in Rehabilitation
advances
A Newsletter for Health Professionals

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In March of 2012, thirty-year old Nathan Beels barely survived a wreck on his motorcycle. His multiple injuries included a left open calcaneus fracture that led to a below the knee amputation, pelvic fractures, open laceration of his perineum with urethral injury, and spinal fractures including a C7-T1 distraction injury, posterior and anterior longitudinal ligament disruption, and a C7 fracture with spinal cord contusion. Because Nathan shattered his pelvis, he lacerated his iliac artery and lost 50% of his blood.

After multiple surgical procedures and over sixty days in the acute care hospital, Nathan admitted to St. David’s Rehabilitation Hospital for comprehensive inpatient rehabilitation. In addition to medical management, Nathan required interdisciplinary care, including rehabilitation nursing, psychology, nutrition and physical and occupational therapy.

At the time of his admission to St. David’s Rehabilitation Hospital in May of 2012, he required supervision for eating, minimal assistance for grooming and total assistance for all remaining activities of daily living. He transferred with maximal assistance and was unable to ambulate. During his stay at St. David’s Rehabilitation Hospital, we focused on a combination of our spinal cord injury and amputee programs. We were able to optimize the healing of his stump and work on progressive strengthening and endurance skills. Individualized prosthetic recommendations were provided while in rehabilitation and after obtaining a preparatory prosthetic leg, we saw Nathan progress in therapy to the point of walking 50 feet with supervision using his prosthesis and a rolling walker, and being independent with all activities of daily living.

In July 2012, Nathan discharged to home. He continued with our outpatient prosthetic therapy program and is currently walking independently with his prosthesis and no other assistive device. Recently he was able to return to active sports including wakeskating, which made him (and all of us) very proud.

“\"When I came to St. David’s, I was beyond broken. The therapists and nurses truly helped me put the pieces back together.\"”

Juan Latorre, MD, Medical Director of St. David’s Rehabilitation Hospital Spinal Cord Injury and Amputee Programs
A Message from Administration

St. David’s Rehabilitation Hospital looks forward to the challenges of 2013 and beyond. Although, the future is uncertain, we do know that post-acute providers will face additional regulatory and reimbursement changes. More than ever, rehabilitation providers are forced to continually evaluate their programs, services, quality and satisfaction and remain focused on providing excellent and efficient care.

For 2013, our medical staff and leadership identified top priorities for the coming year:

1. Support Research—St. David’s Rehabilitation continues to participate in two research studies involving gait training. One study compares the Walk-Aide, a computerized electrical stimulation device, to the more conventional ankle-foot orthosis. Body-Weight-Supported-Treadmill Training is the focus of the other study.

2. Evaluate Technology—We are committed to providing our patients with the most current rehabilitation technology. As new products enter the market, discerning equipment needs becomes more difficult. Through the use of an interdisciplinary team approach, St. David’s will continue to evaluate emerging technology.

3. Enhance Electronic Medical Record—As part of HCA, staff have used the electronic record for the last fifteen years. Recently, physicians joined the initiative by entering orders and progress notes electronically. Next year, we will refine this documentation system and develop improvements to facilitate efficiency and compliance.

4. Develop Staff—Last year, our rehabilitation hospital provided forty hours of continuing education in the field of neurological rehabilitation. Through online learning, lecture and lab, we provide additional courses to enhance growth and development.

In this issue, you will learn about several of our efforts to offer the best possible rehabilitation experience for our patients. In this constantly changing environment, focus on providing exceptional care will be the key to achieving our goals.

Diane Owens, PT, FACHE
Assistant Administrator, St. David’s Rehabilitation Hospital
The Integrated Team and Brain Injury Rehabilitation

Dr. Everett Heinze, MD and Medical Director | St. David’s Rehabilitation

Comprehensive brain injury rehabilitation requires an integrated treatment team consisting of diverse and specialized rehabilitation professionals. At St. David’s Rehabilitation Hospital, both neurologists and physiatrists work together with our rehabilitation experts. Our core team consists of physical, occupational and speech therapists, nurses, psychologists, dieticians and licensed social workers. In addition, we collaborate with other specialists to develop care plans for spasticity management, wheelchair seating and assistive technology. In addition, in our environment, aquatic therapy and pet therapy provide valuable services to our patients.

Brain injury may result from trauma, stroke, encephalopathy, anoxia, cerebral edema, or brain tumor. Traumatic brain injury (TBI) alone affects over 1.5 million Americans each year. Common causes for TBI include motor vehicle accidents (50%), military action (TBI being referred to as the “signature wound” of the Iraq and Afghanistan wars), and sports injuries. TBI results from a coup injury at the site of direct skull impact, a contrecoup injury at the opposite side and rotational and shearing forces, leading to vascular damage and diffuse axonal injury. Depending on the degree and nature of these injuries, the result may be mild brain injury or a concussion.

Although minor brain injury sounds innocent, 15% of patients still have compromised function one year after injury, and multiple concussions can lead to dementia, ALS-like motor neuron disease, or depression. Moderate-to-severe brain injury can also occur with contusions, skull fractures, epidural, subdural, intracerebral bleeds, or severe diffuse axonal injury. Neurologic deficits reflect the injured areas of the brain that are affected. Brain injury sequelae included physical, cognitive, and behavioral abnormalities, especially visual abnormalities, deficits of attention, memory deficits, reasoning deficits, executive dysfunction, and especially lack of inhibition. General therapy treatment concepts include modifying environment to decrease external distractions, written schedules, calendars, alarms, cues, simplifying and breaking tasks into small parts, slowing down or sometimes speeding up, visualizing information, repetition linking information to familiar concepts, and bed or chair alarms for safety. Other important concerns begin with controlling pain since pain limits ability to participate in rehabilitation. However, it is important to monitor closely for side effects of pain medication, regulating bowel and bladder, helping people sleep at night, staying awake during the day, controlling medical conditions such as diabetes, blood pressure, infection, heart problems, and treating depression, anxiety, stress. All contribute to improved outcomes.

