia, or zinc deficiency/vitamin deficiency), pharmacological (aspirin compounds, non-steroidal anti-inflammatory drugs, caffeine, nicotine, aminoglycosides, or antidepressants), neurological (whiplash, skull fracture/closed head trauma, multiple sclerosis, or following meningitis), psychological (depression or anxiety), as well as infectious and neoplastic (syphilis, acoustic neuroma, autoimmune diseases, or acquired immune deficiency syndrome) disorders. Objective tinnitus, the less common type of tinnitus, usually refers to noises that can be heard by an examiner. The physician must put his/her ear against the patient’s ear or use a stethoscope against the patient’s external auditory canal. Objective tinnitus usually has a vascular (arteriovenous malformations/shunts, arterial bruits, hypertension, arteriosclerosis, venous hums, or aneurysms) or mechanical (eustachian tube dysfunction, temporomandibular joint disease, palatal myoclonus, or idiopathic stapedal muscle spasm) origin. The management of patients with tinnitus often depends on the severity of the condition. If the patient’s activities of daily living are not affected by tinnitus, treatment options include counseling, reassurance, and/or behavioral and dietary modifications (avoidance of excessive noise, nicotine, salt, and caffeine). All medications should also be evaluated to eliminate
ototoxic drugs. If the tinnitus interferes with the patient’s sleep and his/her activities of daily living, treatment options include habituation therapy and pharmacotherapy. However, it should be noted that no drug has been approved by the Food and Drug Administration for the specific treatment of tinnitus.

Another therapeutic modality is biofeedback. The major outcome measures that are deemed important in assessing the effectiveness of biofeedback in treating tinnitus are suppression or reduction of tinnitus severity and/or frequency. Reviews on tinnitus indicated that biofeedback is an useful treatment modality for patients with severe tinnitus. Studies have reported that EMG or thermal biofeedback training alone or supplemented with relaxation techniques is effective in treating patients with severe subjective tinnitus.

Appropriate candidates for biofeedback for tinnitus should not have a medically correctable cause of tinnitus, and have tried and failed conservative treatments including counseling and reassurance, behavioral and dietary modifications, masking devices and drug therapy. Patients taking medications for other medical problems known to have a side effect of tinnitus, such as aspirin, Vasotec (Enalapril Maleate), etc., are generally not appropriate candidates for biofeedback, nor are patients with active ear disease, or patients with psychiatric problems such as schizophrenia, depression, hysteria, or hypochondria.

Milner et al (2016) stated that they were the first to demonstrate outcomes of slow cortical potential (SCP) neurofeedback training in chronic tinnitus. A 50-year old male patient with tinnitus participated in 3 SCP training blocks, separated with 1-month breaks. After the training, the patient reported decreased tinnitus loudness and pitch, as well as improved quality of daily life. A quantitative EEG analysis revealed close to normal changes of resting state bioelectrical activity in cortical areas considered to be involved in tinnitus generation. The authors concluded that the present case study indicated that SCP neurofeedback training can be considered a promising method for tinnitus treatment.
Temporomandibular joint disorders, also known as temporomandibular pain dysfunction syndrome (TMPDS), or myofascial pain dysfunction syndrome (MPD or MPDS), are a collective term for a variety of problems affecting the jaw's joints, muscles, and surrounding tissues. These terms are often confused with myofascial pain dysfunction (MPS), myofascial syndrome, and myofascitis which refer to body pain and autonomic phenomena associated with trigger points.

Temporomandibular joint disorders are characterized by pain in the preauricular area, TMJ, or masticatory muscles; limitation or deviation in mandibular motion; and clicking/popping sounds during opening or closing of the jaw (crepitus). The causes of TMJ disorders range from emotional stress, orthodontic problems, degenerative disease that may produce arthritic conditions, to trauma/injury to the head or neck. Signs and symptoms of TMJ disorders usually increase in frequency and severity from the age of 20 to 50. These disorders are generally self-limiting or fluctuate over time, and pain seems to decrease markedly by the 6th decade of life. It is estimated that approximately 5% of this patient population requires medical care.

Because of their variable etiologies, TMJ disorders have been treated with different approaches including behavioral therapies, physical therapy, pharmacotherapy, occlusal appliance therapy, as well as surgery. Behavioral therapies often entail removal of causative factors, if known, to prevent continued damage. These include biofeedback, counseling the patients to lower the frequency of clenching, bruxing, and unhealthy oral habits, as well as reducing stress via identification of behaviors that result in clenching and muscle pain. Physical therapy includes the use of vapocoolant sprays, moist heat, massage, and cold packs to tender muscles, and general physical exercise to decrease the focus on excessive use of the jaw muscles. Pharmacotherapy consists of the use of muscle relaxants such as diazepam and cyclobenzaprine, hypnotics such as florazepam, analgesics such as aspirin and...
ibuprofen, and antidepressants such as amitriptyline and desipramine. Occlusal appliance therapy is the use of TMJ appliances such as bite splint, night guard, occlusal orthopedic appliances and occlusal splint to alleviate jaw movement habits and reduce the frequency of diurnal and nocturnal clenching habits. Most patients with TMJ disorders attain good relief of symptoms with these noninvasive, conservative treatment methods. In general, there is a 70 to 90% rate of success with the use of occlusal appliances. All of the above-mentioned modalities are reversible except for surgery. Temporomandibular joint surgery is considered to be an irreversible treatment. It should be considered only when all noninvasive conservative methods of treatment have been exhausted and there is conclusive evidence that the pain and dysfunction are due to major structural changes.

Among biofeedback techniques used to treat TMJ disorders, EMG biofeedback is the most common one. This technique usually entails teaching patients to reduce muscle (the masseter and/or the temporalis, frontalis muscles) activity and produce physical relaxation of the muscles of the jaw. Many studies have reported that EMG biofeedback is effective in treating TMJ disorders.

The use of EMG biofeedback for the treatment of TMJ disorders has been shown to be safe and effective. Appropriate candidates are those who have been diagnosed to have TMJ disorders. Patients' history should be the prime indicator for biofeedback. Patients should be willing and motivated to learn and practice the specific tasks needed to correct/improve their problems.

**Hypertension**

It is estimated that about 65 million adult Americans have been diagnosed to be hypertensive. Moreover, 90% of all hypertension cases are classified as essential, primary, or idiopathic hypertension -- the exact etiology of the condition is unknown. Essential hypertension is among the most common
diagnosis for patients visiting offices of physicians, accounting for 4% of visits. The Joint National Committee on Detection, Evaluation and Treatment of High Blood Pressure considered an individual 18 years or older to be hypertensive if the average of 2 or more diastolic blood pressure (DBP) readings on at least two subsequent visits is 90 mm Hg or above, or when the average of multiple systolic blood pressure (SBP) measurements on 2 or more subsequent visits is consistently higher than 140 mm Hg.

The main objective of antihypertensive therapy is to lower the overall cardiovascular risk. Pharmacological treatments for hypertension are available in many forms that range from diuretics, beta-blocking agents, ganglionic blockers, post-ganglionic neuronal depletors, centrally acting post-synaptic alpha-adrenergic agonists, alpha-adrenergic receptors inhibitors, to vasodilators including hydralazine, minoxidil, angiotensin-converting enzyme inhibitors, and calcium antagonists. Non-pharmacological treatments of hypertension mainly entail changes in lifestyle and diet which include weight reduction, moderation in alcohol and caffeine intake, smoking cessation, exercise, sodium restriction, dietary supplement of potassium, calcium, or magnesium. Cognitive behavioral techniques such as biofeedback, relaxation, and meditation have also been employed for the treatment of hypertension.

The Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure has published evidence-based guidelines on the treatment of hypertension. This report and its predecessors were initiated by the National High Blood Pressure Education Program Coordinating Committee which includes member organizations such as the American Academy of Family Physicians, American College of Cardiology, American College of Physicians, American College of Preventive Medicine, American Medical Association, American Society of Hypertension, National Hypertension Association, Inc., and National Stroke Association, as well as federal agencies such as the Agency for Health Care Research and Quality, the Centers for Medicare and Medicaid Services, and National Heart, Lung,
and Blood Institute. The current report states that biofeedback
techniques have been evaluated in short term and long-term
controlled studies with little effect beyond that observed in the
control groups. The Committee concluded that the available
literature does not support the use biofeedback in the
management of hypertension.

**Attention Deficit Hyperactivity Disorder**

Attention deficit hyperactivity disorder (ADHD) is one of the
most common and serious neurobehavioral disorders among
children with a prevalence of 1 to 5%. This disorder is
characterized by developmentally inappropriate degrees of
inattention, impulsiveness, and hyperactivity which are
frequently manifested at home, in school, and in social
situations. For approximately 50% of the cases, the onset is
usually before school age, yet the disorder is often not
recognized until the child starts schooling. Most children with
ADHD often perform poorly at school. Academically,
adolescents with ADHD are generally 2 years behind their
normal counterparts. It has been demonstrated that 30 to 50% of
individuals with ADHD continue to manifest the symptoms in
adulthood.

The cause of ADHD is unknown, however, many theories have
been proposed to explain the etiology of hyperactivity. Some
authorities have suggested that there is a metabolic
dysfunction in the brain, whereas others believe that the
noradrenergic and dopaminergic systems are involved in the
pathophysiology of ADHD. Other factors that may be
associated with the etiology of ADHD are heredity, toxic
substances, as well as prenatal and perinatal risks. There are 3
major approaches in treating ADHD: (i) pharmacotherapy, (ii)
behavior modification, and (iii) cognitive behavioral
techniques.

