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# Ride the Wave: A Guide for Implementing Biofeedback in Occupation-Based Interventions in a Rehabilitation Setting

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RIDE THE WAVE:  
A GUIDE FOR IMPLEMENTING BIOFEEDBACK IN OCCUPATION-BASED  
INTERVENTIONS IN A REHABILITATION SETTING

by

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## ABSTRACT

Historical and current research studying EMG biofeedback has shown this method to be an effective adjunct to occupational therapy intervention. Utilizing EMG biofeedback has been shown through research as effective in improving functional gains. The use of biofeedback allows an individual to visualize unseen physiological processes which are unique to each individual and provide better understanding of otherwise unseen functions (Laurenção, Battistella, Moran de Britto, Tsukimoto, & Mayizaki, 2008). An extensive literature review and students' observations of clinical occupational therapy practice led the investigators to conclude that EMG biofeedback was a viable treatment method which has not been utilized to the full potential. The purpose of the scholarly project was to determine the effectiveness of EMG biofeedback through research and develop a resource guide for occupational therapists interested in implementing this method into treatment in a rehabilitative setting. The product developed consisted of eight sections which were selected to provide an overview of EMG biofeedback information and pertinent resources to assist an individual in determining how this method could be implemented during occupation-based interventions.

## CHAPTER I

### INTRODUCTION

Biofeedback has been described by Lorencao et al. 2008 as a simple, non-invasive and painless treatment which has shown beneficial outcomes when integrated into therapy. Biofeedback is further explained as the “use of instruments that help individuals to recognize how their bodies are working and teach them how to control patterns of physiological functioning” (Crepeau, Cohn & Boyt Schell, 2009, p. 1154). The descriptions by Lorencao and Crepeau et al. above and information gained from a literature review during the initial research for the topic proposal, support the hypothesis that biofeedback is a viable and effective adjunct to occupational therapy treatment, but biofeedback is not currently being used to its full potential within rehabilitative settings.

It was found through personal experiences of the authors during modalities education content that current practitioners tend to utilize interventions that are routine to their practice setting. The authors recognized the need to create a guide that would introduce a unique intervention strategy to benefit both the occupational therapist in providing evidenced-based interventions and client-centered practice as well as the client receiving services for a diagnosed disability within a rehabilitative setting. The authors focused their attention on the creation of an informational guide to introduce concepts and evidence related to the implementation and utilization of electromyographic (EMG) biofeedback as an adjunct to occupation-based interventions. Harburn and Spaulding (1987) found that the use of EMG biofeedback in conjunction with occupation-based interventions illustrated an unintentional increase of

motivation in patients to participate in treatment sessions. The authors are proposing that practitioners utilize EMG biofeedback in conjunction with occupation-based interventions to increase client participation in meaningful activities, achieve goals to increase independent living and successful discharge as well as increase productivity within the rehabilitative setting.

A major factor which will influence EMG biofeedback's application to occupation-based interventions will be the years of evidentiary support not only within the profession of occupational therapy, but within a variety of other therapy and medical disciplines as well. The research evidence within the informational guide include both historical as well as current research articles pertaining to the efficacy of EMG biofeedback as an adjunct to conventional therapy. Another factor for successful application includes a glossary of terms related to concepts associated with biofeedback that will assist the practitioner during documentation to ensure reimbursement.

The authors utilized the theoretical Model of Occupational Adaptation (OA) to guide the creation of the informational guide as the core concepts of the model were found to be in line with the purpose and goals of the product; especially in relation to the intended audience of occupational therapists seeking treatment alternatives. The occupational therapy practitioner was viewed by the students as being comprised of cognitive, psychosocial, and sensorimotor systems which impact occupational performance during delivery of occupation-based interventions within a rehabilitative setting. When introduced with a novel challenge pertaining to a client, the occupational therapist is expected to recognize that a change in behavior is needed related to service delivery for the successful meeting of role expectations; this is described as adaptive capacity within OA. This recognition of a need for change is brought about through a self-assessment process during which the practitioner evaluates their ability to modify typical

response behaviors to a novel situation and proceed with necessary steps to result in relative mastery. Within the profession of occupational therapy there has been an innate desire for mastery to provide client-centered services, but more recently there has been a demand for mastery to provide evidence-based interventions as well as occupation-based interventions to solidify client-centered practice. Through personal experiences of the authors, it was found that practicing therapists are currently in a primitive behavior response as evidenced by the lack of exploring new and innovative intervention strategies. The informational guide will allow practitioners to shift toward a transitional behavior response by completing further research pertaining to EMG biofeedback, consideration of clients who may benefit from the utilization of EMG biofeedback in conjunction with conventional therapy as well as contemplate other populations who will benefit. It is the responsibility of the practicing clinician to progress to a mature behavior response by seeking out certification in the utilization of EMG biofeedback. It is through this informational guide and the actions of occupational therapy practitioners that relative mastery can be reached pertaining to the implementation of EMG biofeedback in conjunction with occupation-based interventions in a rehabilitative setting.

This scholarly project solidifies the need for the utilization of EMG biofeedback within rehabilitative settings in occupational therapy. An extensive literature review was conducted to illustrate historical and current research pertaining to the efficacy of EMG biofeedback within occupational therapy as well as other medical disciplines. The process completed to design and create the informational guide is described in detail within the methodology section. The purpose of the product, a complete rationale for the use of the theoretical model, Occupational Adaptation, as well as the completed informational guide can be found within section four entitled “Products”. Section five is a complete summary of the purpose of the project, key



information found throughout the process as well as recommendations for the implementation of the product. Finally, references used to provide evidentiary support throughout the scholarly project process and completed informational guide are found in the reference section.

## CHAPTER II

### REVIEW OF LITERATURE

Biofeedback has consistently been described as a safe and easily applied training technique which helps a person to better understand and monitor physiological processes. Literature over the past decade indicates the use of biofeedback as a beneficial adjunct to occupation based intervention across a wide spectrum of diagnoses. In a position paper published in 2008 The American Occupational Therapy Association (AOTA) identified biofeedback as one of many Physical Agent Modalities (PAMs); specifically as an electrotherapeutic agent, which may be used during occupational therapy interventions (Bracciano, McPhee, & Rose). In regard to PAMs within occupational therapy interventions, AOTA has specified that, “PAMs may be used by occupational therapists and occupational therapy assistants in preparation for or concurrently with purposeful and occupation-based activities or interventions” (Bracciano, McPhee, & Rose, 2008, p. 343). When implementing biofeedback into interventions specialized equipment is utilized to convert factors including skin temperature, heart rate and muscle activation into meaningful visual or auditory cues. These cues in turn are utilized to instruct clients on gaining voluntary control of said factors (Frank, Khorshid, Kiffer, Moravec, and McKee, 2010). Applications of this electrotherapeutic agent which are most often studied include thermal and electromyographic (EMG) biofeedback training. Thermal biofeedback training employs the use of skin temperature sensors which assists a person in learning how to voluntarily increase or decrease skin temperature. EMG biofeedback training involves monitoring the unseen electrical activity of a muscle, or group of muscles, and utilizing visual or auditory cues

to increase or decrease muscle activation. Both methods have been shown to be effective in management of pain, increased relaxation, and increased activation of motor units in affected muscles.

Research regarding the efficacy of biofeedback as an adjunct to treatment for persons with hemiplegia following a cerebral vascular accident (CVA) dates back more than 30 years (Basmajian, Kukulka, Narayan, & Takabe, 1975). In a study published in 1980, authors Binder, Moll, & Wolf evaluated the use of EMG biofeedback in treating persons with chronic lower extremity (LE) hemiplegia. Considering that this was a preliminary examination into the utilization of EMG biofeedback it is not surprising that results led researchers to conclude that EMG biofeedback may be effective in promoting muscle activation in addition to conventional physical therapy but that further research was needed (Binder, Moll, & Wolf, 1980). The effectiveness of these methods has been studied in treating migraine headaches by Lacroix, et al. (1983). Researchers sought to determine whether thermal biofeedback training would have greater benefits for those with migraines in comparison to EMG biofeedback training in conjunction with relaxation training. Results from this study led researchers to determine that thermal biofeedback provided significant, immediate improvements which were maintained at a six month follow-up (Lacroix, et al., 1983). Several other early studies continued to produce results which provided support for the use of biofeedback as an adjunct to conventional treatment of many diagnoses.

In further study, researchers sought to explore the long-term effects of EMG biofeedback when combined with physiotherapy (PT) on upper extremity (UE) hemiplegia in clients' post-CVA (Inglis, Donald, Monga, Sproule, & Young, 1984). Results from this partial-crossover, control study led researchers to conclude that EMG biofeedback with PT produced additional

benefits of increased range of motion (ROM) and muscle strength for participants (Inglis, Donald, Monga, Sproule, & Young, 1984). With EMG biofeedback research providing substantial evidence about the increased benefits for individuals post CVA, researchers began focusing studies on various populations.