While in rehabilitation, the team focuses on improving range of motion, strength, transfers, gait, activities of daily living, balance, endurance and safety. Additionally, a wide variety of therapeutic interventions are available to reach patient goals.

- **Aquatic therapy**—the 92-degree water benefits patients with increased tone and muscle weakness
- **Dynavision**—helps improve reaction time, visual scanning, motor planning, eye-hand coordination
- **Neuromuscular biofeedback therapy**—Use of EMG biofeedback to maximize motor neuron recruitment, improve motor sequencing and motor discrimination for improved voluntary functional movement for individuals with upper motor lesions. Electromyographic measurements of a muscle’s bioelectric function are an indirect measure of CNS function.
- **Saebo-flex**—Dynamic extension hand system (pictured on the right)
- **Interactive Metronome**—Addressing deficient neural timing in the brain with functional therapy interventions
• **Bioness Wireless Hand Rehabilitation System**—improve ability to perform activities of daily living and reduce muscle spasms

• **GaitRite**—Walkway system that measures the temporal and spatial parameters of gait including cadence, walking speed, and step length.

• **Body Weight Supported Treadmill Training**—use of BWSTT improves rate of recovery, gait velocity, energy efficiency and decreases the level of assistance required for ambulation.

• **WalkAide**—Functional Electrical System (FES) to improve walking in people with foot drop

Speech therapists provide a critical role in brain injury rehabilitation. They address speech and language, cognitive and swallow function. Through the use of modified barium swallow testing and the bedside Fiberoptic Endoscopic Esophageal Study (FEES). Our speech therapists find FEES more convenient to use and appropriate for many of our patients. In addition, it does not expose patients to radiation.

Psychology deals with difficult issues of depression, anxiety, stress, lifestyle changes and attitude, which can sabotage the rehabilitation program if not effectively treated. Their expertise is also helpful in developing behavioral management plans.

Nursing is the backbone of a brain injury rehabilitation program. The CRRN, a nurse certified in rehabilitation nursing, is critical to the success of the facility; 50% of our nurses have completed requirement to be designated a CRRN. By encouraging nursing staff to complete this additional training, the unit benefits from a higher level of expertise and integrating structure. The scope of nursing covers completion of orders, medication management, bowel and bladder training, continuing and reinforcing therapy programs, fall prevention, education and communication with the members.

The case manager or social worker help obtain and gather information and facilitate communication among the team members and designated family members. They provide updates to insurance companies and work on discharge planning. Discharge planning includes arranging for equipment and follow-up therapies.

The most important member of the team is the patient because he or she needs to work hard with all the therapies, maintain a positive attitude, and be determined to maximize recovery. With the help of the integrated and specialized team, a brain injured patient is more likely to meet their goals.

The impact of brain injury on patients and families is life-changing. Thanks to the advances of modern technology and ongoing research, rehabilitation facilities have more options available to provide the best possible outcome for their patients.

“...the team focuses on improving range of motion, strength, transfers, gait, activities of daily living, balance, endurance and safety.”
Technology has entered every aspect of our lives and every industry including rehabilitation. As a healthcare provider, it is often difficult to determine the best technology to help our patients.

The internet and the technological age provide consumers with an abundance of information. Consumers can quickly become informed advocates capable of making crucial decisions about what healthcare to seek and where to find it. What is the consumer looking for in a provider? Easy access, affordable cost, providers that know them well, the best treatments and, oh yes, that new medical technology their aunt saw on television the other day.

Modern consumers are well-informed. They ask for new treatments and technologies that they find in their internet searches. They look for rehabilitation clinics equipped with the latest treatment programs and resources. How does a client determine if the latest technology is an appropriate option for them? The new technology must be meaningful to their personal situation and provide some measure of progress toward achieving specific functional goals. A new treatment is most valuable when it helps the patient find permanent change in their daily living.

David Wiesner is a recent client of St. David’s Rehabilitation Hospital. In May of 2000, while playing volleyball, Mr. Wiesner injured his carotid artery and suffered a stroke. He was an avid jogger, running several miles per day, multiple days per week. He played sports and participated in triathlons. He applied his business, marketing and computer skills working for a small high tech company. On that day, after being struck in the neck with the ball, he had only vague symptoms of feeling ill. It was later that evening when he collapsed in his home. Eighteen hours later, he was discovered. The stroke caused severe impairments in his physical and cognitive functions. A young, active professional was now dependent on family and caregivers for his daily needs. He suffered a great loss and faced a long and comprehensive course of therapies to regain his full independence.

Over the past decade, he has worked in several positions in the hotel and tourist industry. He had periods of success, and with time and his hard work, he made meaningful progress toward being more independent. With success came new challenge and loss. He lost his job in Galveston as a result of the destruction caused by Hurricane Ike. Since then he found, and subsequently lost, two other jobs. He is now living in central Texas with his family with the goal to find employment with a challenging career path.

In his current stage of recovery, David continues working with St. David’s speech therapists on his communication skills to prepare him for interviews and to be successful in his next position. His speech therapy is enhanced with the use of an iPad and various applications that help him practice his organizational skills, divided attention and verbal communication.