The drugs most frequently employed in treating this disorder
are psychostimulants such as methylphenidate hydrochloride
(Ritalin), dextroamphetamine sulfate (Dexedrine), and pemoline
(Cylert), with Ritalin being the treatment of choice. Behavior modification is used not only to address hyperactivity and impulsiveness of patients with ADHD, but also to train them to learn adaptive behaviors such as directing attention, self-cueing, and inhibitory processes. Cognitive behavioral techniques are utilized to train patients to develop more reflective organized strategies for learning, as well as to teach them to think before acting for reducing their impulsiveness. Components of behavior modification and cognitive behavioral approaches may include positive reinforcement, limiting hyperactive behaviors by time-out procedures, and parental training to teach them the appropriate ways to attend to, ignore, and reward target behaviors.

Biofeedback and/or relaxation training have been used to reduce hyperactivity and impulsiveness as well as to increase attention to task in patients with ADHD. The rationale proceeds from the belief that muscular tension and inability to relax not only contribute to but also exacerbate symptoms of hyperactivity. The assumption is that when hyperactive patients learn how to maintain muscular tension at low levels, a reduction in hyperactivity will ensure. Many forms of biofeedback have been utilized including EMG, electroencephalogram (EEG), galvanic skin resistance, and skin (surface) temperature.

Most studies that suggested biofeedback is effective in treating this disorder were uncontrolled case series with small numbers of patients. Oftentimes it is unclear whether these patients were truly afflicted by this disorder. On the other hand, there were reports that raised serious questions regarding the effectiveness of biofeedback in treating hyperactivity. More importantly, few studies have shown that the initial treatment successes would result in lasting benefits after the treatment ended.

van As and colleagues (2010) stated that despite its growing popularity, neurofeedback is still a relatively unknown treatment method in psychiatric practices. These investigators
examined the scientific evidence of treating ADHD with neurofeedback. They searched the literature for reports on controlled trials that investigated the effectiveness of neurofeedback on ADHD. Six controlled trials were located. The studies reported that neurofeedback had a positive effect on ADHD, but all the studies were marred by methodological shortcomings. The authors concluded that on the basis of currently available research results, no firm conclusion can be drawn about the effectiveness of treating ADHD by means of neurofeedback. In view of the fact that neurofeedback is being used more and more as a method of treatment, there is an urgent need for scientific research in this field to be well-planned and carefully executed.

Lofthouse et al (2012) stated that as conventional treatments offer incomplete benefit for over 33 % of children with ADHD and many refuse to try them, additional treatments are needed. One of the most promising is NF (EEG biofeedback), which trains the brain with real-time video/audio information about its electrical activity measured from scalp electrodes. Since 2010, data from 8 randomized controlled studies of NF have been published with overall mean effect sizes of: 0.40 (all measures), 0.42 (ADHD measures), 0.56 (inattention), and 0.54 (hyperactivity/ impulsivity). Unfortunately, the benefit reported from randomized studies has not been observed in the few small blinded studies conducted. Main study strengths include randomization, evidence-based diagnostic assessments, multi-domain treatment outcomes, use of some type of blinding, and sham control conditions. Main study limitations include lack of large samples, abnormal EEG participant selection, double-blinding, and testing of blind validity and sham inertness. Most recently, a collaborative NF research group has been planning a definitive double-blind well-controlled trial.

In a research update on “Clinical utility of EEG in attention-deficit/hyperactivity disorder”, Loo and Makeig (2012) stated that “In recent years, the number and the scientific quality of research reports on EEG-based neurofeedback (NF) for ADHD have grown considerably, although the studies reviewed here
do not yet support NF training as a first-line, stand-alone treatment modality. In particular, more research is needed comparing NF to placebo control and other effective treatments for ADHD. Currently, after a long period of relative stasis, the neurophysiological specificity of measures used in EEG research is rapidly increasing. It is likely, therefore, that new EEG studies of ADHD using higher density recordings and new measures drawn from viewing EEG as a 3-dimensional functional imaging modality, as well as intensive re-analyses of existing EEG study data, can better characterize the neurophysiological differences between and within ADHD and non-ADHD subjects, and lead to more precise diagnostic measures and effective NF approaches”.

Moriyama et al (2012) stated that NF is a training to enhance self-regulatory capacity over brain activity patterns and consequently over brain mental states. Recent findings suggested that NF is a promising alternative for the treatment of attention-deficit/hyperactivity disorder (ADHD). These researchers comprehensively reviewed literature searching for studies on the effectiveness and specificity of NF for the treatment of ADHD. In addition, clinically informative evidence-based data were discussed. These investigators found 3 systematic reviews on the use of NF for ADHD and 6 randomized controlled trials that have not been included in these reviews. Most non-randomized controlled trials found positive results with medium-to-large effect sizes, but the evidence for effectiveness are less robust when only randomized controlled studies were considered. The direct comparison of NF and sham-NF in 3 published studies have found no group differences, nevertheless methodological caveats, such as the quality of the training protocol used, sample size, and sample selection may have contributed to the negative results. Further data on specificity comes from electrophysiological studies reporting that NF effectively changes brain activity patterns. No safety issues have emerged from clinical trials and NF seems to be well tolerated and accepted. Follow-up studies support long-term effects of NF. The authors noted that currently there is no available data to
guide clinicians on the predictors of response to NF and on optimal treatment protocol. They concluded that NF is a valid option for the treatment for ADHD, but further evidence is required to guide its use.

An UpToDate review on “Attention deficit hyperactivity disorder in children and adolescents: Overview of treatment and prognosis” (Krull, 2012) states that “In addition to elimination diets and fatty acid supplementation, other complementary and alternative (CAM) therapies that have been suggested in the management of ADHD include vision training, megavitamins, herbal and mineral supplements (e.g., St. John's wort), neurofeedback, chelation, and applied kinesiology, among others. Most of these interventions have not been proven efficacious in blinded randomized controlled trials”.

Furthermore, the Institute for Clinical Systems Improvement (ICSI)'s clinical guideline on “Diagnosis and management of attention deficit hyperactivity disorder in primary care for school-age children and adolescents” (Dobie et al, 2012) states that “Neurofeedback has been demonstrated in one randomized, controlled clinical trial [High Quality Evidence] to be significantly better than a computerized attention skills training control. ADHD symptoms were moderately improved. Long-term benefits have not been definitively proven. The cost and time involved in treatment need to be taken into account. Neurofeedback for ADHD lacks sufficient research support. Treatment response rates have not reached the level shown with psychostimulant medications; therefore neurofeedback cannot be recommended as an alternative to medication use in ADHD”.

**Anxiety Disorders**

Anxiety is a normal, adaptive, emotional response which can be an effective stimulus for improving performance. However, chronic anxiety is a maladaptive, irritating, and debilitating condition which may impair social as well as occupational functioning. Anxiety is manifested in many ways with the
principal psychological symptoms being fear, excessive worrying, and avoidance. Other symptoms are hypervigilance, autonomic hyperactivity, motor tension, and easy fatigability. Anxiety disorders often surface with depression. In fact, mixed states of anxiety and depression are probably the most common psychiatric problem seen by primary care physicians. Many medical, neurological, and toxicological disturbances can mimic anxiety disorders. These include endocrine disorders, cardiovascular and respiratory disorders, neurological problems, infectious diseases, tumors, and medications.

Anxiety disorders can be classified into 2 major groups: (i) panic disorders, and (ii) generalized anxiety disorder (GAD).

Panic disorders are episodic with attack-like symptoms, with the principal feature being the sudden, unexpected, and often overwhelming fear accompanied by somatic symptoms such as dyspnea, palpitations, and faintness. Unlike panic disorders, GAD is a persistent state of anxiety. The cardinal feature of adults with GAD is unrealistic anxiety regarding 2 or more life circumstances such as groundless worrying about one's finances, and possible mishaps to one's offsprings for 6 months or longer. In children and adolescents with GAD, this may emerge as anxiety concerning academic, athletic, and social performance. The prevalence of GAD, which is more common in young women, ranges from 25 to 64 per 1,000. The age of onset is variable, but most frequently is in the 20s and 30s. In patients who seek assistance from health care professionals, women outnumber men by 2 to 1. It is unclear whether there is a familial or hereditary basis for GAD.

Non-pharmacological interventions such as cessation of caffeine, alcohol, and drugs of abuse, combined with vigorous exercises are usually the initial steps in treatment of GAD. Cognitive behavioral therapies including relaxation training, biofeedback, and desensitization that aim at teaching patients methods to reduce anxiety are employed for more severe cases. When GAD is severe enough to warrant pharmacotherapy, SSRIs are the agents of choice.
The 3 most common types of biofeedback in the treatment of GAD are EMG, EEG, and heart rate (HR). Many investigators have claimed that biofeedback alone or in combination with other therapies was effective in treating anxiety disorders. In contrast, others have reported that this method was not effective or not any better than other behavioral techniques in controlling GAD. Very few studies actually used biofeedback independently of other treatment techniques. The majority of the studies reported the use of biofeedback in combination of relaxation training in treating this disorder. To determine the effectiveness of biofeedback alone in treating generalized anxiety disorder, studies should include separate treatment groups of biofeedback and relaxation training (or other techniques) as well as a placebo control group. Additionally, it is unclear whether biofeedback/relaxation skills learned in the laboratory setting can be transferred to social situations. More importantly, few studies have shown that the initial treatment successes would result in lasting benefits after the treatment ended.