In a paper authored by Harburn & Spaulding (1987), utilization of biofeedback was explored in conjunction with conventional occupational therapy (OT) published in a two-case study format. Two participants were studied; one a 45 year old female with a pontine lesion resulting in weakness and decreased function of her right UE and the other a 16 year old male with incomplete C4 quadriplegia (Harburn & Spaulding, 1987). EMG biofeedback was utilized during occupation based activities including looming and leather stamping; respectively, to promote appropriate muscle activation. Resulting benefits for the female participant included higher motor unit recruitment recorded after each session and substantial increase in grip and UE function (Harburn & Spaulding, 1987). Resulting benefits for the male participant included increased muscle strength and an increase in his active participation in therapy sessions (Harburn & Spaulding, 1987). In addition to the results related to muscle function, the significance of this paper was the identification of the unanticipated benefit of increased client volition. In another paper, authored by Reid & Koheil, the use of EMG biofeedback in treating children with hemiplegia due to cerebral palsy (CP) was outlined. A case study was presented to demonstrate the use of EMG biofeedback in promotion of hand function. The approach was altered to meet the unique needs of a 2 ½ year old child. Rather than relying on a video monitor to display muscle activity, a toy was utilized which was activated when the child performed the desired movement; opening his hand. The amount of muscle activity necessary to activate the toy began with minor muscle recruitment and was graded to require increased muscle involvement (Reid &

Koheil, 1988). Researchers Lysaght & Bodenhamer (1990) explored the use of EMG biofeedback with yet another population; adults who had experienced traumatic brain injury (TBI). EMG biofeedback was utilized to monitor muscle tension while being used with conventional relaxation techniques to reduce muscle tension as a result of stress and in turn increase effectiveness of therapeutic intervention (Lysaght & Bodenhamer, 1990). Results from this pilot study led researchers to conclude that relaxation training with EMG biofeedback was effective in helping participants lower their baseline levels of muscle tension. This method was shown to be a useful adjunct to functional relaxation training during simulated stress inducing situations (Lysaght & Bodenhamer, 1990). Clearly research supports that utilization of biofeedback training, offers significant benefits and can be applied with a variety of populations. Current research regarding biofeedback provides additional support for the use of this modality as an adjunct to conventional rehabilitation therapy.

For decades EMG biofeedback has been used in a variety of medical and rehabilitative disciplines. Current research highlights the utilization of EMG biofeedback in physical therapy, pain management and urology with greater prominence than in occupational therapy. Cerebral vascular accidents (CVA), chronic pain, incontinence, post-surgical rehabilitation and neuromotor disorders are the most commonly identified diagnostic groups that benefit from the use of EMG biofeedback by these three disciplines.

Research indicates that physical therapy practitioners use EMG biofeedback most frequently, although not exclusively, in lower extremity rehabilitation. Lower extremity injuries can occur in many fashions and have an impact in many areas of an individual's life. Boucher, Wang, Trudelle-Jackson and Olson (2009) reported that physiological impairments such as decreased strength, range of motion (ROM) and function occurred following a lower extremity

surgery. Following a knee surgery, the inability for individuals to voluntarily activate the quadriceps femoris muscle and the entire lower extremity, resulting from post-surgical pain and swelling, was a major concern. Relearning how to contract and relax particular muscle groups can also be difficult as a result of structural surgical trauma. EMG biofeedback was utilized in the beginning stages of rehabilitation to improve the prognosis of recovery and function of the lower extremity. Boucher et al. (2009) reported that surface EMG biofeedback in conjunction with neuromuscular electrical stimulation had commonly been used clinically to aid in the recruitment of the quadriceps femoris, thus improving function in activities of daily living (ADLs), particularly in regard to transfers and gait. ADLs are difficult to perform post knee surgery, often resulting in the need for significant assistance from a family member or care provider. Kuiken, Amir and Scheidt (2004) studied an alternate application of biofeedback following total knee arthroplasty through the development and use of a computerized biofeedback knee goniometer (CBG) device. This device measured the hourly extension and flexion of the knee throughout the day as well as recorded the daily activity level of each wearer. Visual and auditory cueing from this CBG device and the utilization of conventional physical therapy were explored in relation to individual recovery time and patient acceptance of biofeedback as an adjunct to treatment. The researchers found through the use of the CBG that, “audio feedback had more patient acceptance than the visual feedback, possibly because of the visual display’s limited accessibility” (Kuiken et al., 2004, p. 1030). When the individuals knew that desired ROM was reached during treatment sessions, higher levels of compliance with the treatment program were reported than with participants without the CBG device. This finding provided continued support for previous studies which indicated the positive effects of utilizing biofeedback on increasing motivation to comply with rehabilitation. Additional research studies

sought to determine effectiveness of biofeedback when additional factors interfere with attainment of treatment goals.

Pain is a symptom of many diagnoses which affects a person's ability to engage in daily life roles, and impacts therapeutic interventions. In a study completed by Babu, Mathew, Danda and Prakash (2007), the utilization of EMG biofeedback was evaluated to determine the efficacy of biofeedback as a physical agent modality (PAM) on reducing pain resulting from fibromyalgia. Researchers utilized a double-blind, randomized control trial to determine whether EMG biofeedback could provide pain reduction for participants. The experimental group received biofeedback in conjunction with relaxation techniques, positioning, and were taught to include these relaxation strategies into daily activities while the control group received "sham biofeedback" in conjunction with previously listed intervention techniques (Babu, et. al., 2007, p. 456). The "sham biofeedback" utilized during the study involved the use of a biofeedback device for which the software had been altered to provide visual readings which were not true to the muscle activity of the participant. Participants of this study completed six sessions with the utilization of biofeedback followed by a home program without the use of a biofeedback device. Babu et. al (2007), found that both groups experienced significant reduction in pain and improved scores in areas related to function. The experimental group presented with significantly decreased pain and increased function in comparison with the control group (Babu et al., 2007). This study provides further substantiating evidence for the utilization of biofeedback as an adjunct to treatment and as being effective in the management of pain.

Current research continues to support the utilization of biofeedback as an effective physical agent modality in the treatment of pain. Ma et. al (2011) conducted a randomized control trial in which researchers sought to compare the efficacy of three intervention approaches

in the treatment of neck and shoulder pain resulting from work-related injuries. Participants in the experimental groups did not receive direct treatment but rather were supplied with instructional materials on how to carry out interventions while at work and at home. Experimental group interventions consisted of one group receiving biofeedback utilization instruction, one group receiving an active exercise program, and one group receiving interferential treatment and hot packs; while the control group received no treatment. Specific application of various methods, including the amount time and the number of applications each week, were pre-determined and outlined in instructional materials (Ma et. al., 2011). Researchers found that after six weeks of treatment, participants in all experimental groups indicated decreased pain, with the most significant pain reduction reported from the experimental group which utilized biofeedback. At the six month follow-up the biofeedback experimental group continued to report significant reduction in pain as compared to all other groups (Ma et. al., 2011). The experience of pain has often been identified by clients as having significant impacts on daily life and has been a symptom of several diagnoses for which therapeutic interventions are sought. Historical and current research studies have identified the implementation of biofeedback as an effective adjunct to therapy when addressing pain management.

Internal and external stressors can have an impact on an individual's physiological health. Incontinence is a physiological issue that many people face at different stages in life. Reduced strength in the pelvic floor muscle group as a result of increasing age can be a factor in fecal incontinence. Coffey, Wilder, Majsak, Stolove and Quinn (2002) report that trauma during childbirth, along with pelvic organ prolapse contributes to a higher prevalence of fecal incontinence in younger women. Incontinence can lead to decreased quality of life due to the fear of having an elimination accident in public; individuals have reported isolating in the home to



reduce the likelihood of an elimination accident. For many years the medical community has turned to the use of Kegel exercises to help strengthen the muscles of the pelvic floor before consideration of surgical treatment. Coffey et al (2002) stated “Kegel hypothesized that women with pelvic floor muscle laxity or stress urinary incontinence could improve or restore their pelvic-floor muscle function and tone through exercise” (p.800). The use of biofeedback, in conjunction with Kegel exercises, provided participants with increased ability to recruit the affected muscle group, which resulted in correctly and effectively executed intervention for greater control of symptoms (Coffey et al, 2002). Concerns over the fear of elimination accidents resulting from incontinence have potential to lead to additional injuries. For example, falls among the elderly from rushing to the lavatory while not concentrating on gait has been a frequently reported occurrence (Collins, 1998). Reduction of incontinence as well as potential for decreased effects on quality of life or injury related to incontinence has been reported to be assisted through use of EMG biofeedback in conjunction with convention treatment. With many applications of this adjunct to treatment and substantial evidentiary support for its use the question of why there is limited use of EMG biofeedback within occupational therapy arises.