Physical therapy addressed David’s gait impairments. As a result of the stroke and brain injury, he has developed an equinovarus deformity. Unable to dorsiflex his ankle and toes, David plantar flexed and inverted his foot when walking. In addition, his right arm does not swing by his side. Because of muscle imbalance and impaired sensation, his right arm is held in an atypical position behind his body as if he is resting his arm on the back of a chair.

These gait deviations are clinically limiting in that David cannot get a strong push-off from the right leg due to the mal-alignment of the foot and ankle. But, these gait deviations are also functionally limiting in that they are noticeable to others who see him walking, such as potential employers. His goal is to achieve a natural gait pattern and more efficient communication skills in order to seek employment.

Using Technology to Achieve Rehabilitation Goals: One Man’s Journey
At St. David’s, physical therapy included the use of the WalkAide and the GaitRite (pictured below). The WalkAide was developed by Innovative Neurotronics, a Canadian company with offices here in Austin. It is a functional electrical stimulation device that provides neuromuscular re-education to David’s right leg.

David wears the WalkAide on his right shin just under his knee. It delivers an electrical current which stimulates the local nervous system to lift David’s toes at just the right moment when the right leg takes a step. It turns on when David’s shin tilts forward and turns off when his right foot swings forward. The WalkAide is approved by the FDA for use by an individual diagnosed with certain spinal cord injuries but more data must be collected to prove it is a benefit for individuals recovering from a stroke. St. David’s is a participating site for a clinical trial of the WalkAide for individual’s diagnosed with a stroke. The clinical trial compares outcomes for people when walking with the WalkAide versus when walking with an ankle-foot orthosis. The WalkAide provides exactly the right stimulus to correct David’s right ankle and foot alignment allowing for a much more natural pattern. When he wears the WalkAide, there is no noticeable impairment in his foot and ankle. The technology which makes the WalkAide possible directly affects his gait pattern which allows him to walk with a smooth quality that goes unnoticed by observers and potential employers.

The GaitRite is a sixteen-foot long mat that provides a short runway for clients to walk over. It was developed by CIR Systems. As David walks on the mat, pressure sensors record each step, documenting the spatial and temporal parameters of his walk. Data is collected including the alignment of his feet, the length of his steps, the timing of each step and the cadence. From this data, functionally significant information can be calculated such as the individual’s walking velocity.

Using the GaitRite, David could see numerical data and a graphic image of his footprints. This helped him understand that his right foot took a much longer step than his left and that the right foot pointed in toward the middle. The physical therapist could verbally coach him about the uneven step-lengths and toe-in of the right foot, but seeing numbers on a page was a breakthrough for him. He was better able to understand the deviations in his walk and what was needed to achieve the most natural gait possible. The GaitRite also provides the opportunity to document progress using instrumented goals. These are goals that reference using the GaitRite to document changes in the alignment of his foot and the length of his steps. Thus over time the client and other parties can see permanent, objective changes which provide evidence that therapy is making changes at a functional level.

For David, the WalkAide corrected the alignment of his right foot. He improved from walking with four degrees of inversion, to walking with seven degrees of eversion. Through the use of the GaitRite, David corrected a long-standing malalignment in his foot.

The combination of technology and a neurodevelopmental treatment approach resulted in documented functional change for David. As technology continues to offer choices, therapists will be challenged to incorporate new technology into their care plans. More research, such as the study we are currently participating in, will provide the evidence-based guidelines necessary to make educated choices for our patients.
Each year in the United States about 700,000 people fall victim to stroke. The group of stroke survivors constitutes one of the largest categories of disability leading to decreased productivity and quality of life in the community and at home. A variety of impairments occur as a result of a stroke, gait impairment is one of the major problems.

Impaired gait may be characterized by decreased speed, decreased balance on a variety of surfaces, shortened stride, wide base of support, and asymmetrical walking. Frequently patients need an assistive device such as a cane due to decreased balance. The increased risk for falls associated with impaired gait correlates to hospital readmissions.

Gait training using Body Weight Support Treadmill (BWST) training (pictured below) is gaining popularity as a physical therapy intervention. Patients are fitted with a vest secured around the abdomen with shoulder straps that are attached to an overhead unweighting mechanism. Body Weight on the lower extremities is reduced by a control mechanism which allows the patient to walk on the treadmill securely with less support from the therapist and without the risk of falling.

St. David’s Rehabilitation Hospital is serving as a site for a clinical research study developed by Karen McCain PT, DPT, NCS, principle investigator. Dr. McCain is an Assistant Professor and the Associate Director of the David M. Crowley Research and Rehabilitation Laboratory at the UT Southwestern School of Health Professions. The study, *Comparison of Traditional Gait Training Methods to Early Standardized Task Specific Training (ESTT) in Persons with Acute Stroke*, focuses on gait training using Body Weight Supported Treadmill (BWST) training as the primary intervention for gait training in the inpatient setting. The study has been approved by the Austin Multi-Institutional Review Board. It is the intent of the study to provide support to BWST as an evidenced based treatment.

The aim of the study is to compare the effectiveness of traditional gait training methods to early locomotor treadmill training with partial body weight support. Outcomes will be compared from two groups of persons receiving rehabilitation after a stroke. Group A is composed of patients receiving traditional therapy and Group B consists of persons that receive locomotor treadmill training with partial body weight support. St. David’s Rehabilitation Hospital is currently enrolling patients in Group B. Group A patients are being enrolled in hospitals recruited in the Dallas/Ft. Worth Areas that do not have BWST training.