Fibromyalgia

Fibromyalgia, also known as fibrositis, is characterized by the constant presence of widespread musculoskeletal pain, sleep disturbance, morning stiffness, chronic fatigue, poor endurance, and exhaustion following minimal effort, and is often associated with headache and irritable bowel syndrome. Currently, there is no laboratory test to diagnose fibromyalgia. According to the American College of Rheumatology, the diagnosis of fibromyalgia can be rendered if patients have widespread pain for 3 months and pain in response to palpation at 11 of the 18 identified tender point sites. Pain is considered widespread when all of the following are present: (i) pain in the left and right side of the body, (ii) pain above and below the waist, and (iii) axial skeletal pain -- cervical spine, anterior chest, thoracic spine, or low back. The 18 tender point sites are located bilaterally at the following 9 areas: (i) occiput -- suboccipital muscle insertions, (ii) low cervical -- anterior aspects of the intertransverse spaces at C5 to C7, (iii) trapezius
-- midpoint of the upper border, (iv) supraspinatus -- above the scapula spine near the medial border, (v) second rib -- second costochondral junctions, just lateral to the junctions on upper surfaces, (vi) lateral epicondyle -- 2 cm distal to the epicondyles, (vii) gluteal -- upper outer quadrants of buttocks in anterior fold of muscle, (viii) greater trochanter -- posterior to the trochanteric prominence, and (ix) knee -- medial fat pad proximal to the joint line. It is estimated that 3 to 6 million individuals in the United States may be afflicted with fibromyalgia, and approximately 15 to 20% of patients seen in a rheumatology practice have this disorder. Approximately 80 to 95% of all cases are women, usually between the ages of 30 and 60 years. Fibromyalgia is also found in children between the ages of 5 and 17 years, primarily white females, but the prevalence of this disorder in this age group is unknown. On the other hand, fibromyalgia is seldom seen in elderly patients (between the ages of 70 and 90 years), suggesting that symptoms may improve with time. The exact cause of fibromyalgia is still unclear, and presently there is no cure for this disorder. Spontaneous improvement may occur in mild cases whereas recalcitrant cases need comprehensive treatment. There are a number of methods in the management of fibromyalgia. These include: (i) education of patient and family on current knowledge of fibromyalgia, (ii) myofascial therapy including heat, massage, stretching and trigger point injections, (iii) improvement in sleep quality with medications or via avoidance of aggravating environmental factors, (iv) fitness program with aerobic conditioning, and (v) psychological intervention through stress management and coping strategies. In addition, authorities have recommended a multidisciplinary approach that entails (i) therapy for associated diseases, (ii) lifestyle modifications, and (iii) pharmacotherapy.

Glombiewski et al (2013) critically evaluated the evidence regarding the efficacy of biofeedback (BFB) for fibromyalgia syndrome. These investigators performed a literature search using PubMed, clinicaltrials.gov (National Institute of Health), Cochrane Central Register of Controlled Trials, PsycINFO, SCOPUS, and manual searches. The effect size estimates were
calculated using a random-effects model. The literature search produced 123 unique citations; 116 records were excluded. The meta-analysis included 7 studies (321 patients) on EEG-BFB and EMG-BFB. In comparison to control groups, BFB significantly reduced pain intensity with a large effect size ($g = 0.79; 95\%\ CI: 0.22\text{ to }1.36$). Subgroup analyses revealed that only EMG-BFB and not EEG-BFB significantly reduced pain intensity in comparison to control groups ($g = 0.86; 95\%\ CI: 0.11\text{ to }1.62$). Biofeedback did not reduce sleep problems, depression, fatigue, or health-related quality of life in comparison to a control group. The authors concluded that interpretation of the results was limited because of a lack of studies on the long-term effects of EMG-BFB in fibromyalgia syndrome. Moreover, they stated that further research should focus on the long-term effectiveness of BFB in fibromyalgia and on the identification of predictors of treatment response.

There is insufficient evidence that biofeedback is effective in treating patients with fibromyalgia. Randomized controlled studies with large sample size are needed to ascertain the effectiveness of this treatment modality.

**Visual Disorders**

An abnormality in either the sensory or motor component of the visual system may lead to a variety of visual disorders. Many optometrists have employed vision therapies to treat these problems. While some vision therapies are concerned with the perceptual aspects of the sensory component of vision, most vision therapies deal with dysfunctions in the motor component. Vision therapy usually encompasses a wide variety of non-surgical methods including eye exercises, eye patches, penlights and mirrors, prisms and lenses, as well as computerized devices that provide feedback to patients to improve their visual problems by programming activities directed at stimulating proper function or building compensating systems to alleviate insufficiencies.

Since the 1970's, biofeedback has been employed for the
management of various ophthalmic problems such as oculomotor training for the correction of strabismus, nystagmus, amblyopia, refractive error reduction, and control of blepharospasm. Early biofeedback techniques for treating visual disorders centered on the utilization of EMG to monitor the frontalis muscle as a means of monitoring eye position. Although the use of EMG on extraocular muscles is rather straightforward, it is compromised by powerful signals from the facial muscles and by the imprecision introduced by the electrodes. Presently, the application of ophthalmic biofeedback usually involves direct monitoring of the eyes. There are several methods to achieve this goal including television systems, electromagnetic coil monitoring, electro-oculography (EOG), and photoelectro-oculography (PEOG).

The Accommotrac Vision Trainer is a high speed infrared optometer that provides biofeedback training of accommodation. The primary goal is to train patients to achieve better control of voluntary accommodation to improve functional myopia although it is claimed that this equipment can also be used to treat early presbyopia and latent hyperopia. This device records the vergence of light reflected from the retina at a rate of 30 to 40 times per second, and the signal is converted into an auditory tone which increases in pitch and rate as accommodation decreases. The subject receives immediate auditory feedback through headphones concerning his/her accommodative status. The signals can also be heard by the experimenter through an external speaker. Training takes place in a dark room with the subject watching a small amorphous green fixation light which can be presented at various dioptic settings.

Because of a lack of objective data, the effectiveness of biofeedback in the treatment of visual disorders such as nystagmus, strabismus, amblyopia, and blepharospasm remains unclear. Although some studies have suggested biofeedback may be useful in the treatment of various visual disorders, almost all reports were either in-house publications, abstracts of conference proceedings, case studies, or uncontrolled
studies with small sample sizes. When sound experimental studies with control groups, randomization, masking, and statistical analysis have been conducted, biofeedback has not been demonstrated to be effective in the treatment of visual disorders. More research with better experimental design and large sample size is needed to ascertain the effectiveness of biofeedback in the treatment of visual disorders, and the long-term effectiveness of any improvement.

Seizures

Epilepsy, one of the most common neurological disorders, is characterized by seizures that usually occur repeatedly over months or years without consistent provoking factors. The principal treatment modality for epilepsy is pharmacotherapy. The main objective is to protect patients from having seizures without interfering with normal cognitive function, or in children with development of normal intellectual function, without producing adverse side effects. Approximately 70% of patients with epilepsy can be satisfactorily managed by pharmacotherapy. The remaining patients appear to be resistant to medications or develop undesirable side effects. For patients who have intractable seizures despite adequate treatment with appropriate antiepileptic drugs, surgery may be their last hope.

A non-pharmacological intervention for intractable seizures is EEG biofeedback. Electroencephalography is the recording of the electrical currents generated spontaneously from nerve cells in the brain using electrodes placed usually on the scalp. Electroencephalographic biofeedback entails the monitoring of brain wave activity associated with different mental states. There were studies, usually uncontrolled with small number of subjects, that reported the successful treatment of epileptic seizure disorders through biofeedback training of various EEG patterns, especially a 12 to 16 Hz EEG pattern also known as sensorimotor rhythm. However, there have been very few controlled studies with large sample size that included long-term follow-up to ascertain the improvements, if any, of EEG
biofeedback in the treatment of patients with intractable seizures.

Based on frequency and amplitude, EEGs commonly comprise 4 types of brain waves -- beta, alpha, theta, and delta (in order of frequency from fastest to slowest). Beta waves (above 13 Hz) predominate when the cerebrum is engaged with sensory stimulation or mental activities. Alpha waves (8 to 13 Hz) characterize EEGs of individuals who are awake, in a relaxed, non-attentive state, but with eyes closed. Theta waves (4 to 7 Hz) generally represent EEGs of individuals who are in a state of drowsiness. Delta waves (less than 4 Hz) are normally observed in individuals who are in deeper stages of sleep. The aim of EEG biofeedback in treating seizures is to train patients to increase the desired alpha waves (to enhance the 12 to 16 Hz sensorimotor rhythm in the EEG) and/or decrease the undesired theta and delta waves.

There is insufficient scientific evidence to support the effectiveness of EEG biofeedback in the management of patients with intractable seizures. Studies that claimed EEG biofeedback to be effective were uncontrolled case studies involving small number of subjects.

Back Pain

Chronic low back pain (LBP) is one that lasts for more than 3 months. Treatments of chronic LBP include bed rest, traction, wearing of spinal braces and other movement-restricting appliances, exercises, heating or cooling modalities, massage, chiropractic manipulation, pharmacotherapies such as non-steroidal anti-inflammatory drugs, muscle relaxants, non-narcotic analgesics, narcotic analgesics, and psychotropic medications, as well as surgeries such as discectomy/discotomy, laminectomy/laminotomy, therapeutic injections, spinal fusion, spinal osteotomy, and neuroablative procedures. Behavior therapy and behavior modification techniques have also been employed in the management of patients with chronic LBP. One of the behavioral therapies used is EMG biofeedback. This
technique is often used to improve lumbar paraspinal muscle strength, sometimes in conjunction with the upper trapezius and frontalis muscle groups.