Literature shows that occupational therapists have used biofeedback as an adjunct to occupation based intervention in the past, but a significant lack of literature over the past decade indicates that its use has been far from widespread, despite studies with results indicating efficacy. Where biofeedback has appeared in occupational therapy literature, the focus has largely addressed tension headaches, writer’s cramp and tenodesis grasps. Tension headaches have been described as the result of sustained muscle contractions around the scalp, face, neck and shoulders. The contractions have been reported to cause a dull and steady pain in the posterior region near the occiput, or back part of the skull. Biofeedback was utilized in

occupational therapy treatment in conjunction with progressive muscle relaxation, home exercise programs and upper extremity task performance. Use of biofeedback provided participants with visual and auditory cues which were shown to be effective in training the individuals to relax specific muscle groups. King (1992) found that when EMG biofeedback was used in conjunction with occupational therapy treatment during a four week program to decrease tension headaches, outcomes were positive and participants reported an increased ability to attend to their children and complete household activities.

Handwriting dystonia, more commonly known as “writer’s cramp”, can limit an individual’s ability to perform daily tasks requiring sustained functional use of the hand. Clients are often prescribed oral or injectable medications to help with the muscle weakness. These medications tend to rarely be effective, due to limited exposure of physicians to the diagnosis. O’Neill, Gwinn and Adler (1997) report that out of the one million people believed to have this condition, only 69 had received a diagnosis of handwriting dystonia. It was stated that “biofeedback may alter an afferent sensory input and efferent motor output loop related to genesis of the dystonia” (O’Neill, Gwinn & Adler, 1997, p. 607). The use of biofeedback allows individuals to train their bodies to relax when manipulating writing utensils. Hands and the upper extremity are important to complete activities of daily living.

A tenodesis grasp is an essential function after a spinal cord injury at the level of C5 and C6. Kohlmeyer, Hill, Yarkony and Jaeger (1996) describe a tenodesis grasp as “opposition of the thumb and index finger with extension of the wrist” (p.702). Traditionally the tenodesis grasp is enhanced utilizing passive range of motion, splinting, surgery and strengthening muscles of the forearm. Electrical stimulation is often used in conjunction with biofeedback when addressing hand function after a spinal cord injury. Learning to optimize use of the tenodesis grasp after a

spinal cord injury is essential to promoting an individual's quality of life and independence. Kohlmeier, Hill, Yarkony and Jaeger (1996) found that electrical stimulation and biofeedback did not provide any additional benefit over conventional therapy, but the visual and auditory cues could be a motivating factor for clients throughout the treatment. Research showed promise for the use of biofeedback when treating individuals diagnosed with a spinal cord injury; however, sample sizes were often too small to show significant results.

Reimbursement for biofeedback as an adjunct to treatment is inconsistent and can be unpredictable (Rosenthal, 2008). Prior to utilizing biofeedback as an adjunct to treatment it is necessary to have a physician review and approve the proposed protocol to help ensure reimbursement (Painter & Painter, 2010). It is recommended that an individual's insurance company be contacted to verify coverage prior to treatment as some companies require pre-authorization (Rosenthal, 2008). Reimbursement through Medicare will be dependent on local carriers, despite there being a National Coverage Decision (NCD) regarding biofeedback, and should also be checked on an individual basis to determine whether specific criteria are met for reimbursement (Painter & Painter, 2010). When billing for biofeedback treatment the combination of codes provided to an identified pay source, third party payer or Medicare, will determine the approval or denial of reimbursement. There are a relatively small number of codes used for reimbursement of biofeedback treatment, and the success of reimbursement largely depends on the implementation of biofeedback in treatment and the manner in which its use has been documented and coded. It is important to ensure that each service be correctly and separately documented and supported to avoid denials (Painter & Painter, 2010). An understanding of the codes used for biofeedback billing will be essential for those implementing biofeedback into interventions.

There are three primary codes which are applicable to the use of biofeedback in a rehabilitation setting. The 97532 code is used for cognitive retraining and has been used by neurofeedback providers when working with clients with traumatic brain injuries (TBI) to improve cognitive function (Rosenthal, 2008). The 97112 code has been used when billing for surface electromyographic (EMG) biofeedback training in neuromuscular reeducation of movement, balance, and coordination (Rosenthal, 2008). The code 96002 was described by Rosenthal as being relatively new and used for, “dynamic surface EMG recording for gait training and other functional activities”, as well as improvement of motor control (Rosenthal, 2008, p. 2). Each of the three codes listed could be utilized by occupational therapy providers to while implementing variety of services with biofeedback to supplement occupation-based interventions.

The foundation goal of occupational therapy is to teach individuals with impairments or a diagnosis to relearn activities of daily living for an independent life. Poole (1991) identified this relearning as “the training and retraining of motor skills and motor tasks” (p. 531). Injuries, developmental delays, mental illness and cognitive impairments can all affect an individual’s ability to perform daily activities independently. In the past biofeedback has been utilized in occupational therapy to assist individual’s diagnosed with cerebral palsy. The output of visual and auditory cues would allow the client to know when a muscle was activating. These cues served as external motivators for clients who may have become or were depressed because of limitations. It is difficult for individuals to feel a sense of purpose when he or she has to rely on another person to assist with activities needed daily for healthy living. Activities such as bathing, brushing one’s teeth or hair, cooking, self-feeding, using the restroom independently and cleaning one’s house are all activities that healthy people tend to take for granted. Each of these

activities requires specific, coordinated muscle activation which can be monitored and more consciously controlled with the use of EMG biofeedback. The ability to visualize these otherwise unseen processes has been shown in the literature to improve muscle activation leading to ultimately improving one's ability to perform in everyday life activities.

The use of biofeedback would be a positive contributor during motor training and retraining. The auditory and visual cues will allow the therapist and client to identify when an activity or exercise is being performed correctly. Motor training and retraining would ideally be completed in an individual's least restrictive environment or in the actual environment where the skill would be performed, most likely the home or workplace. Providing interventions within the least restrictive environment is not always feasible, so occupational therapy environments within most hospitals are designed to simulate individualized environmental factors. EMG biofeedback machines are also available within most hospitals or clinics allowing for easy access and utilization during interventions. The skills taught within the hospital can then be expected to be transferred to the client's environment of choice as a result of performing activities within simulated environments. Motor training is a process in which an individual practices a movement that will eventually lead to a permanent change in the ability to respond to situations. The process of motor training requires time and dedication by not only the client, but also by the occupational therapist particularly in the area taking on the role of teacher and understanding principles of how learning occurs. Poole (1991) explained that there are four factors which influence motor learning: "(a) the stages of learning, (b) the type of task, (c) feedback and (d) practice" (p. 531). In order for a treatment plan utilizing motor learning to be successful, all four factors need to be assessed by the occupational therapist.

The stages of learning as defined by Fitz and Posner (1967) include: the cognitive stage, the associative stage and the autonomous stage. During the cognitive stage the client may have a general idea of a task, but lack the knowledge to perform the task successfully. Performance in this stage is often inconsistent because the client will try a variety of strategies that to identify those effective in producing successful task completion. Clients in the cognitive stage will often verbalize the movement strategy before attempting the task. As the client begins to practice and refine his or her skills the client moves into the associative stage. In the associative stage, the client's movements become more consistent and errors are decreased. Clients will begin to recognize errors and make the necessary changes to complete the task successfully and correctly. Guidance from an occupational therapist regarding mistakes and techniques are provided and gradually reduced as learning occurs. In the associative stage, the client would become comfortable with the task and possess the skills needed to complete the task independently. Finally, the autonomous stage includes the client performing the task automatically without the need for external, cues such as verbal commands. Once the autonomous stage has been reached performance of the task requires little cognitive processing, and the client can begin to focus on other aspects of performance as needed. An understanding of the concepts involved in motor learning provide a framework which one can apply when considering and utilizing biofeedback as an adjunct to occupational therapy treatment.

The second factor which must be assessed for application of the motor learning theory is the type of task. An occupational therapist must evaluate each client, their current ability and how the client's performance has been impacted by the task when designing a treatment plan. Importance must be placed on setting up the client for success by matching tasks with current levels of function as identified during evaluation. Poole explained that tasks are classified on a

continuum based on the environmental factors in which the task would be performed. Poole explained, “Critical features of the environment determine the spatial and temporal arrangement of a performer’s movements” (1991, p. 532). In explaining environmental factors Poole identified two types of tasks which; closed tasks and open tasks. Closed tasks include those for which the environmental factors or objects; such as a flight of stairs; are immobile and determine the motor performance required by an individual (Poole, 1991). Open tasks are those for which environmental objects are in motion; such as when driving a car, and require an individual’s ability to adapt to changing elements of the environment. The environment and many variable factors must be considered when training or retraining motor movements to adequately evaluate current performance of a client as well as expectations of motor performance.