The hypothesis is that Group B will demonstrate a more symmetrical and faster gait 6 months after discharge from inpatient rehabilitation, than the gait of
participants who have not received BWST training. It is possible that participants will walk sooner and with less assistance than those who received traditional therapy.

There are three criteria for inclusion: 1) CVA less than 4 weeks post. 2) Able to give informed consent independently or have family member or other authorized surrogate available to give consent 3) first time stroke or complete gait recovery from prior stroke. The exclusion criteria are based on medical and cognitive status that would limit the patient’s ability to participate in the daily treatment interventions.

Once a patient qualifies for the study, they will be asked to sign an Informed Consent and then will be enrolled in the study. Upon enrollment there will be a set of baseline assessments that serve as the outcome measures. Once the assessments are complete, therapy will proceed. Participants will receive 3 hours of therapy per day for 5 days/week during inpatient rehabilitation and will include one hour of physical therapy a day. Thirty minutes will be scheduled for body weight supported treadmill training and thirty minutes for functional mobility and strengthening/motor control activities.

The only time spent on gait training will be on the treadmill during the 30 minute scheduled session.

Gait training on the treadmill will initially start with 30% of the body weight removed with the speed of the treadmill set at a slower rate. The goal is to gradually decrease the amount of body weight supported and to increase the speed of the treadmill. Over ground walking will not be initiated until the participant can walk with no more than 10% of body weight support. BWST training continues until the participant can walk 10 minutes without resting and with no body weight support. At discharge the participant will receive a custom fitted AFO to be worn when walking. The AFO allows for increased mobility of the ankle while providing stability.

Participants who continue with outpatient therapy at St. David’s Rehabilitation Hospital will continue with BWST training as well as working on balance and strengthening activities. St. David’s Rehabilitation Hospital is currently in process on working with Dr. McCain on the implementation of an outpatient arm of the clinical study. Participants who complete the study will be scheduled for 6 month follow-up assessment which will include an assessment on the GaitRite Mat that provides objective measurements on a variety of gait parameters.

Please direct any questions to Yolanda Strickland, PT, Supervisor of Rehabilitation Programs at St. David’s Rehabilitation Hospital: yolanda.strickland@stdavids.com

“Participants who continue with outpatient therapy at St. David’s Medical Center will continue with BWST training as well as working on balance and strengthening activities.”
Many rehabilitation facilities now offer Vision Rehabilitation to address a myriad of deficits resulting from a neurological insult to the brain.

**Visual Acuity vs. Vision**

Vision consists of more than just visual acuity. Acuity is the sharpness of the image seen by the eye. Vision is how our brain processes, interprets and recalls visual information in our surroundings or environment. It also is comprised of visual motor control and visual perception.

**The Importance of Vision**

Vision is one of the major sensory systems used for balance and gait. About 20% of the nerve fibers in the eye interact with the vestibular system. Dizziness and balance issues can ensue when there is a conflict between the systems, where the brain detects differing information from the visual, vestibular and somatosensory systems. Since vision tends to dominate the other systems, visual information will supersede information from the other sensory systems when conflicts arise.

Difficulty with visual motor relationships can present challenges with spatial relationships. The client is unaware of where they are in space with respect to the environment and/or objects around them or where objects are relative to one another that manifest as eye-hand or eye-foot incoordination or clumsiness.

Vision is essential to many daily living functions, such as, being able to dress oneself, to perform grooming and hygiene tasks like shaving, coordinating eating and drinking. Other activities include the use of distance vision, scanning, and peripheral awareness in open environments like shopping at the grocery store or malls, crossing a busy intersection and driving. Good binocular vision is required for activities with near focus and sustained visual attention, such as reading, looking at cell phones, electronic tablets, computer work and paperwork.

**Potential Visual Issues**

People may report symptoms, such as headaches, frustration or anger, and difficulty concentrating, but fail to connect these symptoms with underlying visual dysfunction or may not perceive a visual issue. Some visual disturbances may be as easily detectable as double vision or a strabismus. Strabismus may present as an eye that points inward, outward, up, down or a combination due to a muscle imbalance or nerve palsy involvement. Following neurological injury, one may also experience a loss of part of their visual field called anopsia or experience an involuntary jerk to the eye causing the inability to focus the images bounce around called nystagmus. Other visual disturbances may be subtle.

A common activity that individuals with visual dysfunction may have a challenge with is reading. Reading is a highly coordinated visual activity that requires the eyes to aim at the same point simultaneously and accurately to allow focus across the line of print. To reiterate, clients may not be aware of their visual impairments. For example, someone that may have been an avid reader prior to injury, now avoids reading, experiences blurred vision when reading, misses beginnings or endings of sentences, uses their finger to read, squints, skips words or lines, has decreased reading comprehension, rearranges words, has long pauses with reading, has eyestrain, exhibits sudden frustration and/or changes in head or body position while reading.
If a client has loss of 3D vision or depth perception, called stereopsis, the individual may experience falls or trips when encountering changes in grade of terrain, like curbs, ramps, steps and stairs. Additionally, the individual may knock items over or hit items due to the inability to accurately judge distance, depth or height.

Those that have inefficient accommodation or difficulty with focus, they may present with an inability to change focus or have blurred vision that usually manifests with difficulty to shift focus. For instance, having the inability of focusing on the road ahead, looking down to the speedometer and back to the road while driving. Other common visual challenges may be:

- Difficulty copying information from signs, TV, billboards, advertisement
- Misaligned writing, inability to write in a straight line
- Short attention span
- Moving one’s head excessively when reading or poor head position especially with attempting to focus
- Poor handwriting
- Burning, itching, crusting over or watering of the eyes
- Bumping into things
- Holding books too close or too far
- Squinting
- Difficulty recognizing faces
- Light sensitivity
- Visual overstimulation: intolerance to busy environments with noise, changing light patterns, visual movement, and/or clutter
- Difficulty with visual memory or the ability to remember or recall information the individual sees.

