

# XI. Low Back Pain

[See also pgs. 204, 207, 241]

## Low Back Pain Prevention, Rehabilitation, and High Risk Inventory Development

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**Sponsor:** National Institute of  
Handicapped Research

**Purpose**—The Employee Back Program has established a curriculum that was used with approximately 240 hospital employees. Definitive changes in the employee's education about back care, exercising to promote fitness, and use of these management techniques were documented. The problem with the low-base rate of back injury in the current hospital setting prompted the distribution of our program for wider study to a national hotel chain and perhaps to a national health maintenance organization. The residual program will be continued under the hospital Employee Health Division. There are three formats of the program that differ in their total length (4, 8, and 12 hours).

**Progress**—Current plans call for the establishment of a computer-based low back pain registry. Intake information and follow-up data will be collected on 1,000 patients with low back pain; their physical, psychological, and socioeconomic characteristics studied; and their response to treatment analyzed in a consistent fashion at 3-, 6-, and 12-month intervals.

The training function of the RRTC continues. Educational programs about low back pain for the benefit of health care professionals are being developed. These will include CME-type multispecialty programs of 1 and one-half to 2 days duration of presentation to large audiences and similar programs for use with small groups.

## Inversion Therapy for Low Back Pain in Elderly Patients

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**Sponsor:** Department of Veterans'  
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**Progress**—A device was constructed to allow for variable angles of head down tilt. On this device, the patient is fixed by the pelvis instead of the ankles. The head down tilt is produced by flexing the knees. The advantages of pelvic versus ankle fixation are:

- 1) The possibility of doing abdominal exercises with the lower limbs free;
- 2) Straightening of the lumbar vertebral column, which increases the direct traction force for any given inclination-inversion; and
- 3) Increased safety of handling. The device tilts back to the "head up" position by stretching the knees. No undue physical effort or complicated maneuver is needed to reverse the inversion.

Hydraulic knee joints evaluation is conducted in order to establish firm prescription criteria for the various models of this device that are commercially available.

## Biobehavioral Studies of Chronic Low Back Pain

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**Purpose**—The project objectives are to develop and test new behavioral and physical therapy treatments for chronic low back pain (CLBP), develop a comprehensive assessment methodology, and test theories regarding the psychophysiological nature of the pain experience.

**Progress**—A treatment outcome study was completed testing behavioral and physical components of CLBP treatments. Groups received either standard physical therapy, a behaviorally enhanced physical therapy, or a control procedure. Currently being completed is an evaluation of traditional physical therapy methods versus learning theory methods for teaching back protection behaviors. Studies have been completed that evaluated patients' responses to mildly painful heat stimuli using a signal detection model. Other studies have examined the patterning of muscle detection model. Other studies have examined the patterning of muscle activity during various static postures and movement. Similar studies are in progress in a continuing pursuit of understanding the variables that maintain and exacerbate CLBP.

Outcome research uses behavioral and physical therapy treatments based upon the latest developments and theories in the field. The psychophysiological studies record bilateral electromyograms from major muscle groups controlling the trunk, galvanic skin response, electrocardiograms, and digital plethysmograms with a Grass polygraph, while scoring of data and laboratory control is accomplished with a PDP 11 computer system.

**Preliminary Results**—Both behavioral and physical therapies are uniquely effective for controlling low back pain, but neither is a sufficient treatment. Preliminary analyses indicate that an enhanced learning theory approach is superior to traditional methods for teaching back protection behaviors. Psychophysiological studies reveal that patients are more stressed than controls when making movements but that back muscle functioning is similar.

## Myoelectric Analysis of Human Spine Function

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**Purpose**—The goal of this project is to develop objective quantitative measures of lumbar muscle (erector spinae) function for patients with low back pain and measurement techniques that can be easily used in the clinic. Techniques have been developed for analysis of the frequency power spectra of myoelectric signals obtained during exercise.

**Progress**—Myoelectric data from 40 normal, healthy young adults performing isometric extension exercises on a back testing device at load levels of 20 percent, 50 percent, and 100 percent of their maximum voluntary contraction (MVC) force has been collected to form a normal database. A group of 36 patients with low

back injuries have been tested repeatedly during rehabilitation therapy. A linear decay frequency slope measure (mean power frequency over time, with linear slope estimate expressed as percent decrease per minute and normalized for initial frequency) was shown to correlate with load level. Significant improvement of the correlation between the linear decay fatigue measure and the load level has been obtained by expressing the load as a percent of body weight, as opposed to the traditionally used expression of load in terms of percent MVC. Additional improvement was obtained by using the mean force output over the trial to compute the percent body weight measure.

Using the normal database, a strong correlation ( $r=0.87$ ) was observed between the linear decay measure and load levels ranging from 20 to 120 percent of body weight, where increased load corresponded to an increased muscle fatigue rate. This curve defining normal erector spinae fatigue rates in isometric extension exercise was used to compare the measured fatigue rates of low back pain patients with expected normal values for the measured load level during exercise. Results suggest an increased fatigue rate associated with low back pain.

## The Vermont Rehabilitation Engineering Center for the Study of Low Back Pain \_\_\_\_\_

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**Sponsor:** National Institute for Handicapped Research

**Purpose**—The Vermont Rehabilitation Engineering Center for the study of Low Back Pain was established in 1983 by a grant from the National Institute for Handicapped Research to the Department of Orthopaedics and Rehabilitation at the University of Vermont, Burlington, Vermont. The mission of the Rehabilitation Engineering Center (REC) is improvement of the diagnosis and successful rehabilitation of low back pain (LBP) sufferers.