The outcome measures deemed important in assessing the effectiveness of EMG biofeedback for the treatment of patients with chronic LBP are resolution or reduction of pain, decreases in the use of pain medications, and increases in functional activity level.

The effectiveness of EMG biofeedback in the treatment of patients with chronic LBP has not been established. Although biofeedback may reduce the activity of paraspinal muscles, there are conflicting data regarding the effectiveness of EMG biofeedback in the treatment of patients with chronic LBP.

**Cardiovascular Diseases**

In a review on the use of biofeedback in the treatment of cardiovascular diseases, Moravec (2008) noted that studies have clearly shown that patients can use biofeedback techniques to regulate the input of the autonomic nervous system to the heart, but the clinical utility of these techniques has not been well-explored in systematic trials. Much biofeedback research to date has focused on patients with hypertension, but outcomes have been inconclusive. Preliminary studies suggested that heart rate variability biofeedback may be useful in improving symptoms and quality of life in patients with cardiac disease, and early studies suggested a possible effect of biofeedback on remodeling of the failing heart. Both of these areas require further research, however. Biofeedback is increasingly used as an adjunct to stress management in cardiac rehabilitation programs, providing the impetus for a large-scale, systematic study of self-regulation in cardiac disease.

McKee and Moravec (2010) stated that biofeedback training can be used to reduce activation of the sympathetic nervous system (SNS) and increase activation of the parasympathetic
nervous system (PNS). It is well-established that hyper-
activation of the SNS contributes to disease progression in
chronic heart failure. It has been postulated that under-
activation of the PNS may also play a role in heart failure
pathophysiology. In addition to autonomic imbalance, a chronic
inflammatory process is now recognized as being involved in
heart failure progression, and recent work has established that
activation of the inflammatory process may be attenuated by
vagal nerve stimulation. By interfering with both autonomic
imbalance and the inflammatory process, biofeedback-assisted
stress management may be an effective treatment for patients
with heart failure by improving clinical status and quality of life.
Recent studies have suggested that biofeedback and stress
management have a positive impact in patients with chronic
heart failure, and patients with higher perceived control over
their disease have been shown to have better quality of life.
The authors' ongoing study of biofeedback-assisted stress
management in the treatment of end-stage heart failure
examine biological end points in treated patients at the time of
heart transplant, in order to assess the effects of biofeedback
training on the cellular and molecular components of the failing
heart. These researchers hypothesize that the effects of
biofeedback training will extend to remodeling the failing
human heart, in addition to improving quality of life.

**Childhood Apraxia of Speech**

In a Cochrane review on childhood apraxia of speech (CAS),
Morgan and Vogel (2008) evaluated the effectiveness of
intervention delivered by speech and language
pathologists(s)/speech and language therapists targeting CAS in
children and adolescents. The review considered RCTs and
quasi-randomized studies of children aged 3 to 16 years with
CAS, grouped by treatment types (e.g., perceptual and
instrumentally-based biofeedback treatment techniques). Two
authors independently assessed titles and abstracts identified
from the searches and obtained full text versions of all
potentially relevant articles. Articles were assessed for design
and risk of bias. In addition to outcome data, a range of
variables about participant group and outcomes were documented. Of 825 titles and abstracts searched, only 31 abstracts appeared to meet inclusion criteria. The remaining 794 papers were excluded predominantly on the basis of not including participants with CAS (e.g., focused on other developmental speech disorders or adult acquired apraxia of speech), or for not being intervention studies (i.e., being diagnostic or descriptive). All 31 full text articles obtained were excluded following evaluation as they did not meet inclusion criteria on design. Thus, no studies are included in this review. The authors concluded that the review demonstrated a critical lack of well-controlled treatment studies addressing the effectiveness for CAS, making it impossible for conclusions to be drawn about which interventions are most effective for treating CAS in children or adolescents.

Neurogenic Bladder

Aslan and Kogan (2002) noted that urinary diversion, usually with an ileal conduit, was the ultimate outcome for most children with spina bifida. The revolutionary institution of clean intermittent catheterization has changed the algorithm totally. Furthermore many new drugs have been developed during the past decade and have decreased the need for surgery dramatically. These researchers focused on the most recent data on new modalities of therapy to help avoid urinary diversion or bladder augmentation. In addition to clean intermittent catheterization and oxybutynin treatment, a new generation of anti-cholinergic medications, such as tolterodine, has been developed. For patients who drop out because of the side-effects of oral administration, new methods of administration are now available, including extended release and intravesical instillation. For those unresponsive, botulinum-A toxin and resiniferatoxin are 2 relatively new drugs in the field, administered as intravesical injection and instillation, respectively. Intravesical or transdermal electrical stimulation, sacral nerve stimulation and biofeedback therapy are under development, but as currently administered, are not yet completely successful.
In a pilot study, McClung et al (2006) determined the effectiveness of a combined program of pelvic floor training and advice (PFTA), EMG biofeedback, and neuromuscular electrical stimulation (NMES) for bladder dysfunction in multiple sclerosis (MS). Females (n = 30) who fulfilled strict inclusion/exclusion criteria were recruited. Outcome measures (weeks 0, 9, 16, and 24) included: 3-day voiding diary; 24-hr pad-test; uroflowmetry; pelvic floor muscle assessment; incontinence impact questionnaire; urogenital distress inventory; King's health questionnaire, and the MS quality of life-54 instrument. Following baseline (week 0) assessment, participants were randomly allocated, under double blind conditions, to one of the three groups: Group 1 (PFTA); Group 2 (PFTA and EMG biofeedback); and Group 3 (PFTA, EMG biofeedback, and NMES). Treatment was for 9 weeks. Baseline severity (measured by number of leaks and pad weight) showed some variation between groups, although not statistically significant (p > 0.05); with the caveat that this baseline imbalance makes interpretation difficult, a picture emerges that at week 9, Group 3 demonstrated superior benefit as measured by the number of leaks and pad test than Group 2, with Group 1 showing less improvement when compared to week 0; this was statistically significant between Groups 1 and 3 for number of leaks (p = 0.014) and pad tests (p = 0.001), and Groups 1 and 2 for pad tests (p = 0.001). A similar pattern was evident for all other outcome measures. The authors concluded that results suggest that these treatments, used in combination, may reduce urinary symptoms in MS. They stated that further research will establish the effectiveness of these interventions.

In a review on the diagnosis and treatment of neurogenic bladder, Hattori (2007) stated that bladder function has 2 phases, urine storage and urine evacuation which are based on the complex neurological controls including central as well as peripheral nervous system. Thus, various neurological lesions can cause bladder dysfunctions such as disturbed storage or disturbed urine evacuation. Micturitional symptoms can be divided into storage symptoms and voiding symptoms. Storage symptoms include urgency, frequency of micturition and
urinary incontinence, on the other hand voiding symptoms include difficulty in starting micturition, prolonged or intermittent micturition and urinary retention. The pathophysiology of bladder dysfunction is known by performing urodynamic studies such as uroflowmetry, residual urine measurement, cystometry, external urethral sphincter electromyography, pressure-flow study and voiding urethrocystography. The most common cause of storage symptom is detrusor overactivity, which can occurs in the central nervous system disorders. Disturbed voiding can be due to poor relaxation of urethral sphincter or detrusor weakness. The treatment of neurogenic bladder usually can be done by the combination of bladder training, intermittent catheterization and pharmacotherapy. It is very important to try to avoid the bladder over-distension which can cause weak detrusor and poor recovery. Biofeedback is not mentioned as an option for treatment.

**Diabetes**

McGrady (2010) stated that the metabolic syndrome is likely to develop in patients in whom chronic stress, genetic predisposition, negative emotion, as well as unhealthy lifestyle habits converge. In light of the psychophysiological aspect of most of these factors, biofeedback, relaxation, and many other psychophysiological interventions have been studied and used in the management of patients with elements of the metabolic syndrome, especially in diabetic and hypertensive patients. The author reviewed the rationale and evidence of biofeedback for the treatment of diabetes and hypertension, which has been shown to effectively lower blood glucose and BP in numerous studies. Individuals with pre-hypertension may be a particularly appropriate target population for biofeedback for BP reduction. The author concluded that further investigation is needed to identify the best candidates for psychophysiological intervention for these conditions.

**Balance Training**
The Melbourne (Australia) 2010 National Stroke Foundation's clinical guidelines for stroke management does not mention the use of balance training and visual biofeedback for stroke rehabilitation. Also, the Scottish Intercollegiate Guidelines Network's clinical guideline on management of patients with stroke (2010) states that (i) EMG biofeedback is not recommended as a routine treatment for gait, balance or mobility problems after stroke, and (ii) balance platform training with visual feedback is not recommended for the treatment of gait, balance or mobility problems after stroke.