**Vision Therapy**

Vision therapy (also called vision training, orthoptics, eye training, and eye exercises) is a clinical approach of an individualized, progressed regimen of exercises or activities for correcting and improving the effects of eye movement disorders, non-strabismic binocular dysfunctions like accommodative insufficiency, double vision, focusing disorders, strabismus, convergence insufficiency, nystagmus, and certain visual perceptual (information processing) disorders. The practice of vision therapy entails a variety of non-surgical therapeutic procedures designed to modify different aspects of visual function. The purpose is to treat a diagnosed neuromuscular, neurophysiological, or neurosensory visual dysfunction. The goal of vision therapy is to train the eyes to work together, track, perceive and focus properly, eliminate visual problems, thereby reducing the frequency and severity of the patient’s signs and symptoms, improvement of visual comfort, ease and efficiency. It is like a form of “physical therapy” for the eyes. A vision therapist relies on prisms, eye patches, filtered lenses, specialized charts and tools and computerized systems to conduct therapy sessions.

Vision therapy encompasses a team approach between ophthalmologists, developmental or behavioral optometrists and vision therapy trained therapists. Ophthalmologists perform a comprehensive eye exam to assess the health of the eyes. Behavioral or developmental optometrist, that support use the of vision therapy exercises, perform a comprehensive eye exam to determine eye alignment, visual perception, the ability for the eyes to work well together or binocularity
and how these may affect a client’s ability to learn, read, coordinate movements and activities of daily living.

Vision therapy trained therapists administer screenings and specific exercise and activities for clients to perform in order to improve quality of their vision by facilitating binocularity or the eyes working as a team, improve efficiency, comfort with vision, processing of vision and visual memory in order to enhance clients’ function and activities of daily living.

A vision screening or comprehensive vision examination may include the following to evaluate the clients’ ability to perform:

- Near/Far Visual Acuity (Central Vision)
- Detection of Nystagmus or involuntary/uncontrolled eye movement
- Alignment of the Eyes with Near/Far Focus
- Binocularity or Eye Teaming/using the eyes as a team
- Detection of Strabismus or Turning in/out/up/down of eye
- Detection of a Phoria or inability to sustain fixation
- Accommodation or ability to readily/efficiently transition from near/far focus
- Visual tracking or ability to smoothly track a moving object
- Saccades or ability for eyes to move from one target to another
- Peripheral Visual field awareness
- Detect Depth Perception
- Fine/Gross Eye-Hand (and sometimes Leg) Coordination
- Visual Perception
- Color Perception

Based on the deficits found in the examination by the ophthalmologist they may prescribe medication for dryness or intervention for any disease processes that may be present, use Botox to relax tight/spastic ocular muscles (in some cases of weak antagonist muscles), and/or surgeries to improve alignment. Developmental or behavioral optometrists may prescribe press on or ground in prisms or corrective lenses to facilitate alignment of visual images, make recommendation of exercises, tools, use computer software programs, balance boards (vestibular devices) and visual-motor-sensory integration training devices or activities for the client to perform to foster improvement in the quality of the client’s vision.

**Vision Therapy Program and Its Efficacy**

The number of office visits required depends on the diagnosis and the age of the patient. Vision therapy programs typically involve one to three in-clinic sessions throughout the week, for a varying number of months depending on need. Home exercises are issued to reinforce in clinic therapy.

American Optometric Association found in their journal and literature reviews that approximately 65-71% of patients with convergence insufficiency, strabismus/eye misalignment, double vision, eye incoordination, non-strabismic anomalies of binocular vision, and accommodative insufficiencies made significant improvements in visual function and ability with vision therapy.

Following neurological insult, due to the likelihood of visual disturbance, it is highly recommended to receive a vision screening from a vision therapy trained therapist, a comprehensive visual examination from a developmental optometrist and/or ophthalmologist in order to identify potential visual issues that may influence the quality of life and safety of clients.

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Vision Therapy (continued)

As a comprehensive stroke center, the need for swallow testing at St. David’s Medical Center and St. David’s Rehabilitation Hospital has increased dramatically over the years. However, modified barium swallow studies are not feasible for a high percentage of our patients. As a result, our speech therapists recommended that we add Fiber-optic Endoscopic Evaluation (FEES) to our program. After comprehensive hands-on training, we implemented this service and became the first and only hospital in Austin and Central Texas to provide Fiber-optic endoscopic evaluation of swallow.

Through FEES, the speech language pathologists can perform an instrumental bedside examination by passing a flexible fiber-optic endoscope through the nose to the patient’s hypopharynx. This enables the clinician to clearly view laryngeal and pharyngeal structures and their respective motor function. The therapist administers a variety of textures of food and liquids and is able to watch the physiological response in real time, to fully assess the integrity of the pharyngeal swallow, the patients’ risk for aspiration, and their ability to safely and efficiently consume the least restrictive diet, preventing life threatening complications such as aspiration pneumonia or failure to thrive.

