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## Improvement in Arm Function after Spinal Cord Injury

Individuals with cervical spinal cord injuries at or above C5-C7 usually experience a disruption in arm and hand function. The extent of the disruption depends on the level and the completeness of the injury. Dr. Vivian Mushawhar's Human Rehabilitation Engineering Laboratory at the University of Alberta is investigating the effectiveness of two interventions for improving arm function after incomplete cervical spinal cord injury. The first intervention focuses on inducing "targeted plasticity," or guided modifications, in the neuronal networks of the spinal cord. This involves the use of biofeedback-based strategies to retrain the arm control networks within the cord and to strengthen the connectivity from the brain to the spinal cord, the result of which is expected to provide a general improvement in arm function. The second intervention focuses on the use of arm ergometer training in conjunction with functional electrical stimulation (FES). Cyclic arm movements are induced through FES against various levels of resistive loads. The use of this intervention is expected to improve muscle strength and to regulate the sensory input to the arm control networks in the spinal cord. Regulation of sensory input could reinforce the original neural circuits involved in the control of arm movements and enhance the connectivity between the brain and the spinal cord. The effectiveness of each intervention in improving arm function is evaluated separately. Methods for combining both interventions to further enhance the recovery of arm function after spinal cord injury will be investigated in future extensions of the work.

## Prevention of Deep Pressure Sore Formation after Spinal Cord Injury

Pressure sores frequently develop after spinal cord injury, especially in individuals with extensive loss of motor or sensory function. Sores can develop at the surface of the skin and extend to deep tissue if unattended. They can also develop deep within the body, at bone-muscle interfaces, and extend to the surface. Sores originating deep within the body are more perilous than surface sores because they are very difficult to detect early in their process of development. Once they exhibit themselves at the surface of the skin, significant tissue damage involving bone, muscle, fascia and fat would have occurred. Deep sores primarily develop due to the occlusion of blood flow through capillaries to muscles surrounding bony prominences such as the ischial tuberosities. Occlusion of blood flow deprives the muscle of its oxygen and nutrient supply and results in its death and decay. To avert the formation of deep sores, frequent relief of pressure is necessary to allow the restoration of blood supply to muscles around bony prominences. Dr. Vivian Mushawhar's team at the University of Alberta is developing a technique for inducing frequent pressure relief to prevent the formation of deep pressure sores in wheelchair-dependent individuals with spinal cord injury. This technique involves the use of intermittent electrical stimulation (IES) to induce contractions in the gluteus maximus muscles of the buttocks. Intermittent, or periodic, contractions of the muscles provide periodic reconfiguration of internal pressure and, in turn, pump blood into occluded capillaries. Experiments are currently underway to assess the effectiveness of this intervention in preventing the formation of deep tissue sores.

### FACULTY OF MEDICINE AND DENTISTRY:

Spinal Cord Injury research laboratory tours will be held the week of **January 22nd, 2006**.

Dr. Vivian Mushawhar's labs will be a part of the tour. See [www.scitcs.org](http://www.scitcs.org) for an overview of the applied research.



*You may be on  
the right track,  
but if you just sit  
there you'll get  
run over.*

*- Paul H. Dunn*

Since 1987 we have been very fortunate to be associated with researchers at the University of Alberta. Much of this is due to the Alberta Heritage Foundation for Medical Research (AHFMR). Over the past 25 years \$800 million has been awarded to researchers at the various Universities throughout the Province and their affiliated institutions.

In 2004 AHFMR was commended for “the excellence of its achievements and activities.” In acknowledgment of this success the Alberta government has pledged an additional \$500 million to the Foundation endowment, which now stands at \$1 billion. The endowment supports an annual investment of approximately \$45 million in health research in Alberta.

Dr. Richard Stein was featured in a supplement to advertise AHFMR 25 years of excellence that was included in the local newspaper dated November 20, 2005. We congratulate Dr. Stein on his many accomplishments. We are proud of our 18-year association with Dr Stein. The initial contact, between SCITCS, Dr Stein and his associates, focused SCITCS to support and promote Functional Electrical Stimulation (FES). See SCITCS web site [www.scitcs.org](http://www.scitcs.org) to view FES in action, including videos of people with a spinal cord injury exercising and walking.

SCITCS Board of Directors has always maintained that if FES equipment is available elsewhere then there is no reason why it should not also be available in Edmonton, with this philosophy in mind, we are presently in contact with the suppliers of the BerkelBike in the

Netherlands and the suppliers of the Arm Crank in Germany. To view the Arm Crank that allows people with quadriplegia to exercise their arms go to web site <http://fesnet.eng.gla.ac.uk/CRE>

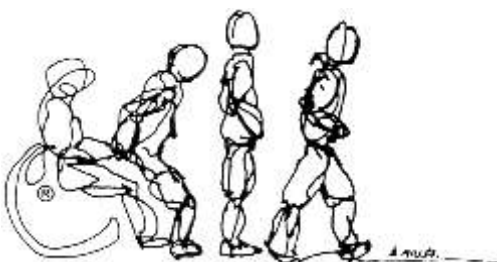
Dr. Vivian Mushahwar, whose labs and personnel can be seen at [www.scitcs.org](http://www.scitcs.org), is very interested in the acquisition of the Arm Crank; as is one of her researchers, Andrew Ganton, a recent member of the research team whose research is directed at arms and their function.