Another factor of motor learning which has been described by Poole as a, “potent learning variable” (1991, p. 533) can be provided through various mediums to provide a client with information on their level of performance. Feedback can be used to assist clients in achieving successful performance of a variety of tasks. Feedback can be provided both intrinsically and extrinsically from any number of sources. Intrinsic feedback includes the sensory input to and from muscles, tendons, ligaments, joints and skin receptors that are produced during and after movement. Extrinsic feedback is information from an external source producing an intrinsic response. For example an individual might feel where their arm is in space to determine effective motor performance (intrinsic feedback) or a cup might fall over indicating that motor performance was not effective (extrinsic feedback). Intrinsic feedback can be difficult to evaluate by an individual, particularly when the information is unfamiliar such as when motor learning is being addressed. With the use of biofeedback the occupational therapist could help clients see typically unseen processes; which can be hard to understand, and turn the stimuli into

visual or auditory cues, through the use of biofeedback equipment. EMG biofeedback would benefit the field of occupational therapy when motor learning is being utilized because of the added benefits of additional forms of feedback when retraining or training various muscle movement patterns.

The final component to be understood by occupational therapists implementing the motor learning theory has been identified by Poole (1991) as practice. According to Poole (1991) the amount of time spent practicing a specific skill directly correlates to the success or failure new skill acquisition. Practice should be performed on a regular basis and not be limited to only being performed at times when a client is participating therapy sessions. During practice sessions EMG biofeedback could be implemented to provide additional feedback, another factor of motor learning discussed earlier; to provide cues for a client in relation to proper performance of a motor action. This additional feedback would result in increased success during performance of necessary skills. Repetition has also been identified as an important element in motor learning for developing the correct movements needed to perform a task. With repetition there is an emphasis on proper muscle activation during movement. With EMG biofeedback a client could see when appropriate muscle activation has been achieved during practice. Tasks could also be graded to match a client's level of function and gradually increase in difficulty once the client as successfully learned each succeeding step through practice of skills. Grading activities can be a beneficial tool during practice of motor movements due to the repetition of movement; with each preceding skill being reinforced with addition feedback provided through EMG biofeedback to ensure appropriate muscle movements. The inclusion of EMG biofeedback in conjunction with motor training and retraining can assist occupational therapists in shifting their utilization of



biofeedback from a physical agent modality to an adjunct to conventional treatment implemented during occupation-based interventions.

EMG biofeedback is a technique that has been shown within historical and current literature as being useful as a physical agent modality and has been shown within literature from various disciplines; including occupational therapy, as being an effective adjunct to conventional intervention for motor performance deficit resulting from a variety of diagnosis. The use of occupation-based interventions has been identified as an effective approach during occupational therapy interventions. EMG biofeedback could be implemented into occupation-based interventions during which the additional feedback provided would give clients a better understanding of how to achieve successful motor movement while performing meaningful occupations and thus improving generalization of learning. EMG biofeedback has been identified within current occupational therapy literature as being effective when utilized with clients experiencing occupational performance deficits resulting from tension headaches, writer's cramp and abnormal muscle tone resulting cerebral vascular accident. The effects these diagnoses have on an individual's motor performance lead to significant deficits in daily activities for which motor learning could be supplemented by the implementation of EMG biofeedback. Additional clients for whom EMG biofeedback could be implemented include those diagnosed with spinal cord injury, unilateral neglect following a CVA, muscle retraining after an amputation, a joint replacement, or relearning movement sequences to complete activities of daily living following a traumatic brain injury. Current literature has shown that implementation of EMG biofeedback has had limited focus within school curriculums has not been utilized to the full potential within clinical practice in the field of occupational therapy.

A significant impact on the use of biofeedback within occupational therapy interventions was the removal of biofeedback from the list of PAMs supported by AOTA in the early nineties. At the time biofeedback was considered a monitoring tool rather than a physical agent modality intended to penetrate the skin and soft tissues (AOTA, 1990). Biofeedback has been returned to the list of PAMs approved by AOTA for occupational therapy intervention. Although, the brief removal of biofeedback from the PAMs list was likely a key factor which impacted the lack of biofeedback focused research during the early to mid nineties. Additionally this could provide explanation for why biofeedback has currently not been utilized to the full potential within clinical practice or within educational curriculum. King (1992) completed a study which focused on the current use of biofeedback in rehabilitation clinics as well as the inclusion of biofeedback in educational curriculum within the field of occupational therapy. Authors found that 49% of rehabilitation clinics were utilizing biofeedback as a treatment modality and 59% stated that they would like to begin using biofeedback in their clinic in the near future. The study also addressed the types of biofeedback being utilized in these rehabilitation clinics; results showed that EMG biofeedback was used 95% of the time compared to blood pressure (7%), skin temperature (31%), heart rate (12%), and galvanic skin response was used 17% of the time. Researchers also found that, “39% of educational programs surveyed indicated they were currently including biofeedback as a topic in the physical dysfunction portion of their curriculum” (King, 1992, p.56). The educational programs that were including biofeedback in their teachings indicated that EMG biofeedback was focused on more heavily (84%) as related to skin temperature (66%), blood pressure (63%), heart rate (56%) and galvanic skin response (38%) during classroom training. Results from this study provide clear evidence that EMG biofeedback has been utilized within clinical settings and taught in classrooms. Although, the level of biofeedback

implementation at the time of this study provides evidence that biofeedback has not been implemented to the full potential supported within historical and current literature. This lack of implementation could be attributed to the lack of occupational therapy specific literature related to biofeedback implementation within the last five to ten years.

In addition to the above mentioned barriers to biofeedback implementation within occupational therapy, not all research related to the use of biofeedback intervention has indicated positive results. The use of EMG biofeedback in physical therapy has been shown in the research to have conflicting results when combined with conventional therapy. In a meta-analysis conducted in 2010, authors Silkman and McKeon specifically sought to determine the effectiveness of biofeedback in increasing the activation and function of the quadriceps muscle following a knee injury. The authors found that there was inconsistent evidence to support the use of biofeedback in conjunction with conventional therapeutic exercises. These inconsistencies were identified as being, in part, due to a lack of patient compliance either in the clinic or at home, limited sample sizes during research, a lack of knowledge of how to properly read biofeedback outcomes, or inappropriate placement of sensors (Silkman and McKeon, 2010). Despite the conflicting results found within biofeedback related literature, EMG biofeedback has been utilized by a percentage of rehabilitation clinics consistently. Additional research studies with clearly outlined methods would provide additional evidence needed for supporting continued and increased utilization of biofeedback with rehabilitation settings.

The authors of this project found that despite a substantial body of research supporting the use of EMG biofeedback as a supplement to conventional occupational therapy there has been a lack of application of this treatment modality within clinical settings. The authors sought to develop a manual with information pertinent to the use of EMG biofeedback within

occupation-based interventions to provide occupational therapy practitioners with a starting point for implementation of EMG biofeedback into practice.

## CHAPTER III

### METHOD

The product which was developed for this project was meant to serve as an informational guide for occupational therapy practitioners to explore the appropriateness and utilization of biofeedback in occupation-based interventions. This product is not meant to serve as a treatment protocol, but rather as a resource manual highlighting the potential benefits of biofeedback implementation in clinical treatment. The information in the manual consists of product information related to available biofeedback machines, biofeedback trainings and certifications, , billing and reimbursement information, limitations to implementation, a glossary of terms, and current resources for the use of biofeedback with various populations.

The occupational therapy students were introduced to the concept of biofeedback in conjunction with occupational therapy treatment during an introductory course on physical agent modalities. An extensive review of literature, both historical and current, led the occupational therapy students to conclude that biofeedback has successfully been used in the past as a viable and effective adjunct to conventional occupational therapy in the rehabilitative setting. This literature review highlights a considerable gap in utilization of biofeedback in occupational therapy practice. Several databases were utilized to gather pertinent research including; CINAHL, PubMed, PsycInfo and SCOPUS. An internet search was also completed to obtain information related to billing requirements, Current Procedural Terminology (CPT) coding for biofeedback reimbursement, information regarding certification and training, and a variety of informational handbooks and guides. Continued findings of duplicate articles led students to

conclude that saturation has occurred in the research process; this lead to the conclusion that a reintroduction of biofeedback to occupational therapists was necessary through the development of this product.

The occupational therapy students and the scholarly project advisor attended a meeting with a physical therapist trained in utilization of biofeedback. Students developed a set of questions prior to the meeting and conducted a semi-structured interview with the physical therapy practitioner to gain further knowledge and understanding of the application of biofeedback in rehabilitation; and in his treatment specifically. Suggestions presented during the interview process provided students with a framework for possibilities in regard to product development and future research ideas.

The product was developed after the occupational therapy students found that current and past literature indicated biofeedback as an effective adjunct to conventional therapy with various populations. The students found that despite the support of research evidence, biofeedback had not been utilized in the rehabilitative settings by occupational therapy practitioners for the past decade. Development of the product was meant to serve as a resource for occupational therapy practitioners interested in implementing biofeedback into occupational therapy treatment. Students also intended for development of this product to build a foundation for potential future student scholars and clinical researchers to focus on specific diagnostic groups.