Diagnostic information obtained from this examination includes the patients’ ability to manage one’s own secretions, protect their airway and sustain airway protection for a period of several seconds, and to initiate a prompt swallow without spillage of material into the hypopharynx. FEES also monitors the timing, direction, and clearance of the bolus during the swallow, the presence of pooling and residual material in the hypopharynx, sensitivity of the pharyngeal/laryngeal structures, and the effect of any anatomical abnormalities on the swallow function, such as vocal fold paralysis, pharyngeal edema from cervical surgeries, and cricopharyngeal dysfunction. By visualizing the anatomy and its role in dysphagia, FEES has led to multiple referrals for Otolaryngologists and Gastroenterologists.

The benefit of FEES being conducted bedside is crucial for assessing critically ill patients such as in the intensive care unit; patients on a ventilator; patients unable to be properly positioned for fluoroscopy due to morbid obesity, paralysis, frailty, orthopedic conditions; or pain from either contractures or pressure ulcers; and for patients with suspected laryngeal incompetence after intubation or post-surgery where the recurrent laryngeal nerve was vulnerable. It also provides a barium-free alternative to the modified barium swallow test.

Since FEES can be conducted over the course of a meal, it is also a valuable tool in identifying fatigue-induced dysphagia, such as in cases of patients with chronic obstructive pulmonary disease where disruption in swallowing and breathing coordination occurs midway through a meal. FEES is now considered the gold standard for evaluating this patient population. FEES also allows the clinician to fully assess the efficacy of therapeutic strategies, such as postural changes or swallowing maneuvers, during a meal and provide the patient with instant feedback and education. Each FEES is recorded and can be viewed with the patient and their family for improved education and understanding of the complicated nature of their dysphagia by showing them a 3D video of the anatomy and physiology and how it functions. This leads to improved patient insight into their swallowing dysfunction, adherence to swallowing precautions and strategies, and improved outcomes which ultimately improves patient satisfaction.
St. David’s Rehabilitation Hospital developed the neuromuscular retraining program (NMRT) to provide our patients with a state-of-the-art biofeedback lab to retrain motor function. The NMRT Program at St. David’s was established approximately 10 years ago. The program utilizes s-EMG biofeedback in conjunction with an operant conditioning protocol. The term biofeedback refers to any technology that is used to influence physiological processes through learning. Operant conditioning is a term originating from the behavioral sciences, often referred to as trial and error learning. Goals are to maximize motor neuron recruitment, improve motor sequencing and motor discrimination for improved voluntary functional movement for individuals with upper motor lesions. Electromyographic measurements of a muscle’s bioelectric function are an indirect measure of CNS function. There are many different types of biofeedback that differ in the targeted patient populations and physiological processes, inclusion/exclusion criteria, protocols, goals, equipment and training of clinicians. The St. David’s Rehabilitation Hospital NMRT patient population primarily targets patients with CNS lesions that are non progressive in nature. This includes patients with stroke, spinal cord injury (SCI), and traumatic brain injury (TBI). This technique is also used for some orthopedic cases post surgically, when a patient has difficulty eliciting sufficient motor responses and/or need to decrease compensatory movements. Inclusion criteria for the program include being at least 8 years of age, ability to follow basic commands, motivation to improve and sufficient attention span. The NMRT is part of an integrated team approach and the candidate will need physical and/or occupational therapy to build on gains in volitional motor gains.

Theoretical Background

The NMRT program at St. David’s Rehabilitation Hospital is largely based on the research of the late Bernard Brucker, Ph.D., ABPP who started developing this specific technique in the late 60’s. The technique is based on principles of Neural Behavioral Theory. It is known that CNS cells are mostly formed before birth. This theory states that normal motor learning early in life is not automatic but rather a product of trial and error learning that eventually results in automatic functional movement patterns. Through this learning process, neural cell task assignment occurs and proper motor sequencing is achieved.

After a CNS insult, CNS cells will die but other CNS cells do have the potential for recovery over time. Advances in imaging have also demonstrated neuroplasticity of the CNS. Cortical remapping of the brain is well documented although the exact mechanisms are not well known and remains an active area of research. Following an injury to the motor cortex or corticospinal pathways, recovery and repair will be dependent on surviving neural structures and their response to task specific learning. After a CNS insult, the individual has to relearn functional movements through new motor cell task assignments and proper sequencing utilizing surviving neural structures. The NMRT protocol assists with this motor learning aspect by allowing the individual to observe in real time their level of motor activation and sequencing when practicing desired movement patterns to facilitate neuroplasticity. This is especially useful in individuals with somatosensory deficits and/or when sufficient levels of motor recruitment for active movement are not apparent but may exist.

Equipment and Operant Conditioning Protocol

The equipment used in the NMRP program offers the patient the ability to observe their motor neuron activity visually and/or auditory in real time. Eight
microprocessor amplifiers allow measurements over a bandwidth of 10-1,000 Hz with an accuracy of 1/100 of a uV. The sensitivity of the system can be scaled to match the patient’s abilities, with the most sensitive scale able to display the activation of a single motor neuron. Noise can be eliminated through the software and cardiac filters are also available. Four channels are available which allows work on multiple muscle groups. The visual display is large and uncluttered to allow easy visualization and interpretation.

The treatment protocol is tailored to the individual’s needs. An evaluation measures current functional abilities and determines which muscles groups would most likely improve function if greater motor control could be established. Electrodes are placed on the targeted muscles and the individual is asked to make the desired functional movement. The motor activity is observed by the client in real time on a computer monitor. Clients unable to attend to the visual display have a choice of several auditory feedback options. If the person is unable to initiate the desired movement, they are placed in a position that is likely to elicit a motor response.