In a prospective, multi-center study, Badke et al (2011) evaluated balance recovery and quality of life after tongue-placed electrotactile biofeedback training in patients with stroke. Patients (n = 29) were administered 1 week of therapy plus 7 weeks of home exercise using a novel tongue-based biofeedback balance device. The Berg Balance Scale (BBS), Timed Up and Go (TUG), Activities-Specific Balance Confidence (ABC) Scale, Dynamic Gait Index (DGI), and Stroke Impact Scale (SIS) were performed before and after the intervention on all subjects. There were statistically and clinically significant improvements from baseline to post-test in results for the BBS, DGI, TUG, ABC Scale, and some SIS domains (Mobility, Activities of Daily Living/Instrumental Activities of Daily Living, Social, Physical, Recovery domains). Average BBS score increased from 35.9 to 41.6 (p < 0.001), and DGI score, from 11.1 to 13.7 (p < 0.001). Time to complete the TUG decreased from 24.7 to 20.7 seconds (p = 0.002). Including the BBS, DGI, TUG, and ABC Scale, 27 subjects improved beyond the minimal detectable change with 95 % certainty (MDC-95) or minimal clinically important difference (MCID) in at least 1 outcome and 3 subjects improved beyond the MDC-95 or MCID in all outcomes. The authors concluded that electrotactile biofeedback seems to be a promising integrative method to balance training. They stated that a future RCT is needed.

Parker et al (2011) reviewed the evidence to determine the current scientific basis underpinning the use of visual and/or auditory feedback for computer technology in home-based
upper-limb stroke rehabilitation. A systematic search was conducted using the following databases: CINAHL (EBSCO), MEDLINE (Ovid and CSA), PubMed, Science Direct (Elsevier) and Cochrane Library. Journals, book chapters and conference proceedings were also used in the systematic search. Relevant papers were critically appraised using the Critical Appraisal Skills Programme tool for RCTs/quantitative designs. Four controlled trials were identified as being relevant. Although the evidence is scarce, existing findings suggested that extrinsic visual and auditory feedback may improve motor and functional performance. In addition, concurrent feedback, knowledge of performance, knowledge of results and explicit feedback may be key components in the promotion of improved performance. The authors concluded that there is a paucity of evidence to inform the development and the use of technological systems for home-based stroke rehabilitation and specifically how such systems might be developed to provide best forms of feedback in the absence of a therapist. They stated that further work is required to first investigate the efficacy of visual and auditory feedback using technology systems and second to explore their utilization with the end user.

Cleft Palate Speech

Neumann and Romonath (2012) conducted a systematic review analyzing the effectiveness of nasopharyngoscopic biofeedback in clients with cleft lip and palate and velopharyngeal dysfunction. Extensive electronic search and analysis of the databases of Cochrane Library, MEDLINE, EMBASE, ERIC, PsycInfo, CINAHL, AMED, Journals@Ovid, and German Databases, including all papers published since 1970 plus a manual search of the Cleft Palate-Craniofacial Journal (1970 to 3/2010) were carried out. A total of 6 studies met the inclusion criteria. Their analysis reflects a low level of evidence and a broad heterogeneity concerning age range, intervention methods, and outcome measurement. The authors concluded that the analyzed studies showed that nasopharyngoscopy may be effective only in combination with traditional speech therapy
in helping patients with cleft palate speech optimize their velopharyngeal closure in articulation, but the quantity and quality of studies were limited.

**Pelvic Floor Dysfunction**

Fitz et al (2012) stated that biofeedback (BF) has been widely used in the treatment of pelvic floor dysfunctions, mainly by promoting patient learning about muscle contraction with no side effects. However, its effectiveness remains poorly understood with some studies suggesting that BF offers no advantage over the isolated pelvic floor muscle training (PFMT). These investigators systematically reviewed available RCTs assessing the effectiveness of BF in female pelvic floor dysfunction treatment. Trials were electronically searched and rated for quality by use of the PEDro scale (values of 0 to 10). Randomized controlled trials assessing the training of pelvic floor muscle (PFM) using BF in women with PFM dysfunction were selected. Outcomes were converted to a scale ranging from 0 to 100. Trials were pooled with software used to prepare and update Cochrane reviews. Results were presented as weighted mean differences with 95 % CI. A total of 22 trials with 1,469 patients that analyzed BF in the treatment of urinary, anorectal, and/or sexual dysfunctions were included. Pelvic floor muscle training alone led to a superior but not significant difference in the function of PFM when compared to PFMT with BF, by using vaginal measurement in the short- and intermediate-term: 9.89 (95 % CI: -5.05 to 24.83) and 15.03 (95 % CI: -9.71 to 39.78), respectively. These researchers found a few and non-homogeneous studies addressing anorectal and sexual function, which do not provide the cure rate calculations. Limitations of this review were the low quality and heterogeneity of the studies, involving the usage of distinct protocols of interventions, and various and different outcome measures. The authors concluded that the results of this systematic review suggested that PFMT with BF is not more effective than other conservative treatments for female PFM dysfunction.
Pre-Term Labor

Siepmann et al (2014) examined the effects of heart rate variability (HRV)-biofeedback in patients with pre-term labor. These researchers conducted a controlled randomized parallel group study in 48 female patients aged 19 to 38 years (median = 29) with pre-term labor at gestational week 24th to 32nd (median = 29th). In this study, one group (n = 24) attended 6 sessions of HRV-biofeedback over 2 weeks whereas patients of the other group (n = 24) were assigned to control sessions. In the HRV-biofeedback treated group, perception of chronic stress was decreased 4 weeks after completion of training compared to baseline (p < 0.05) but there was no change in the control group. In the HRV-biofeedback group, pre-term birth was seen in 3 patients (13 %) whereas in the control group, pre-term delivery occurred in 8 patients (33 %, p = non-significant). There was no difference in birth weight between groups and HRV remained unchanged. The authors concluded that the findings of this study demonstrated that HRV-biofeedback can reduce chronic stress in patients with pre-term labor when administered as an adjunct to routine care. However, it remains unclear whether stress reduction through HRV-biofeedback has a beneficial effect on pre-term birth.

Sleep Bruxism

In a systematic review, Wang et al (2014) evaluated the effectiveness of any biofeedback treatment on sleep bruxism. These investigators searched the Cochrane Central Register of Controlled Trials, Medline, Embase, ISI Web of Science, System for Information on Grey Literature in Europe, Chinese Biomedical Literature Database, and PsycINFO up to October 2012 for RCTs and controlled clinical trials involving biofeedback treatment for sleep bruxism. Reference lists of relevant studies were hand-searched. Quality assessment and data extraction were performed by 2 reviewers independently. A total of 7 eligible studies involving 240 participants were finally included; 3 of them had moderate risk of bias, and 4 had high risk of bias. In an EMG-measured sleep bruxism episode, meta-analysis
showed no significant difference between contingent electrical stimulation and blank control (95% CI: 12.33 to 3.38, p = 0.26). Moreover, 5 studies reported EMG activity index. Due to the diversity of biofeedback modalities (auditory, electrical, and visual stimulus) and controls (splint, occlusal adjustment, etc.), these data were unable to be pooled, so only qualitative description was provided. The authors concluded that in the current stage, there is no powerful evidence to support the use of biofeedback technology on sleep bruxism treatment.

Contingent electrical stimulation, which is defined as a kind of biofeedback modality, showed no effect on reducing sleep bruxism episode compared with the no-treatment group. They stated that although many studies supported the effectiveness of biofeedback treatment, more large sample-sized RCTs that adopt uniform outcome index are needed to verify its application.

Miscellaneous Indications

In a single-center, randomized trial, Peirce et al (2013) compared early home BFB physiotherapy with pelvic floor exercises (PFEs) for the initial management of women sustaining a primary third-degree vaginal tear (n = 120). Women were randomized in a 1 to 3 ratio: 30 to early postpartum home BFB physiotherapy and 90 to PFEs. Main outcome measures included differences in anorectal manometry results, Cleveland Clinic continence scores and Rockwood fecal incontinence quality of life scale scores after 3 months of post-partum treatment. The mean anal resting pressure was 39 ± 13 mmHg in the early BFB physiotherapy group and 43 ± 17 mmHg in the PFE group. The mean anal squeeze pressure was 64 ± 17 mmHg in the BFB group and 62 ± 23 mmHg in the PFE group. There was no significant difference in anal resting and squeeze pressure values between the groups (p = 0.123 and p = 0.68, respectively). There were no differences in symptom score and quality of life measurements between the groups. The authors concluded that the findings of this study demonstrated no added value in using early home BFB physiotherapy in the management of women sustaining
Fazeli et al (2015) stated that BFB has been used to treat children with symptoms of bladder dysfunction not responding to standard therapy alone. However, evidence of the effectiveness of BFB is scarce and is based on small studies. These investigators conducted a systematic review of the literature to assess the effects of BFB as adjunctive therapy for symptoms of non-neuropathic voiding disorders in children up to age 18 years. They searched MEDLINE, Embase and CENTRAL on the OvidSP platform as well as conference proceedings for randomized trials presented at scientific conventions, symposia and workshops through August 13, 2013. Hand-searches and review of reference lists of retrieved articles were also performed. A total of 5 eligible studies were included in the systematic review, of which 4 (382 participants) were pooled in the meta-analysis based on available outcomes data. The overall proportion of cases with resolved incontinence at month 6 was similar in the BFB and control groups (OR 1.37 [95 % CI: 0.64 to 2.93], RD 0.07 [-0.09, 0.23]). There was also no significant difference in mean maximum urinary flow rate (mean difference of 0.50 ml, range of -0.56 to 1.55) or likelihood of urinary tract infection (OR 1.30 [95 % CI: 0.65 to 2.58]). The authors concluded that current evidence does not support the effectiveness of BFB in the management of children with non-neuropathic voiding disorders. They stated that more high-quality RCTs are needed to better evaluate the effect of BFB.