During the production of the informational guide, the students contacted representatives from the STENS Corporation and the Association for Applied Psychophysiology and Biofeedback (AAPB) to request utilize information from websites to be presented within the guide. Permission to use information from the above websites can be found in the appendix.

## CHAPTER IV

### PRODUCT

The primary purpose of the product was to provide evidence based information to occupational therapists interested in implementing electromyographic (EMG) biofeedback into practice within a rehabilitative setting. The product is presented in the form of an informational guide providing an over view of key information pertinent to utilization within occupational therapy. Occupational Adaptation (OA) drove the development of the informational guide and was chosen as the theoretical basis because the core concepts of the model were found to be in line with the purpose and goals of the product; especially in relation to the intended audience. Within OA the person is viewed as being comprised of cognitive, psychosocial, and sensorimotor systems which impact occupational performance. It is expected that the reader will possess readiness skills in the person system for successful utilization of the product and integration of EMG biofeedback into occupation-based interventions. These readiness skills include experience as a clinical practitioner in the field of occupational therapy (OT) and experience working in a rehabilitative setting. The informational guide has been separated into sections including; an introduction, a glossary of terms, implementation references, case scenarios, training and certification information, manufacturer and machine information, billing and coding recommendation, and limitations to implementation.

The introduction section provides the reader with an understanding of the purpose for the development of the informational guide, the intended audience and utilization of the product and a brief explanation of biofeedback as it relates to occupational therapy. The glossary of terms

provides the reader with definitions of key terms found throughout the informational guide to establish a better understanding of biofeedback implementation. A list of references pertaining to various populations who are commonly treated within occupational therapy were compiled in the implementation reference section to illustrate EMG biofeedback implementation and benefit within specific diagnostic groups. Three case scenarios were developed to provide the reader with examples of biofeedback incorporation into occupation-based interventions. A list of training courses accredited through Biofeedback Certification International Alliance (BCIA) along with board certification process and requirements are provided in the training and certification section. A list of commonly utilized biofeedback machines distributed by the STENS Corporation along with approximate prices is available in the machines, prices and manufacturer's section. Contact information for other distributors of biofeedback machines is also available within this section. A brief discussion of biofeedback reimbursement when utilized in a rehabilitative setting along with current procedural terminology (CPT) codes specific to use in rehabilitation are presented in the billing and coding section. Finally, a list of possible limitations to the utilization of biofeedback within occupational therapy is present in the limitation section. The described sections were selected to facilitate the reader in moving from one adaptive response behavior to the next; as outlined within OA.

Key concepts from OA which are reflected in the scholarly project include the importance of occupations, adaptive capacity, occupational adaptation process, and relative mastery. Schkade and Schultz, the developers of OA, conceived an occupation as actively involving the person, being meaningful and having a process and product (Cole & Tufano, 2008). This is reflected in the scholarly project as the reader will be expected to access, utilize, and implement the informational guide into practice when faced with novel situations which



present an occupational challenge to the practitioner. In response to this occupational challenge it is anticipated that the therapist will have the capacity to recognize that a change in behavior is needed for the successful meeting of role expectations; within the OA model, this is described as adaptive capacity. An occupational challenge could arise from conventional treatment approaches not being effective in reaching expected results from interventions. This recognition of the need for change is brought about through a self-assessment process during which the practitioner evaluates their ability to modify typical response behaviors and modifies these behaviors in a desire for mastery. Prior to the seeking of information by the OT practitioner related to the implementation of EMG biofeedback into treatment, the adaptive response behavior would be described as primitive. The primitive response behavior is characterized by inaction of an individual and, in the terms of an OT, would include lack of exploration into alternative treatment methods or augments to treatment. Through the utilization of information provided within the product to research and explore the use of EMG biofeedback the practitioner moves through the adaptive process from a primitive to a transitional response behavior on the way to developing relative mastery. This concept of relative mastery is defined as an individual's as well as society's perception of efficient and effective responses to novel situations that occur during engagement in occupation (Cole & Tufano, 2008). In an individual's effort to achieve relative mastery the adaptation process occurs when an occupational challenge is presented, as described above. The transitional response behavior is attained, and the clinician recognizes the opportunity presented through novel information for greater success in treatment outcomes through adaptation to the new response. This process involves the abilities of a person and their desire for mastery, the environmental factors which creates a demand for mastery and the interaction between these two components that result in an occupational challenge (Cole &

Tufano, 2008). This concept of relative mastery will not be reached as it relates to the implementation of EMG biofeedback within occupation-based interventions until necessary steps are taken by the reader to receive appropriate training and certification to allow for application of EMG biofeedback to novel situations.

PRODUCT

# **Ride the Wave:**

**A Guide for Implementing Biofeedback  
in Occupation-Based Interventions in a  
Rehabilitative Setting**

**Created by: Sarah Averett, MOTS and Johanna Meister, MOTS**

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# **Introduction**

## **Purpose of the Informational Manual**

This manual is meant to serve as an informational guide for occupational therapy practitioners who are interested in exploring the appropriateness and utilization of biofeedback in occupation-based interventions. This product is not meant to serve as a treatment protocol, but rather as a resource manual highlighting the potential benefits of biofeedback implementation in clinical treatment. The information in this manual consists of a glossary of terms, current resources for the use of biofeedback with various populations; case scenarios, biofeedback trainings and certifications, product information related to available biofeedback systems, billing and reimbursement information and limitations to implementation.

## **Brief Explanation of Biofeedback**

Biofeedback has consistently been described as a safe and easily applied training technique which helps a person to better understand and monitor physiological processes. Literature over the past decade indicates the use of biofeedback as a beneficial adjunct to occupation based intervention across a wide spectrum of diagnoses. Specialized equipment is utilized to convert factors including skin temperature, heart rate and muscle activation into meaningful visual or auditory cues which in turn are utilized to instruct clients in gaining voluntary control of said factors (Frank, Khorshid, Kiffer, Moravec, and McKee, 2010). Electromyographic (EMG) biofeedback training involves monitoring the unseen electrical activity of a muscle, or group of muscles, and utilizing visual or auditory cues to increase or decrease muscle activation.

## **Occupational Adaptation Model**

The occupational adaptation (OA) model was chosen by the students due to the innate desire for mastery within the profession of occupational therapy to provide client-centered

services. Recently there has been a demand for mastery to provide evidence-based interventions as well as occupation-based interventions to solidify client-centered practice. It was found through personal experiences from the informational guide creators, that practicing therapists are providing interventions that are routine to their practice setting and not exploring new and innovated intervention strategies leaving them in a primitive behavior response. With the provided informational guide it is the hope that practitioners will shift toward a transitional behavior response by completing research reviews pertaining to EMG biofeedback within occupational therapy, think about clients that may benefit from the utilization of EMG biofeedback in conjunction with conventional therapy as well as other populations that will benefit from EMH biofeedback. It is the responsibility of the practicing clinician to progress to a mature behavior response through becoming certified in the implementation of biofeedback before utilizing within a rehabilitative setting. Through this informational guide and the actions of the individual therapists that relative mastery can be reached pertaining to the implementation of EMG biofeedback in conjunction with occupation-based interventions in a rehabilitative setting.

# **Glossary of Terms**



Adjunct: An added component of treatment that is not meant to serve as the primary or stand-alone method of intervention

Audio feedback: External stimuli provided by the biofeedback system, that an individual can hear to indicate a pre-set condition being achieved

Biofeedback: “Use of instruments that help individuals to recognize how their bodies are working and teach them how to control patterns of physiological functioning” (Crepeau, Cohn & Boyt Schell, 2009, p. 1154 )

Electromyographic (EMG) biofeedback: A form of biofeedback utilizing sensors that monitor and measure muscle activity

Flaccidity: “Muscle tone that is lower than normal, also known as hypotonicity” (Radomski & Trombly-Lathem, 2008, p.643)

Functional Electric Stimulation (FES): “Neuromuscular electrical stimulation to activate targeted muscle groups for orthotic substitution or to facilitate performance of functional activities or movements” (Radomski & Trombly-Lathem, 2008, p.555)

Hemiplegia: “Loss of muscle control on one side of the body” (Radomski & Trombly-Lathem, 2008, p.644)

Incontinence: Inability of the body to control fecal or urinary voiding processes

National Coverage Determination (NCD): “Set forth the extent to which Medicare will cover specific services, procedures, or technologies on a national basis” (Glossary, [www.cms.gov](http://www.cms.gov))

Occupation-based intervention: Selection of activities in which the “client engages in client-directed occupations that match identified goals” (AOTA, 2008, p. 653)

Physical Agent Modality (PAM): “Procedures and interventions that are systematically applied to modify specific client factors when neurological, musculoskeletal, or skin conditions are present that may be limiting occupational performance” (McPhee, Bracciano, & Rose, 2008, p.343)

Relaxation training: A teaching strategy to promote an individual’s conscious awareness of and control over physiological and emotional states

Spasticity: Muscle tone that is higher than normal, also known as hypertonicity” (Radomski & Trombly-Lathem, 2008, p.643)

Tenodesis grasp: “The mechanical effect caused by the length of extrinsic finger flexors and extensors. When the wrist is flexed, the fingers tend to extend because the extensors are too short to allow full finger flexion and wrist flexion at the same time. Similarly, when the wrist is extended, the fingers tend to flex” (Radomski & Trombly-Lathem, 2008, p.92).