After the initial run, the appropriate scaling for the person’s level of available motor recruitment is determined. A horizontal line is placed on the video monitor based on the standard deviations of the initial EMG measurements to act as an operant. The individual tries to cross this threshold line by activating more motor units on successive trials. When successful, the line is continually raised until no further increases in motor recruitment occur. The motor activation of the targeted muscles is shaped through progressively more functional movement patterns. For example, the initial targeting of the gluteus medius muscle may involve simple weight shifting. The client may then work on single leg stance and finally work on weight shifting during gait, with the client able to compare activation of the affected side with the stronger side.

**NMRT Biofeedback and CVAs, TBI and SCI**

Most of the applied research studying the use of biofeedback during CNS rehabilitation has focused on the CVA population. A meta-analysis conducted between 1976-1995 examined the efficacy of using s-EMG biofeedback with physical therapy versus just physical therapy of individuals with foot drop following a CVA. The group that included s-EMG biofeedback had significant improvements in anterior tibialis muscle strength and active dorsiflexion when compared to the control group. Another study found increases in gait velocity and stride length in a hemiparetic population with the use of EMG biofeedback to supplement physical therapy when compared to the control group performing just physical therapy.

The management of increased tone in upper motor neuron disorders is a challenging task. Often increased tone interferes with a client’s functional movement and/or results in a pain limited lifestyle. The causes of increased tone are variable and much debate exists concerning best practices. In some cases, traditional PT, OT, orthosis manufacturing, etc. may be sufficient to restore function. Often, spasticity remains a
limiting issue. Intrathecal Baclofen, oral agents and/or multi-focal intramuscular agents are often needed in conjunction with PT/OT/NMRT. A recent study reported improved upper extremity function in individuals with flexion synergies using EMG biofeedback during rehab when flexor patterns were not too severe. It should be noted that electrophysiological measurements do not always correlate well with the clinical signs of hypertonicity. This lack of correlation may be confounded by combinations to abnormal tone from both biomechanical factors as well as neural stretch hyperreflexia. During the use of focal point intramuscular agents, s-EMG provides useful information for quantifying motor recruitment before and after the administration of the agent, which may aid in assessing dosing efficacy. The data assists the rehab team through a better understanding of current levels of agonist motor function as well as the degree of inhibition from antagonist motor activity. In general, a 100uV difference in motor recruitment between agonist/antagonist activation tends to translate into innervation sufficient for strengthening a muscle for anti-gravity movement. Knowledge of available levels of motor recruitment and degree of antagonist co-activation along with rate of motor return may assist in determining appropriate goals and optimizing interventions.

The use of EMG biofeedback to reduce spasticity arising from the spinal cord due to increased reflex arc from decreased voluntary descending motor pathways traditionally works on relaxation methods. These methods do reduce tone at rest but the benefits often do not translate into decreased spasticity with functional movements. The NMRT program differs from this approach and targets increasing voluntary motor control to the spastic muscles to override hyperactive reflexes in the spinal cord.

In cases of co-recruitment, reciprocal innervation to modulate a person’s movement demands becomes dysfunctional as excessive antagonist co-recruitment interferes with normal movement. Co-recruitment may mask the true strength of the agonist. When a person exerts more force attempting a functional movement the brain has difficulty differentiating between the opposing muscle groups.

During an NMRT session, the individual works to optimize function by increasing agonist motor neuron recruitment while better controlling antagonist hyperactivity. At first the person may need to concentrate on just separating the agonist activity over the antagonist’s co-activation. When motor separation is attained, the visual display will display two lines, one to act as an upper limit for acceptable level of antagonist co-activation and the second line to maximize agonist activation. The client attempts to increase the distance between the two threshold lines to improve motor discrimination between agonist and antagonist, resulting in improved movement patterns and improved economy of movement.

The research on the use for EMG biofeedback with SCI is more limited. A study of ten ambulating subjects with incomplete SCI found the group utilizing continuous electromyographic feedback of the gluteus medius muscles were able to ambulate with a decreased Tredelenburg gait when compared a control group. A second study of 100 individuals with C6 or higher SCI that had plateaued in return of function demonstrated a significant increase in triceps voluntary EMG responses. The mean time from injury was five years suggesting intact neural pathways were not being fully exploited. Review of several clients with chronic SCI’s attending NMRT, indicated functional gains even though the increase in motor neuron recruitment was not large in relation to baseline measurements. Improvements were seen in balance, strength, functional activity tolerance, ROM, transfers, ambulation and ADL’s. This suggests the use of NMRT in a multidisciplinary team approach may lead to better functional outcomes.

A recent incomplete SCI is presented as a brief case study.
The patient had four limb paralysis and was diagnosed with incomplete spinal cord injury, central cord type. He had an open reduction internal fixation of C4-C5, posterior cervical laminectomy and fusion from C3 to C7. The patient started inpatient rehabilitation on 2/14/12 and began NMRT while still in inpatient. He transferred to outpatient therapies 5/5/12, continuing PT, OT, aquatic and NMRT therapies. Throughout this client’s rehabilitation stay in both IP and OP, NMRT was scheduled weekly to maximize motor neuron gains. Results quantifying motor gains were shared with the medical and therapy staff to objectively access motoric levels. This aided the staff in setting reasonable goals and establishing an effective progression to maximize functional progress. The primary PT, OT and NMRT staff discussed results on a weekly basis to maximize continuity of the plan of care. All levels of motor recruitment increased substantially during the rehab process. A table detailing changes in motor recruitment of the different upper extremity muscle groups from initial levels attained in inpatient to the final readings in outpatient is attached. Without biofeedback, the patient was able to see small increments in motor improvement that eventually led to functional changes. Because of his sensory and proprioceptive deficits, without biofeedback, the motor gains may have taken longer and been more limited in scope. In addition, compensation patterns would have likely been more severe.