Hunt et al (2014) compared performance error and perceived difficulty during toe-out gait modification in people with knee osteoarthritis (OA) across 3 different types of visual feedback: (i) mirror, (ii) raw video, and (iii) real-time biofeedback of toe-out angle. Individuals with knee OA (n = 20; 11 women; mean age of 65.4 ± 9.8 years) participated in this study; 7 participants had mild knee OA, 9 had moderate knee OA, and 4 had severe knee OA. Participants were trained to walk on a treadmill while matching a target indicating a 10° increase in stance phase toe-out compared with toe-out angle measured during self-selected
walking. The target was provided visually via the 3 types of feedback listed above and were presented in a random order. Kinematic data were collected and used to calculate the difference between the target angle and the actual performed angle for each condition (toe-out performance error). Difficulty was assessed using a numerical rating scale (0 to 10) provided verbally by participants. Toe-out performance error was significantly less when using the real-time BFB method than when using the other 2 methods ($p = 0.025$; mean difference versus mirror = $2.05^\circ$; mean difference versus raw video = $1.51^\circ$). Perceived difficulty was not statistically different between the groups ($p = 0.51$). The authors concluded that although statistically significant, the $2^\circ$ difference in toe-out gait performance error may not necessitate the large economic and personnel costs of real-time BFB as a means to modify movement in clinical or research settings.

Richards et al (2017) reviewed the evidence regarding methods and effects of real-time BFB used as a method for gait retraining to reduce knee adduction moment (KAM), with intended application for patients with knee OA (KOA). Searches were conducted in Medline, Embase, CINAHL, SPORTDiscus, Web of Science, and Cochrane Central Register of Controlled Trials with the keywords gait, feedback, and knee osteoarthritis from inception to May 2015. Titles and abstracts were screened by 1 individual for studies aiming to reduce KAM. Full-text articles were assessed by 2 individuals against pre-defined criteria. Data were extracted by 1 individual according to a pre-defined list, including participant demographics and training methods and effects. Electronic searches resulted in 190 potentially eligible studies, from which 12 met all inclusion criteria. Within-group standardized mean differences (SMDs) for reduction of KAM in healthy controls ranged from 0.44 to 2.47 and from 0.29 to 0.37 in patients with KOA. In patients with KOA, improvements were reported in pain and function, with SMDs ranging from 0.55 to 1.16. Methods of implementation of biofeedback training varied between studies, but in healthy controls increased KAM reduction was noted with implicit, rather than explicit, instructions. The authors concluded that
this review suggested that BFB gait training is effective primarily for reducing KAM but also for reducing pain and improving function in patients with KOA. However, the review was limited by the small number of studies featuring patients with KOA and the lack of controlled studies. They stated that the results suggested that there is value and a need in further researching BFB training for reducing KAM; future studies should include larger cohorts of patients, long-term follow-up, and controlled trials.

Anger Management

Francis et al (2016) stated that research suggested that heart rate variability (HRV) is a physiological indicator of the flexibility of the autonomic nervous system and can provide an objective measure of an individual's ability to appropriately match emotional responses to environmental demands. These researchers examined if angry response to emotional stimuli was related to HRV, and whether manipulation of HRV using BFB could change the anger response in a healthy adult population. A total of 58 participants received HRV-BFB (n = 29) or an active control condition (n = 29); HRV measures included standard deviation of normal-to-normal intervals (SDNN), low-frequency (LF) and high-frequency (HF) power, and was recorded across 3 sessions: (i) baseline, (ii) training, and (iii) anger induction. The anger induction procedure resulted in increased subjective experience of anger, as well as physiological changes. The BFB group had higher HRV than active controls both during the training session (SDNN and LF HRV) and during anger induction (LF HRV). Heart rate variability during anger induction was significantly associated with self-reported emotional response for participants receiving BFB but not for active controls. The authors concluded that results provided support for HRV as an index of emotion regulation, specifically anger. Moreover, they stated that further research is needed to determine whether long-term HRV-BFB can have a lasting effect on managing anger.

Improvement of Anorectal/Bowel Functions After Sphincter-Saving
Surgery for Rectal Cancer

Kim and colleagues (2015) prospectively examined the effects of BFB therapy on objective anorectal function and subjective bowel function in patients after sphincter-saving surgery for rectal cancer. A total of 16 patients who underwent an ileostomy were randomized into 2 groups: one receiving conservative management with the Kegel maneuver and the other receiving active BFB before ileostomy closure. Among them, 12 patients (mean age of 57.5 years; range of 38 to 69 years; 6 patients in each group) completed the study. Conservative management included lifestyle modifications, Kegel exercises, and medication. Patients were evaluated at baseline and at 1, 3, 6, and 12 months after ileostomy closure by using anal manometry, modified Wexner Incontinence Scores (WISs), and fecal incontinence quality of life (FI-QoL) scores. Before the ileostomy closure, the groups did not differ in baseline clinical characteristics or resting manometric parameters. After 12 months of follow-up, the BFB group demonstrated a statistically significant improvement in the mean maximum squeezing pressure (from 146.3 to 178.9, p = 0.002). However, no beneficial effect on the WIS was noted for BFB compared to conservative management alone. Overall, the FI-QoL scores were increased significantly in both groups after ileostomy closure (p = 0.006), but did not differ significantly between the 2 groups. The authors concluded that although the BFB therapy group demonstrated a statistically significant improvement in the maximum squeezing pressure, significant improvements in the WISs and the FI-QoL scores over time were noted in both groups. They noted that the study was terminated early because no therapeutic benefit of BFB had been demonstrated.

Pain Associated with Multiple Sclerosis

In a proof of principle study, Jensen et al (2016) examined the potential benefits of EEG neurofeedback for increasing responsiveness to self-hypnosis training for chronic pain management. The study comprised 20 individuals with
multiple sclerosis (MS) who received 5 sessions of self-hypnosis training: 1 face-to-face session and 4 pre-recorded sessions. Participants were randomly assigned to have the pre-recorded sessions preceded by either (a) EEG-BFB (neurofeedback) training to increase left anterior theta power (NF-HYP) or (b) a relaxation control condition (RLX-HYP). A total of 18 participants completed all treatment sessions and assessments; NF-HYP participants reported greater reductions in pain than RLX-HYP participants. The authors concluded that the findings of this study provided support for the potential treatment-enhancing effects of neurofeedback on hypnotic analgesia and also suggested that effective hypnosis treatment can be provided very efficiently.

Post-Traumatic Stress Disorder

Chrapusta et al (2015) evaluated the effectiveness of neurofeedback in reducing the symptoms of post-trauma stress disorder (PTSD), which had developed as a result of a high-voltage electric burn to the head. Quantitative EEG (qEEG) and event related potentials (ERPs) were utilized in the evaluation. These investigators presented the case of a 21-year old patient who experienced 4th degree burns to his head as a result of a high-voltage electric burn. The patient was repeatedly operated on and despite the severity of the injuries was able to recover. However the patient complained of flashbacks, difficulties with sleeping as well as an inability to continue work in his given profession. Special tests showed the presence of PTSD. As a result, the patient was treated with neurofeedback therapy. The effectiveness of this therapy in the reduction of the symptoms of PTSD were evaluated through the utilization of qEEG and ERPs. It was found that in the first examination that ERPs displayed the most significant deviations from the reference in the 2 components: (i) the one component was generated within the cingulate cortex. The pattern of its deviation from the norms was similar to that found in a group of obsessive-compulsive disorder patients. In contrast to healthy subjects the component repeated itself twice; (ii) the second component was generated in the medial prefrontal
cortex. Its pattern was similar to that found in PTSD patients. There was a delay in the late part of the component, which probably reflected the flashbacks. In the second examination, after neurofeedback training, the ERPs were similar to the norm. The patient returned to work. The authors concluded that chronic PTSD developed within the patient as a result of a high-voltage electric burn. The application of neurofeedback resulted in the withdrawal of the syndrome symptoms.

Reiter et al (2016) stated that neurofeedback is an alternative, non-invasive approach used in the treatment of a wide range of neuropsychiatric disorders, including PTSD. Many different neurofeedback protocols and methods exist. Likewise, PTSD is a heterogeneous disorder. These investigators reviewed the evidence on effectiveness and preferred protocol when using neurofeedback treatment on PTSD. They performed a systematic search of PubMed, PsychInfo, EMBASE, and Cochrane databases. A total of 5 studies were included in this review; neurofeedback had a statistically significant effect in 3 studies. Neurobiological changes were reported in 3 studies. The authors noted that interpretation of results was, however, limited by differences between the studies and several issues regarding design. They stated that these optimistic results qualify neurofeedback as probably effective for PTSD treatment.

Blase and colleagues (2016) analyzed the effectiveness of HRV-BFB as an additional psychophysiological treatment for depression and PTSD. These researchers performed a Systematic review with search terms HRV, biofeedback, PTSD, depression, panic disorder and anxiety disorder. The search of the literature yielded 789 studies. After critical appraisal using the GRADE method, these investigators selected 6 RCTs and 4 relevant studies. The RCTs with control groups “treatment as usual” and muscle relaxation training revealed significant clinical effectiveness and better results than control conditions after 4 to 8 weeks training. The authors concluded that although this systematic review showed the popularity of HRV in literature, it did not indicate that HRV-BFB really has been
reviewed systematically. Significant outcomes of this limited number of randomized studies indicated there may be a clinical improvement when HRV-BFB training is integrated into treatment of PTSD and depression, particularly when this integration procedure is combined with psychotherapy. They stated that more research with larger groups is needed to integrate HRV-BFB into treatment of stress-related disorders in psychiatry. Moreover, they stated that future research also needs to focus on the psychophysiological mechanisms involved.