Thermal biofeedback: A form of biofeedback that utilizes sensors that monitor and measure skin temperature

Visual feedback: External stimuli provided by a biofeedback system that an individual can see to indicate a pre-set condition being achieved

# **Implementation References**

This section serves as a reference list of evidentiary support within the rehabilitation literature pertaining to how biofeedback has been utilized and researched with various diagnostic groups. This list is not all-inclusive, but serves to highlight key pieces of literature which provide examples of biofeedback implementation as an adjunct to occupational therapy interventions. The diagnostic groups featured include cerebral vascular accidents (CVA), chronic pain management, hand function as it relates to spinal cord injuries (SCI), cerebral palsy (CP), hand dystonia and potential areas of application.

## **Cerebral Vascular Accident (CVA)**

Clients who have experienced a CVA are often treated by occupational therapists to address decreased function in various areas of occupation. This decrease in function is often a result of hemiplegia. Decrease in functional muscle activation due to hemiplegia can be effectively treated with the use of biofeedback as an adjunct to conventional occupational therapy interventions. Results of research studies pertaining to effectiveness of biofeedback in occupational therapy have shown a significant increase in abilities to perform daily occupations post biofeedback implementation. The following articles provide evidentiary support for the use of biofeedback in rehabilitation of clients post-CVA.

**Doğan-Aslan, M., Nakipoğlu-Yüzer, G.F, Doğan, A., Karabay, İ., & Özgirgin, N. (2010).**

**The effect of electromyographic biofeedback treatment in improving upper extremity functioning of patients with hemiplegic stroke. *Journal of Stroke and Cerebrovascular Diseases*, 1-6.**

**Lourenção, M.I., Battistella, L.R., Moran de Britto, C.M., Tsukimoto, G.R., & Miyazaki,**

**M.H. (2008). Effect of biofeedback accompanying occupational therapy and functional electrical stimulation in hemiplegic patients. *International Journal of Rehabilitation Research*, 31(1), 33-41.**

## **Chronic Pain Management**

The experience of pain has often been identified by clients as having significant impacts on daily life and has been a symptom of several diagnoses for which therapeutic interventions are sought. Current and historical research supports the utilization of biofeedback as an effective physical agent modality in the treatment of pain as evidenced by the following articles.

**Lacroix, J.M., Clarke, M.A., Bock, J.C., Doxey, N., Wood, A., & Lavis, S. (1983).**

**Biofeedback and relaxation in the treatment of migraine headaches: Comparative effectiveness and physiological correlates. *Journal of Neurology, Neurosurgery, and Psychiatry*, 46, 525-532.**

**Ma, C., Szeto, G. P., Yan, T., Wu, S., Lin, C., & Li, L. (2011). Comparing biofeedback with active exercise and passive treatment for the management of work-related neck and shoulder pain: A randomized controlled trial. *Archives of Physical Medicine & Rehabilitation*, 92(6), 849-858. doi:10.1016/j.apmr.2010.12.037.**

**Ehrenborg, C., & Archenholtz, B. (2010). Is surface EMG biofeedback an effective training method for persons with neck and shoulder complaints after whiplash-associated disorders concerning activities of daily living in pain: A randomized control trial. *Clinical Rehabilitation* 24, 715-726.**

## **Hand Function**

Hand function is of importance to many clients seeking occupational therapy services for the satisfactory completion of many essential areas of occupation. Decreased hand function can be a component of many diagnoses including spinal cord injuries, cerebral palsy and hand dystonia.

### Spinal Cord Injuries (SCI)

SCI's can result in significant impacts on a person's ability to perform in daily activities. Occupational therapists are often involved in assisting clients with maximizing hand function especially in relation to the tenodesis grasp, dependent on the level of injury.

**Harburn, K., & Spaulding, S. (1987). Use of a biofeedback device to promote appropriate muscle involvement during prescribed activities. *Canadian Journal of Occupational Therapy, 54(2), 79-80.***

**Kohlmeyer, K.M., Hill, J.P., Yarkony, G.M., & Jaeger, R.J. (1996). Electrical stimulation and biofeedback effect on recovery of tenodesis grasp: A controlled study. *Archives of Physical Medicine Rehabilitation, 77, 702-706***



## Cerebral Palsy (CP)

The presence of spasticity (high muscle tone) or flaccidity (low muscle tone) is a common element in children diagnosed with CP. Abnormal muscle tone affects a child's ability to functionally use their hands during daily activities.

**Reid, D. & Koheil, R. (1987). EMG biofeedback training to promote hand function in a cerebral palsied child with hemiplegia. *Occupational Therapy in Healthcare*, 4(3/4), 97-107.**

## Hand Dystonia

Hand dystonia, more commonly known as “writer’s cramp”, can limit an individual’s ability to perform daily tasks requiring sustained functional use of the hand. The use of biofeedback can be implemented with clients experiencing hand dystonia to promote hand function.

**O'Neill, M. E., Gwinn, K. A., & Adler, C. H. (1997). Biofeedback for writer's cramp. *American Journal of Occupational Therapy*, 51(7), 605-607.**

## **Emerging Areas of Implementation**

### Incontinence

Incontinence is a physiological issue that many people face at different stages in life. Reduced strength in the pelvic floor muscle group can be a factor leading to incontinence. This issue of incontinence as well as the fear associated with the possibility of experiencing a voiding accident in social situations contributes significantly to decreased participation in daily occupations. The following articles provide information pertaining to clinical utilization of biofeedback in addressing incontinence as well as the role of occupational therapists in treating this population.

**Collins, L.F. (1998). Using biofeedback to treat incontinence. *Occupational Therapy***

***Practice*, 3(5), 30-32.**

**Coffey, S. W., Wilder, E., Majsak, M. J., Stolove, R., & Quinn, L. (2002). The effects of a progressive exercise program with surface electromyographic biofeedback on an adult with fecal incontinence. *Physical Therapy*, 82(8), 798-811.**

## Traumatic Brain Injury (TBI)

Adults diagnosed with a TBI often experience high levels of emotional stress which have been attributed to decreased attainment of rehabilitation potential. Stress management and relaxation become important factors to be addressed by occupational therapists to promote occupational performance.

**Lysaght, R. & Bodenhamer, E. (1990). The use of relaxation training to enhance functional outcomes in adults with traumatic head injuries. *The American Journal of Occupational Therapy*, 44(9), 797-802.**

# Case Scenarios

### Cerebral Vascular Accident (CVA)

A 65 year old male has experienced a left CVA two months prior, resulting in limited use of his right upper extremity. Minor activation of upper extremity muscle groups is present although abnormal tone affects functional use of his arm in completion of ADL's. The use of EMG biofeedback could be utilized during engagement in his ADL routine to promote function through motor learning. During initial phases of treatment EMG biofeedback could be applied to proximal muscle groups such as the anterior deltoid for shoulder flexion to 90° while completing dressing tasks. With progression of therapy, EMG biofeedback can be applied to distal muscle groups such as the supinator and biceps brachii for supination and pronator teres for pronation during a cooking task. Occupational therapists can grade intervention approaches based on the individual's level of performance which can be assessed with the help of biofeedback readings to achieve therapy goals.

### Spinal Cord Injury

An 18 year old male has sustained an incomplete spinal cord injury at the level of C6. He was injured 3 months prior in a cliff diving accident. At this level, facilitation of the tenodesis grasp is a priority to promote function. EMG biofeedback and functional electrical stimulation (FES) could be used simultaneously to facilitate the tenodesis grasp during self-care activities, eating, dressing and any number of occupation-based interventions. EMG biofeedback sensors could be placed over the wrist flexor (flexor carpi ulnaris and flexor carpi radialis) and wrist extensors (extensor carpi radialis longus, extensor radialis brevis and extensor carpi ulnaris) for grasp facilitation.

### Chronic Pain

Myrna is 32 year old female who has been experiencing lower back pain with enough severity to interfere with successful participation in her valued roles. Myrna is employed as a certified nursing assistant (CNA) and has been experiencing pain for the past several years after sustaining an injury during the transfer of a patient. Several forms of treatment have been unsuccessful in alleviating Myrna's daily discomfort. EMG biofeedback could be applied in conjunction with relaxation training and during completion of home management tasks. Sensor placement could correspond with the muscle groups in painful areas as identified by Myrna. Visual output produced by biofeedback software will be helpful in illustrating to Myrna the level of tension in her muscles as well as effective muscle relaxation strategies resulting in lower level of muscle activation.