**Progress**—Five long-term projects as well as a group of pilot studies are currently underway at the REC. Brief descriptions follow.

*Project One: Prediction of Disability and Assessment of Rehabilitation in Low Back Pain.* Project One aims to develop a reliable information-gathering system, which will broaden our understanding of both organic and functional correlates of LBP. This information will be used to develop a multi-attribute, utility model for predicting LBP impairment and LBP-related disability. The group also is involved in measuring costs associated with LBP and seeks to determine the cost-benefit ratio for various rehabilitation techniques.

*Project Two: Mechanical Rehabilitation of Back Pain: Optimization of Spinal Orthoses through Biomechanical Analysis.* Research is designed to develop and refine measuring techniques in order to describe the functioning of spinal orthoses in biomechanical terms. These techniques can then be used to characterize currently-available types of spinal orthoses, allowing correlation between biomechanical characteristics and effectiveness in pain reduction. Such analyses should also lead to the design and fabrication of new spinal orthoses which combine

mechanical support and electrical stimulation. Recently, this group has explored the use of ultrasound scans, valuable because they are both noninvasive and nondeleterious, to measure muscle dimensions with good results.

*Project Three: Electrical Rehabilitation of Back Pain: Evaluation and Design of TEMS, TENS, and Biofeedback.* If electrical stimulation is to be used as a treatment, it should be designed with the aim of modifying physical characteristics, rather than merely to reduce pain. Research is currently underway to address three questions related to this issue:

- 1) Can electromyography be used during a strength test to quantify the efficiency or other aspects of healthy trunk muscles?
- 2) Can muscular changes be demonstrated in patients with low back pain?
- 3) Can muscular changes be demonstrated during treatment designed to improve trunk muscle strength?

The group has carried out extensive research to determine the usefulness of electromyography as an index of muscle efficiency and to identify sources of variability in the relationship between force and EMG. Also underway is a training study designed to determine whether abdominal muscle strengthening (through exercise) produces change in EMG.

*Project Four: Optimum Seating in Static and Vibration Environments.* The objective of this research is to improve the seats and other spinal supports in both static and vibration environments. One of the principal means of attaining this objective lies in determining the relative contribution of each of the spinal support structures and how the overall response varies as a function of seating components and posture under static or vibration exposure. Currently, the group is investigating the effects of three sets of variables in static and vibration seating environments: 1) subjective assessments of discomfort; 2) objective changes in EMG center frequency characteristics; and 3) mechanical transmissibility factors.

*Project Five: Five Pilot Studies:*

- A. *Digital Image Processing Techniques of Flexion-Extension Radiographs.* The purpose of the project is to produce a device which will assist clinicians in "extracting" information from flexion and extension X-rays of the lumbar spine. The use of video technology and computers promises a substantial improvement over current techniques for analyzing radiographs.
- B. *Thermography: A Blinded Study of Its Efficacy in the Diagnosis of Low Back Dysfunction.* This study represents the first scientifically controlled evaluation in a clinically established and radiographically verified population of low back sufferers with herniated nucleus pulposus compared to a control group of non-affected subjects.
- C. *Lateral Bending of the Lumbar Spine with Disc Herniation.* It is hypothesized that herniated nucleus pulposus at a given level of the lumbar spine is associated with asymmetry of lateral bending at that level, since patients tend to avoid a painful range of motion. Biplanar radiography is being used to document and measure the motion.

- D. *Isthmic Spondylolisthesis: Instability at the L4-5 Level.* The study aims to define the clinical presentation and radiographic manifestations of this condition through an international collaborative effort.
- E. *An Internal Fixator for Improved Surgical Management of LBP-Producing Spinal Instability.* The study includes the design, development, and testing of a fundamentally new spinal implant, the Vermont Spinal Fixator, which will correct the shortcomings of currently available stabilization devices and improve care of surgically treatable low back pain patients, particularly those whose spines are unstable.

*Project Six: Rehabilitation Engineering for Vocational Rehabilitation of Low Back Pain.* Project Six seeks to increase the rate of successful return to work for low back pain sufferers through the application of modern techniques of functional assessment and rehabilitation engineering.

## Objective Evaluation of Muscle Fatigue in the Trunk

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**Sponsor:** Liberty Mutual Insurance  
Company

**Purpose** — As many as 75 million Americans now suffer from severe lower back pain, and each year 7 million more people develop this problem. Despite the many millions of dollars spent on innumerable treatments for the back, the majority of patients have chronic remitting symptoms. Improved methods for assessing back disorders could help to diminish the problem and the financial burden of this disabling condition.

**Progress** — We have begun to develop and implement a technique to provide the clinician with an objective index to measure treatment outcome for lower back musculature. This technique estimates the fatigue rate of contracting muscles by measuring the shift occurring in the frequency spectrum of the surface detected electromyogram (EMG). The dynamic interaction of synergistic back muscles during fatiguing contractions can be represented by fatigue patterns created by the different frequency shifts occurring for different muscles. Differences in these patterns associated with lower back disorders may represent functional disturbances in back muscles.

In preparation for implementing this technique, we have designed and constructed a restraining device to reliably stabilize the trunk in selective positions from sitting to standing. The device is equipped with strain-gauge load cells to monitor flexion, extension, or rotation torques of the trunk. A force meter is placed in front of the subject to provide visual feedback. In addition, preliminary modifications have been made to another device that will analyze multiple channels of EMG to track the median frequency of the signal. Plans are underway to test subjects with recurrent low back pain and normal controls.