**Psychosis**

Clamor and colleagues (2016) stated that arousal and the way it is coped with are relevant to the emergence of psychotic symptoms; HRV stems from autonomic responses to environmental demands such as stress and is an index of physiological arousal, adaptability, and homeostatic reflexes forming autonomic balance. A randomized-controlled between-subjects trial that compared HRV-BF to an active relaxation and to a waiting control condition was conducted in a sample with attenuated sub-clinical psychotic symptoms (n = 84). A 20-min intervention was preceded and followed by repeated assessments of stress responses. Change scores of the post-stress periods were analyzed using ANOVAs for HRV, subjective stress, perceived control, and state paranoia. As expected, BF participants showed greater improvements in perceived control than waiting controls (p = 0.006). However, no group differences occurred in HRV, paranoid symptoms or subjective stress. In exploratory analyses in a subset of subjects who were breathing per protocol, the expected effects were found for total HRV and state paranoia. The authors concluded that the findings of this trial of HRV-BF for people with attenuated psychotic symptoms indicated that the intervention may hold potential if conducted per protocol. They stated that to reach this, longer training might be inevitable; future studies are needed to further elucidate applicability and effectiveness of HRV-BF in clinical samples.
Combined Neurofeedback and Heart Rate Variability Training for the Treatment of Anxiety and Depression:

White et al (2017) stated that neurofeedback (NFB) and heart rate variability (HRV) training present promising, non-pharmaceutical intervention strategies for anxiety and depression. In a retrospective study, these researchers examined if concurrent NFB and HRV (NFB+HRV) provides a viable intervention for symptoms of anxiety and depression, measured by the Achenbach System of Empirically Based Assessment (ASEBA) questionnaire. A total of 183 children and adults with symptoms of anxiety and/or depression underwent NFB+HRV training. Psychological symptom rating, EEG, blood pressure (BP), breathing pattern, and HRV were measured before and after treatment. After NFB+HRV training, symptoms of anxiety (p < 0.001, dz = 1.42) and depression (p < 0.001, dz = 1.34) were reduced in children and adults. The majority of individuals with pre-treatment symptoms of anxiety (82.8 %) or depression (81.1 %) experienced ASEBA improvements of clinical importance. There were also significant changes in EEG, breathing rate, and HRV. For the 16 individuals co-presenting with hypertension, systolic and diastolic BP were significantly reduced. The authors concluded that NFB+HRV training may provide an effective, non-pharmaceutical intervention to reduce symptoms of anxiety and depression in children and adults. Additionally, NFB+HRV training may improve EEG, BP, resting breathing rate, and HRV.

The authors noted that the drawbacks of this study included its retrospective design and the lack of a sham control group. Also, a limited EEG, and not a full-cap 19- electrode quantitative EEG, was utilized to analyze brain wave activity at baseline and follow-up visits. Rather than training individual rhythms, this NFB protocol trained 2 ratio metrics; which meant that for a given change in the trained ratio, these investigators did not distinguish whether this was accomplished by a change in the numerator rhythm, an opposing change in the denominator rhythm, or both. Measurement of psychological symptom presence and severity in this study was based on the ASEBA,
which does not finely distinguish between subtypes of anxiety or depression (e.g., post-traumatic stress disorder or obsessive compulsive disorder). Any differential effects of the NFB+HRV protocol on various subtypes of anxiety and depression could therefore have been missed. For the HRV portion of the study, the study design enabled these researchers to consider only relative changes within the HRV power spectrum (rather than absolute changes). Subjects were also not re-examined after the conclusion of the program to determine whether the post-NFB+HRV changes were long-lasting. Finally, due to the study design, the authors were unable to distinguish between the potential benefits of NFB+HRV treatment versus either NFB or HRV treatment alone. They stated that although some factors, such as the large sample size (n =183), robust effect size, use of standard diagnostic DSMV criteria and ASEBA scores, and presence of physiological biomarkers mitigate the negative impact of these drawbacks, a prospective, blinded study with appropriate sham control group, more stringent inclusion criteria, and long-term follow-up is needed to determine whether NFB+HRV can indeed produce robust and long-lasting results.

In a meta-analysis, Goessl and associates (2017) examined the effect of HRV biofeedback on symptoms of anxiety and stress. Studies were extracted from PubMed, PsycINFO and the Cochrane Library. The search identified 24 studies totaling 484 participants who received HRV biofeedback training for stress and anxiety. These researchers conducted a random-effects meta-analysis. The pre-post within-group effect size (Hedges' g) was 0.81. The between-groups analysis comparing biofeedback to a control condition yielded Hedges' g = 0.83. Moderator analyses revealed that treatment efficacy was not moderated by study year, risk of study bias, percentage of females, number of sessions, or presence of an anxiety disorder. The authors concluded that HRV biofeedback training was associated with a large reduction in self-reported stress and anxiety. They stated that although more well-controlled studies are needed, this intervention offers a promising approach for treating stress and anxiety with wearable devices.
Chemotherapy-Induced Peripheral Neuropathy:

In a pilot study, Prinsloo and colleagues (2017) examined if EEG neurofeedback (NFB) could alleviate chemotherapy-induced peripheral neuropathy (CIPN) symptoms in cancer survivors. This was a RCT with survivors assigned to (i) an NFB group, or (ii) a wait-list control (WLC) group. The NFB group underwent 20 sessions of NFB, in which visual and auditory rewards were given for voluntary changes in EEGs. The Brief Pain Inventory (BPI) worst-pain item was the primary outcome. The BPI, the Pain Quality Assessment Scale, and EEGs were collected before NFB and again after treatment. Outcomes were assessed with general linear modeling. Cancer survivors with CIPN (average duration of symptoms, 25.3 months), who were mostly women and had a mean age of 62.5 years, were recruited between April 2011 and September 2014; 100% of the subjects starting the NFB program completed it (30 in the NFB group and 32 in the WLC group). The NFB group demonstrated greater improvement than the controls on the BPI worst-pain item (mean change score of -2.43 [95 % CI: -3.58 to -1.28] versus 0.09 [95 % CI: -0.72 to -0.90]; p = 0.001; effect size, 0.83). The authors concluded that NFB appeared to be effective at reducing CIPN symptoms. There was evidence of neurological changes in the cortical location and in the bandwidth targeted by the intervention, and changes in EEG activity were predictive of symptom reduction.

This study had several drawbacks: (I) these researchers did not have a placebo group. Because of this, they analyzed regions of the brain that are shown to be active in placebo analgesia, including regions of the brain that are associated with patient-reported outcomes during placebo conditions. The findings of this pilot study suggested that although the placebo effect may be a factor in this study, it was not the only factor leading to improvements in symptoms. Also, although the brain analyses used a Bonferroni correction, the results should still be considered exploratory and should be interpreted with caution, (ii) most of the subjects were women and breast cancer
survivors, so future research should investigate the effectiveness of NFB by chemotherapy type. An investigation is also needed that includes a sham NFB intervention to elucidate the exact mechanisms of NFB. Other questions to investigate include the role of NFB in the prevention of CIPN and other cancer pain conditions, the effectiveness of NFB in acute pain settings, and the role of NFB in symptom management both during and after active cancer treatment. Lastly, medications given for CIPN could affect the EEG; however, the participants in this study had symptoms even though they may had been on medications, and there were no differences between the 2 groups in the number of participants taking CIPN medications at the baseline.

**Chronic Pain in Survivors of Torture:**

In a Cochrane review, Baird and colleagues (2017) evaluated the effectiveness of interventions for treating persistent pain and associated problems in survivors of torture. These investigators searched for RCTs published in any language in CENTRAL, Medline, Embase, Web of Science, CINAHL, LILACS, and PsycINFO, from database inception to February 1, 2017. They also searched trials registers and grey literature databases; RCTs of interventions of any type (medical, physical, psychological) compared with any alternative intervention or no intervention, and with a pain outcome were selected for analysis. Studies needed to have at least 10 participants in each arm for inclusion. These researchers identified 3,578 titles in total after deduplication; they selected 24 full papers to assess for eligibility; and requested data from 2 completed trials without published results. These investigators used standard methodological procedures expected by Cochrane. They assessed risk of bias and extracted data; and calculated SMD and effect sizes with 95 % CI. They assessed the evidence using GRADE and created a “Summary of findings” table. A total of 3 small published studies (88 participants) met the inclusion criteria, but 1 had been retracted from publication because of ethical problems concerned with confidentiality and financial irregularities. Since these did not affect the data, the study was...
retained in this review. Despite the search including any intervention, only 2 types were represented in the eligible studies: 2 trials used cognitive behavioral therapy (CBT) with biofeedback versus waiting list on unspecified persistent pain (58 participants completed treatment), and 1 examined the effect of complex manual therapy versus self-treatment on LBP (30 participants completed treatment). Excluded studies were largely either not RCTs or did not report pain as an outcome. There was no difference for the outcome of pain relief at the end of treatment between CBT and waiting list (2 trials, 58 participants; SMD -0.05, 95 % CI: -1.23 to 1.12) (very low quality evidence); one of these reported a 3-month follow-up with no difference between intervention and comparison (28 participants; SMD -0.03, 95 % CI: -0.28 to 0.23) (very low quality evidence). The manual therapy trial also reported no difference between complex manual therapy and self-treatment (30 participants; SMD -0.48, 95 % CI: -9.95 to 0.35) (very low quality evidence). Two studies reported drop-outs, 1 with partial information on reasons; none of the studies reported AEs. There was no information from any study on the outcomes of use of analgesics or quality of life (QOL). Reduction in disability showed no difference at the end of treatment between CBT and waiting list (2 trials, 57 participants; SMD -0.39, 95 % CI: -1.17 to 0.39) (very low quality evidence); one of these reported a 3-month follow-up with no difference between intervention and comparison (28 participants; SMD 0, 95 % CI: -0.74 to 0.74) (very low quality evidence). The manual therapy trial reported superiority of complex manual therapy over self-treatment for reducing disability (30 participants; SMD -1.10, 95 % CI: -1.88 to -0.33) (very low quality evidence). Reduction in distress showed no difference at the end of treatment between CBT and waiting list (2 trials, 58 participants; SMD 0.07, 95 % CI: -0.46 to 0.60) (very low quality evidence); one of these reported a 3-month follow-up with no difference between intervention and comparison (28 participants; SMD -0.24, 95 % CI: -0.50 to 0.99) (very low quality evidence). The manual therapy trial reported superiority of complex manual therapy over self-treatment for reducing distress (30 participants; SMD -1.26, 95 % CI: -2.06 to -0.47) (very low quality evidence). The risk of
bias was considered high given the small number of trials, small size of trials, and the likelihood that each was under-powered for the comparisons it reported. These investigators primarily down-graded the quality of the evidence due to small numbers in trials, lack of intention-to-treat analyses, high unaccounted drop-out, lack of detail on study methods, and CIs around effect sizes that included no effect, benefit, and harm. The authors concluded that there was insufficient evidence to support or refute the use of any intervention for persistent pain in survivors of torture.