# **Training and Certification**

To become board certified in biofeedback implementation one must complete necessary training and meet criteria as outlined by Biofeedback Certification International Alliance (BCIA). Being certified in biofeedback is not required to implement this adjunct to treatment in practices, although a firm understanding of biofeedback concepts is necessary for utilization within occupational therapy practice. One could complete various training courses offered through a number of educational channels to become appropriately trained to implement biofeedback into occupation-based interventions. Completion of the appropriate training prior to utilization of biofeedback is advised to ensure proper application, optimize outcomes, and follows best practice guidelines as outlined by the American Occupational Therapy Association (AOTA). A list of biofeedback training courses is provided followed by the requirements for BCIA certification.

### **Training:**

The following is a list of programs offering training courses accredited through BCIA:

Association for Applied Psychophysiology  
and Biofeedback (AAPB)  
Wheat Ridge, CO  
(303) 422-8436  
[www.aapb.org](http://www.aapb.org)

Ossining, NY  
(877) 669-6463  
[www.biofeedbackinternational.com](http://www.biofeedbackinternational.com)

Behavioral Medicine Research and Training  
Foundation  
Port Angeles, WA  
(360) 452-5020  
[www.behavmedfoundation.org](http://www.behavmedfoundation.org)

East Carolina University  
Greenville, NC  
(252) 328-0024  
[www.ecu.edu](http://www.ecu.edu)

Biofeedback Resources International  
Corporation

Cambridge Health Alliance: A Teaching  
Affiliate of Harvard Medical School  
Cambridge, MA



Contact: Catherine Schuman, PhD  
(781) 338-0036  
cschuman@cha.harvard.edu

STENS Corporation  
San Rafael, CA  
(800) 257-8367  
[www.stens-biofeedback.com](http://www.stens-biofeedback.com)

Widener University  
Biofeedback Clinic & Certification Center  
Chester, PA  
(610) 499-4514  
[www.widener.edu/biofeedback](http://www.widener.edu/biofeedback)

**Specific Program Courses:**

Behavioral Medicine Research and Training Foundation: General Biofeedback Training Course which is required by BCIA. The cost is \$550 and is a home study program. A Neuromuscular Reeducation in Biofeedback course is also available for \$550; also a home study program with access to instructor via telephone and e-mail. Several other courses in related areas including ethics are offered through this association.

Stens Corporation: Offers several courses with the most appropriate for OT practice specifically being a 5-day Professional Biofeedback Certificate Program which costs \$1295.00. This price does not include travel or lodging.




**Certification:**




Biofeedback certification can be provided through the Biofeedback Certification International Alliance (BCIA). There are three levels of certification outlined in the following table:


Type of Certification	Requirements
<p><b>Clinical Certification:</b></p> <p>Completion of certification earns the designation of Board Certified in Biofeedback (BCB) and is open to professionals in clinical healthcare practice areas (i.e. occupational therapy).</p>	<p>Must hold a bachelor's degree or higher in approved BCIA field</p> <p>Complete didactic biofeedback education (48 hours) from a BCIA accredited program</p> <p>Biofeedback training (20 hours) with BCIA certified mentor</p> <p>Completion of human anatomy/physiology courses</p> <p>License or credentials for independent practice</p> <p>Submission of application and payment of appropriate fees</p> <p>Pass a written examination</p>
<p><b>Academic Certification:</b></p> <p>Available to professionals holding an MA/MS degree in no specific field and who wish to use biofeedback in academic research or in a supervisory role but not providing clinical treatment.</p>	<p>Complete didactic biofeedback education (48 hours) from a BCIA accredited program</p> <p>Mentoring (10 hours) with BCIA certified provider</p> <p>Completion of human anatomy and physiology courses</p> <p>Submission of application and payment of appropriate fees</p> <p>Pass a written examination</p>
<p><b>Technical Certification:</b></p> <p>For individuals currently working as biofeedback technicians and supervised by a BCIA-certified provider.</p>	<p>Complete didactic biofeedback education (48 hours) from a BCIA accredited program</p> <p>Mentoring (10 hours) with BCIA certified provider</p> <p>Proof of biological psychology, human anatomy, human biology, human physiology, or physiological psychology courses</p> <p>Submission of application and payment of appropriate fees</p> <p>Pass a written examination</p>

# **Computerized Biofeedback Systems, Prices and Manufacturers**

Below is a list of computerized biofeedback machines available online with approximate prices without the addition of sensors. STENS computerized biofeedback machines are presented below as STENS Corporation is recognized as the leader in distribution and sales according to the Biofeedback Certification International Alliance (BCIA). This list is not meant to promote STENS products, but rather to serve as examples of machines and systems that are compatible with EMG biofeedback.

Product Description	Product Photograph	Price
<p>NeXus-4 Bluetooth Biofeedback</p> <ul style="list-style-type: none"> <li>• Offers 4 input channels for the utilization of : ° EEG, EMG, ECG, EOG, BVP, Skin conductance, Respiration, Skin Temperature, Heart Rate</li> <li>• Offers a “real time” data link to your personal computer</li> <li>• Has the ability to store 24 hours of physiological data on a built-in flash drive</li> <li>• Small and Compact</li> </ul>		<p>\$ 3,195.00</p>
<p>NeXus-10 Wireless Bluetooth Biofeedback</p> <ul style="list-style-type: none"> <li>• Offers 10 channels of physiological monitoring</li> <li>• Uses Bluetooth wireless communication</li> <li>• Clinicians can provide biofeedback training virtually anywhere</li> <li>• 4 fast channels are capable of monitoring 2,048 samples per second of EMG, EEG, ECG, and EOG</li> <li>• 6 channels that measure skin temperature, respiration, heart rate and skin conductance</li> <li>• Can use a dual channel multi-modal EXG cable can be used for recording EMG, EEG, ECG, and EOG signals, which means fewer sensors to purchase</li> </ul>		<p>\$4,695.00</p>
<p>NeXus-32 Wireless Bluetooth Biofeedback</p> <ul style="list-style-type: none"> <li>• 32 channels of multi-modal data collection</li> <li>• Ideal for physiological research or advanced clinical use</li> <li>• The standard configuration supports:</li> </ul>		<p>Pricing is determined by US dollar/Euro conversion</p>

<ul style="list-style-type: none"> <li>°24 uni-polar channels of EEG</li> <li>°4 bi-polar EXG channels for EMG, EOG or ECG</li> <li>°3 auxillary channels for respiration, heart rate and temperature</li> <li>°1 Digital channel for Oximetry and 1 trigger input</li> <li>• Can gather 2,048 samples/second</li> </ul>		
<p>Atlantis I 2x2</p> <ul style="list-style-type: none"> <li>• Offers 2 channels of EEG information</li> <li>• Offers 2 channels of AUX signals for other modalities (EMG, heart rate, skin temp)</li> <li>• Offers photic, vibratory and auditory feedback</li> <li>• Continuous real time impedance checking and recording</li> <li>• Does require additional software for personal computer</li> <li>• Computers need to meet specific requirements before utilization can occur</li> </ul>		\$1,695.00
<p>Atlantis I 4x4</p> <ul style="list-style-type: none"> <li>• Offers 4 channels for EEG information</li> <li>• Offers 4 channels of AUX signals for other modalities (EMG, heart rate, skin temp)</li> <li>• Has the ability to monitor various bio-potentials from two people at the same time</li> <li>• Continuous real time impedance checking and recording</li> <li>• Offers photic, vibratory and auditory feedback</li> <li>• Does require additional software for personal computer</li> <li>• Computers need to meet specific requirements before utilization can occur</li> </ul>		\$2,695.00
<p>J&amp;J I-330-C2+6 Channel</p> <ul style="list-style-type: none"> <li>• 2 different channels for EMG, ECG and EEG</li> <li>• 4 channels for other modalities like skin temperature, respiration, provides power, flexibility and functionality for various customized uses</li> <li>• Utilizes new Windows software to provide signals, data, reports, and exporting data to other files</li> <li>• Has the ability to monitor 2 individuals at the same time</li> <li>• Can gather 1,024 samples per second</li> <li>• Easy hook-ups for reusable gel-free sensors</li> </ul>		\$1,995.00

<p>J&amp;J I-330-C2+12 Channel</p> <ul style="list-style-type: none"> <li>• 4 different channels for EMG, ECG and EEG</li> <li>• 8 channels for other modalities like skin temperature, respiration, provides power, flexibility and functionality for various customized uses</li> <li>• Utilizes new Windows software to provide signals, data, reports, and exporting data to other files</li> <li>• Has the ability to monitor 2 individuals at the same time</li> <li>• Can gather 1,024 samples per second</li> <li>• Easy hook-ups for reusable gel-free sensors</li> </ul>		<p>\$3,195.00</p>
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\*This list was reproduced with permission from the Stens Corporation

For further computerized biofeedback systems please refer to the following distributors:

Company: Stens Corporation  
Address: 3020 Kerner Blvd. Suite D  
San Rafael, CA 94901  
Phone #: 1-800-257-8367

Company: Allied Products: Biofeedback Instrument Corp.  
Address: 255 W. 98<sup>th</sup> St.  
New York, NY 10025  
Phone #: (212) 222-5665

Company: Life Matters: Tools for Stressless Living  
Address: c/o WorldWorks Unlimited  
1275 4<sup>th</sup> St. #725  
Santa Rosa, CA 95404  
Phone #: 1-888-255-9757

# **Billing and Coding**



Reimbursement for biofeedback as a treatment modality has been inconsistent and can be unpredictable (Rosenthal, 2008). Medicare coverage depends on local carriers, despite there being a National Coverage Decision (NCD) regarding biofeedback (Painter & Painter, 2010). When billing for biofeedback treatment the combination of codes will determine the approval or denial of reimbursement. There are a relatively small number of codes used for biofeedback treatment; although biofeedback is often used in conjunction with conventional therapy, the combination of codes can become complex.