The patient started outpatient therapy at a wheelchair level of mobility. He was total assist for all activities of daily living except for brushing his teeth, which was setup. He initially had trace motor activity in the biceps and was not able to feed himself. Presently, he is independent with eating finger foods. See table included below.

Overall mobility has improved to a minimal assistance level to come from supine to sit, sit to stand and transfer. Lower extremity strength has improved, and he is now ambulating one-quarter mile over level surfaces without an assistive device at a standby assist level. He requires contact guard assist for unlevel surfaces. The patient is also able to walk on a treadmill or elliptical trainer for five minutes without resistance and returned to workouts at a fitness center.

Biofeedback provides important and motivating feedback for both therapists and patients. In this day and age where insurance reimbursement is contingent upon objective measures, biofeedback provides a simple, relatively low cost way of documenting short term gains particularly in patients whose diagnoses require significant time for functional changes.

### s-EMG Biofeedback Data for Bilateral Upper Extremities

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Initial Reading (uV)</th>
<th>Last Reading (uV)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>L anterior deltoid</td>
<td>6</td>
<td>53*</td>
<td>783</td>
</tr>
<tr>
<td>L middle deltoid</td>
<td>11</td>
<td>64*</td>
<td>482</td>
</tr>
<tr>
<td>R anterior deltoid</td>
<td>20</td>
<td>166</td>
<td>730</td>
</tr>
<tr>
<td>R middle deltoid</td>
<td>15</td>
<td>173</td>
<td>1053</td>
</tr>
<tr>
<td>L biceps</td>
<td>14</td>
<td>248</td>
<td>1671</td>
</tr>
<tr>
<td>R biceps</td>
<td>52</td>
<td>279</td>
<td>436</td>
</tr>
<tr>
<td>L triceps</td>
<td>77</td>
<td>358</td>
<td>365</td>
</tr>
<tr>
<td>R triceps</td>
<td>17</td>
<td>332</td>
<td>1853</td>
</tr>
<tr>
<td>L wrist extensors</td>
<td>85</td>
<td>328</td>
<td>286</td>
</tr>
<tr>
<td>R wrist extensors</td>
<td>55</td>
<td>179</td>
<td>225</td>
</tr>
<tr>
<td>L finger extensors</td>
<td>54</td>
<td>298</td>
<td>452</td>
</tr>
<tr>
<td>R finger extensors</td>
<td>14</td>
<td>100</td>
<td>614</td>
</tr>
<tr>
<td>L thumb extensors</td>
<td>55</td>
<td>191</td>
<td>247</td>
</tr>
<tr>
<td>R thumb extensors</td>
<td>16</td>
<td>108</td>
<td>575</td>
</tr>
</tbody>
</table>

*100 uV typically allows movement against gravity if there are no co-contraction or tone issues.
At St. David’s Rehabilitation Hospital we are committed to serving the needs of patients living with disability by providing a complete continuum of care. Our after care programs include a comprehensive listing of support groups. One of our groups, the Amputee Support Group, has been active for over twenty years. In all the groups, activities include outings, dinners, speakers and conversation. Both patients and caregivers are welcome.

**AMPUTEE SUPPORT GROUP**  
Third Wednesday of the month from 7:00-8:30pm  
Contact: Laura Grulke 512-284-2658

**BRAIN INJURY SUPPORT GROUP**  
Third Wednesday of the month from 6:30-8pm  
Contact: Jackie Theaker 512-341-1000

**BRAIN TUMOR SUPPORT GROUP**  
Third Wednesday of the month from 7:00-8:30pm  
Contact: Dena Ruiz 512-633-7137 and Rafaela Leal 512-771-6563

**SPINAL CORD INJURY SUPPORT GROUP**  
Second Thursday of the month from 4:30-6:30pm  
Contact: Pam Fletcher 512-826-0813

**CENTRAL AUSTIN STROKE SUPPORT GROUP**  
Second Monday of the month from 4:30-6:00pm  
Contact: Liz Joiner 512-544-8677

**PARKINSON’S SOCIETY SUPPORT GROUP**  
Third Saturday of the month from 2:00-4:00pm  
Contact: www.capitalareaparkinsons.org
Aquatic Physical Therapy after a total knee replacement surgery is often used in conjunction with land based Physical Therapy to reduce pain and swelling, increase a joint’s range of motion, improve strength, dynamic balance and restore a normalized walking pattern. The principle of buoyancy allows a clinician to adjust the amount of weight bearing appropriate for each client’s particular needs/restrictions. Deeper water could be used for decreasing pain or adhering to a person’s weight restrictions following surgery. A person can also work on improving their walking pattern without an assistive device early on and decrease compensatory movements that may develop on land due to weakness edema and discomfort.

A recent peer reviewed research study conducted in Germany investigated whether early participation in an aquatic therapy program following a total knee replacement had any effect over later initiation of aquatic therapy. Patients were randomly assigned to start aquatic therapy either 6 days or 14 days after their knee replacement surgery. Validated tests for joint stiffness, pain and physical function were evaluated at 3, 6, 12 and 24 months after the surgery. All measured outcomes in the group that started aquatic therapy early were better than the group that started later. The lead researcher hypothesized that the amount of joint effusion present inside the repaired knee capsule after surgery was less due to the hydrostatic force of the water during pool therapy. Higher levels of joint effusion generally result in more pain and decreased range of motion.