### CPT Codes / HCPCS Codes / ICD-10 Codes

*Information in the [brackets] below has been added for clarification purposes. Codes requiring a 7th character are represented by "+":*

<table>
<thead>
<tr>
<th>Code</th>
<th>Code Description</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>CPT codes covered if selection criteria are met:</strong></td>
</tr>
<tr>
<td>90834</td>
<td>Psychotherapy, 45 minutes with patient and/or family member</td>
</tr>
<tr>
<td>90875</td>
<td>Individual psychophysiological therapy incorporating biofeedback training by any modality (face-to-face with the patient), with psychotherapy (e.g., insight oriented, behavior modifying or supportive psychotherapy); approximately 20 - 30 minutes</td>
</tr>
<tr>
<td>90876</td>
<td>approximately 45 - 50 minutes</td>
</tr>
<tr>
<td>90901</td>
<td>Biofeedback training by any modality</td>
</tr>
<tr>
<td>90911</td>
<td>Biofeedback training, perineal muscles, anorectal or urethral sphincter, including EMG and/or manometry</td>
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**Other CPT codes related to the CPB:**
<table>
<thead>
<tr>
<th>Code</th>
<th>Code Description</th>
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<tbody>
<tr>
<td>96150 - 96155</td>
<td>Health and behavior assessment (e.g., health-focused clinical interview, behavioral observations, psychophysiological monitoring, health-oriented questionnaires), each 15 minutes face-to-face with the patient; initial assessment</td>
</tr>
</tbody>
</table>

**HCPCS codes not covered for indications listed in the CPB:**

E0746    Electromyography (EMG), biofeedback device

**ICD-10 codes covered if selection criteria are met:**

- **G43.001 - G43.919**: Migraine [muscle, thermal or skin biofeedback only - EEG biofeedback not covered] [not covered for pediatric migraine]
- **G44.201 - G44.229**: Tension-type headache
- **G89.3**: Neoplasm related pain (acute) (chronic)
- **H93.11 - H93.19**: Tinnitus
- **I69.00 - I69.998**: Sequelae of cerebrovascular disease
- **K58.0 - K58.9**: Irritable bowel syndrome
- **K59.00 - K59.09**: Constipation [chronic]
- **K59.4**: Anal spasm [levator ani syndrome]
- **M26.601 - M26.69**: Temporomandibular joint disorders
- **N39.0 - N39.9**: Urinary incontinence
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<td>N39.41 -</td>
<td>Incontinence of urine</td>
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<td>Fecal incontinence</td>
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<td>S06.0X05 -</td>
<td>Intracranial injury [TBI]</td>
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<td><strong>ICD-10 codes not covered for indications listed in the CPB (not all-inclusive):</strong></td>
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<tr>
<td>E08.00 -</td>
<td>Diabetes mellitus</td>
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<td>E13.9</td>
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<td>Alcohol dependence [addictions]</td>
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<td>F10.29</td>
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<td>Code</td>
<td>Code Description</td>
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<td>J30.0 - J30.9</td>
<td>Vasomotor and allergic rhinitis</td>
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<td>L50.0</td>
<td>Allergic urticaria</td>
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<td>Osteoarthrosis, lower leg [knee] [toe-out gait modification in people with knee osteoarthritis]</td>
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<td>M23.00 - M23.92</td>
<td>Internal derangement of knee</td>
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<td>M24.00 - M24.9</td>
<td>Other specific joint derangements [anterior shoulder instability]</td>
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<td>M25.511 - M25.519</td>
<td>Pain in shoulder [anterior]</td>
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<td>M62.48</td>
<td>Contracture of muscle, other site [pelvic floor dysfunction]</td>
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<tr>
<td>M79.7</td>
<td>Fibromyalgia</td>
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<td>N31.9</td>
<td>Neurogenic bladder dysfunction NOS</td>
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<td>N32.81</td>
<td>Overactive bladder</td>
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<td>N32.89 - N32.89</td>
<td>Other specified disorders of bladder [non-neuropathic voiding disorders]</td>
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<td>Chronic prostatitis [abacterial]</td>
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<tr>
<td>N94.2</td>
<td>Vagismus</td>
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<td>N94.818 - N94.819</td>
<td>Vulvodynia</td>
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<td>O00.00 - O9A.53</td>
<td>Pregnancy, Childbirth and the Puerperium [labor pain]</td>
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<td>Q35.1 - Q35.9</td>
<td>Cleft palate</td>
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<tr>
<td>Q37.0 - Q37.9</td>
<td>Cleft palate with cleft lip</td>
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<tr>
<td>R25.0 - R25.9</td>
<td>Abnormal involuntary movements</td>
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<tr>
<td>R26.0 - R26.9</td>
<td>Abnormalities of gait and mobility [includes toe-out gait modification in people with knee osteoarthritis]</td>
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<td>R33.0 - R33.9</td>
<td>Retention of urine</td>
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<tr>
<td>R35.0 - R35.8</td>
<td>Polyuria [daytime syndrome]</td>
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<td>R42</td>
<td>Dizziness and giddiness [vertigo/disequilibrium]</td>
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<tr>
<td>R48.0 - R48.9</td>
<td>Dyslexia and other symbolic dysfunctions, not elsewhere classified [childhood apraxia of speech]</td>
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<td>R51</td>
<td>Headache</td>
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<td>R53.82</td>
<td>Chronic fatigue, unspecified</td>
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<tr>
<td>R56.00 - R56.9</td>
<td>Convulsions, not elsewhere classified</td>
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<tr>
<td>S12.000+ - S12.900+</td>
<td>Fracture of cervical vertebra and other parts of neck</td>
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<td>S13.000+ - S13.900+</td>
<td>Dislocation and sprain of joints and ligaments at neck level</td>
</tr>
<tr>
<td>S14.000+ - S14.900+</td>
<td>Injury of nerves and spinal cord at neck level [includes: late effect or sequela, without evidence of spinal bone injury, Injury to cervical root, Injury to cervical sympathetic nerve]</td>
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<tr>
<td>S31.41x+ - S31.31.42x+</td>
<td>Laceration of vagina and vulva</td>
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<td>T78.40X+</td>
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<td>T78.49X+</td>
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<td>Z51.89</td>
<td>Encounter for other specified aftercare</td>
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<td>Z88.0 - Z88.9</td>
<td>Allergy status to drugs, medicaments and biological substances</td>
</tr>
<tr>
<td>Z91.010 - Z91.09</td>
<td>Allergy status, other than to drugs and biological substances</td>
</tr>
</tbody>
</table>

The above policy is based on the following references:


22. Weatherall M. Biofeedback or pelvic floor muscle exercises for female genuine stress incontinence: A meta-analysis of trials identified in a systematic review. BJU Int. 1999;83(9):1015-1016.


40. Schneider F, Heimann H, Mattes R, et al. Self-regulation of


52. Woodford HJ, Price CIM. EMG biofeedback for the


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101. McClurg D, Ashe RG, Marshall K, Lowe-Strong AS. Comparison of pelvic floor muscle training, electromyography biofeedback, and neuromuscular


111. Wigley FM. Nonpharmacological therapy for the RP. UpToDate [online serial]. Waltham, MA: UpToDate; September 2010.


113. Scottish Intercollegiate Guidelines Network (SIGN). Management of patients with stroke: Rehabilitation,


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131. Ward A. Management of chronic constipation in adults. UpToDate [serial online]. Waltham, MA: UpToDate; reviewed October 2014.


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AETNA BETTER HEALTH® OF PENNSYLVANIA

Amendment to
Aetna Clinical Policy Bulletin Number: 0132 Biofeedback

There are no amendments for Medicaid.

www.aetnabetterhealth.com/pennsylvania  revised 03/30/2018