The following table outlines three codes used specifically for use of biofeedback in the rehabilitation setting:

Code	Description
97532	Used for <b>cognitive retraining</b> and has been used by neurofeedback providers when working with clients with traumatic brain injuries (TBI) to improve cognitive function (Rosenthal, 2008).
97112	Used for <b>surface electromyographic (EMG) biofeedback training</b> in neuromuscular reeducation of movement, balance, and coordination (Rosenthal, 2008).
96002 *This is a relatively new code	Used for <b>dynamic surface EMG training</b> such as neuromuscular reeducation during functional activities (Rosenthal, 2008).

## Basic Tips for Biofeedback Reimbursement

- Prior to utilizing biofeedback as an adjunct to treatment have a physician review and approve the proposed protocol to help ensure reimbursement (Painter & Painter, 2010).
- It is recommended that each individual's insurance company be contacted to verify coverage prior to treatment as some companies require pre-authorization (Rosenthal, 2008).
- For those with Medicare, verify coverage on an individual basis to determine whether specific criteria are met for reimbursement (Painter & Painter, 2010).

# Limitations

It is important to consider all the possible limitations of EMG biofeedback before implementing the training technique as an adjunct to conventional occupational therapy in the clinic. Some possible limitations to utilizing EMG biofeedback can include:

- The dedicated time needed to complete certification and/or training;
  - Most training courses occur over a week's time
  - Traveling to locations of courses
  - A practitioner needs to be competent in areas of human anatomy, human physiology or human biology
  - Completing a didactic educational program (length of time will depend on the specific certification)
  - Locating available Biofeedback Certification International Alliance (BCIA) mentors who are approved and the time required to spend shadowing depending on the certification level
  - The dedicated time that is needed to study for the certification exam

All requirements need to be completed while carrying out the responsibilities of an occupational therapist providing treatment in a rehabilitative setting.

- Expenses related to the certification and/or training according to BCIA;
  - Expenses for traveling and lodging in order to attend courses
  - The courses can cost anywhere up to \$1,300
  - Filing fees for sitting for the certification exam
  - Application fees for the certification exam

- Expense of computerized biofeedback systems
  - Biofeedback machines can range in cost from \$3,000 to \$10, 500 depending on the intended utilization within a hospital or clinic
  - Purchasing the software that is required for the operation of the biofeedback system
    - These can range in cost from \$20 to \$1,000 depending on the intended purpose
  - A laptop will need to be purchased that is compatible with the software so output readings can be displayed for the patient
  - Various sensors will need to be purchased depending on planned use of the EMG computerized biofeedback system
  - Upkeep and maintenance of the laptop, computerized biofeedback system and sensors need to be considered with expenses

There are limitations to consider before an occupational therapy practitioner decides to implement EMG biofeedback as an adjunct to conventional occupational therapy. Although trainings and certifications in the use of EMG biofeedback are not a legal requirement for occupational therapists when treating clients, certification follows best practice within occupational therapy and is ethical.

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# Appendix

# Biofeedback Certification International Alliance

(formerly the Biofeedback Certification Institute of America)



10200 West 44th Avenue, Suite 310, Wheat Ridge, CO 80033

Phone: 303-420-2902 FAX: 303-422-8894 [www.bcia.org](http://www.bcia.org)

*"More than qualified - BCIA Board certified"*

November 22, 2011

Dear Ms. Averett and Ms. Meister:

Thank you for your inquiry regarding the use and reprinting of certification information from our website – [www.bcia.org](http://www.bcia.org). So long as appropriate credits are given, you may have access to any and all documents from our website to be used in your project. We thank you for thinking of our information in your work and we welcome the opportunity to spread the good word about our credential.

Please let me know if I can answer any further questions you may have regarding our certification programs.

Cordially,



Judy Crawford

Director of Certification

**More than qualified - BCIA Board Certified!**

Hi Johanna and Sarah,

The AAPB board of directors have approved your proposal. They request that you cite the materials using the American Psychological Association (APA) Publication Manual (2010) guidelines for citation of material from a website ( <http://www.apastyle.org/learn/faqs/web-page-no-author.aspx>)

Please let me know if you have any questions. Good luck on your project and thanks again for thinking of AAPB as a resource for your citations.

Regards,

Monta A. Greenfield

Associate Director

Association for Applied Psychophysiology and Biofeedback

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x136 | Direct: (720) 881-6136 | Fax: (303) 422-8894 | [mgreenfield@resourcenter.com](mailto:mgreenfield@resourcenter.com) |  
[www.aapb.org](http://www.aapb.org)

Dear Johanna and Sarah,

Sounds like a terrific and extremely comprehensive guide you are creating. I would be pleased to have you take what information is useful to you from our website as long as you can note our contribution. Let me know what pictures you want to use and I will get those sent to you. Our main product line is the wireless NeXus systems. There is a newer model called the NeXus-10 MKII. I will send you a separate email on it. In the interim you might want to watch some interesting videos on the NeXus hardware:

<http://www.youtube.com/watch?v=pHdQ9daL95w>  
<http://www.youtube.com/watch?v=NXbGjkV0UYU>  
<http://www.youtube.com/watch?v=GM0YswggsIw>

Hope you both have a wonderful weekend and I look forward to being of service.

Sincerely,

Steve Stern  
Stephen H. Stern

President



A.A.P.B. & I.S.N.R. Corporate Member

3020 Kerner Blvd, Suite "D"  
San Rafael, CA 94901-5444  
(800) 257-8367  
(415) 455-0111  
(415) 455-0333(Fax)  
Email: [sales@stens-biofeedback.com](mailto:sales@stens-biofeedback.com)  
[www.stens-biofeedback.com](http://www.stens-biofeedback.com)

## CHAPTER V

### SUMMARY

The purpose of the scholarly project was to determine the effectiveness of EMG biofeedback, determine the extent to which EMG biofeedback was being implemented into occupation-based interventions, and provide research in the form of an informational guide to practicing occupational therapists. From research gathered during the literature review, the authors developed an informational guide with information selected to provide an introduction to EMG biofeedback and related concepts. Product development was guided by the occupation-based model of Occupational Adaptation (OA) coupled with the understanding that EMG biofeedback is an effective and viable adjunct to occupation-based intervention as supported by the literature review. The informational guide was meant to provide answers to initial questions occupational therapy practitioners might have regarding EMG biofeedback while promoting further exploration of how biofeedback can be implemented into occupation-based interventions. The guide provides an overview of pertinent information with several resources for individuals to obtain further information from reliable sources. To determine the usefulness of the product the students will develop a brief questionnaire to be included with the product for those utilizing the guide to fill out and return to the authors for further product development. The completion and addition of actual case studies by the authors will also enhance the usefulness of the product.

Limitations of the product include lack of accessibility of the informational guide by practicing therapists. This limitation can be addressed through contacting biofeedback related associations with whom the graduate students have been in contact, and request inclusion of our informational guide as a resource on their web-sites. In addition several copies of the informational guide have been produced to provide to practitioners in the Casper, Wyoming area

who are familiar with the project. Limitations of the scholarly project as a whole include the lack of current occupational therapy specific research related to the use of EMG biofeedback as evidenced in the literature review.

Potential for further scholarly collaboration could be completed as a result of this project. Future graduate students could complete an independent study into the effectiveness of EMG biofeedback with a specific diagnostic group. This would be beneficial in building the body of evidence for EMG biofeedback while also fulfilling the need for evidence-based practice within occupational therapy. Future graduate students could develop a survey regarding the use of biofeedback within occupational therapy practice or a survey of educational programs teaching biofeedback concepts within educational curriculum. Each of these research studies would address areas in which a gap exists in the literature as it pertains to EMG biofeedback and occupational therapy utilization in occupation based interventions.

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