## Shoulder Pain Research

The AHFMR Research News, Summer 2005 issue, describes Dr. Ian Lo, a Calgary orthopedic surgeon, physician and researcher as “a man on a mission” who treats adults with shoulder problems; and as a scientist, he researches ways of preventing shoulder pain. Dr. Lo sees many patients with rotator cuff problems, including tears and tendinitis in the shoulder, problems that many people with spinal cord injury (SCI) experience. A rotator cuff tear may develop in the course of long-term overuse or simply as a result of aging. The article goes on to say that “no one knows exactly what causes rotator cuff tears, but the consensus is that such factors as genetic predisposition, tissue degeneration, and external stresses on the shoulder all contribute.”

Dr. Lo is a member of a multi-disciplinary research team trying to identify the specific factors that cause rotator cuff tears. “Preventing rotator cuff tears or at least preventing the progression of degeneration would help many people” with SCI.

What research is being conducted on the complications of spinal cord injury?



While loss of movement is one of the most obvious consequences of spinal cord injury, many other serious complications are major health issues for people with spinal cord injury. Such secondary conditions as loss of bladder and bowel control, pressure sores, and spasticity dramatically affect quality of life.

Researchers at the University of Alberta are responding to the need for better treatment of these conditions. Heritage Scientist Dr. Arthur Prochazka and Heritage Scholar Dr. Vivian

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Mushahwar are known for their expertise in functional electrical currents to generate activity in the nervous system. In particular, they are using a new procedure called intraspinal microstimulation (ISMS), which involves implanting hair-like microelectrodes into a very specific region of the spinal cord to stimulate muscle contractions. Much of their work aims to induce controlled limb movements similar to normal walking, but they are also applying the technique to other complications. For example, Dr. Prochazka leads a team that is investigating the potential application of ISMS to improve bladder control, and Dr. Mushahwar has recently turned her attention to pressure sores.

Pressure sores develop in wheelchair-bound and bed-ridden individuals. Most of these ulcers are caused by skin breakdown due to continuous surface abrasion, moisture, and low hygiene, but some occur because of localized and sustained external pressure when deep muscle tissue dies. This latter type of pressure sore is the most dangerous; difficult to detect, it causes severe damage and there is currently no effective strategy to prevent it. Dr. Mushahwar has submitted a grant proposal to develop an electrical stimulation method that would prevent the formation of

pressure sores in individuals with spinal cord injury.

Both Dr. Mushahwar and Dr. Prochazka emphasize that their work focuses on exploring the potential of ISMS. Developing this knowledge into effective treatments for spinal cord injury is a long-term undertaking.

In related research, Heritage Senior Scholar Dr. David Bennett studies the extreme muscle spasms that plague many people with spinal cord injury. These exaggerated reflexes occur because some of the neurons (individual nerve cells) in the lower spinal cord become more sensitive after injury. However, because of the injury, the brain can no longer send signals to regulate the contractions. Medication can control spasticity, but the drugs work systemically and dampen all nerve impulses - not a desired outcome for a person with a spinal cord injury. Dr. Bennett's research is aimed at understanding how neurons become hyper-excitable. This is fundamental work that is years away from application in humans.

Reprinted from Alberta Heritage Foundation for Medical Research's newsletter: *ahfmr research news*, Spring 2005.

## Your Health

***Did you know that your diet might make you tired?*** Some foods may boost your energy while others can bring your energy levels down. Fatigue can be caused by numerous conditions, medications, treatments, sleep problems, stress, depression and anxiety, malnutrition, and even the weather.

Start with eating breakfast every morning. Eating 4 - 5 smaller meals during the day can also help keep your blood sugar levels steady.

Eat plenty of fruits and vegetables - raw, lightly cooked, or dried. Bananas, watermelons, dates, mangoes, papaya, and pineapple can increase your energy levels as fast as any candy bar. Carrots and potatoes are also quickly digested and absorbed into the bloodstream.

Dietary fibre intake is absolutely essential to keep things 'moving'. Whole-grains are a good choice. Adequate protein can be gained from lean meats such as chicken and fish, and low-fat dairy products. Drink 6 - 8 eight glasses of water daily! Limit fried and high-fat foods and highly processed foods such as candy bars, chips, and other sweets.

Regular exercise can decrease fatigue and improve your sleeping pattern. Even light exercise can increase your energy levels. Don't know where to get started? Check out The Steadward Centre:



To learn more about the Centre, visit their website [www.steadwardcentre.org](http://www.steadwardcentre.org) or phone: (780) 492-3182