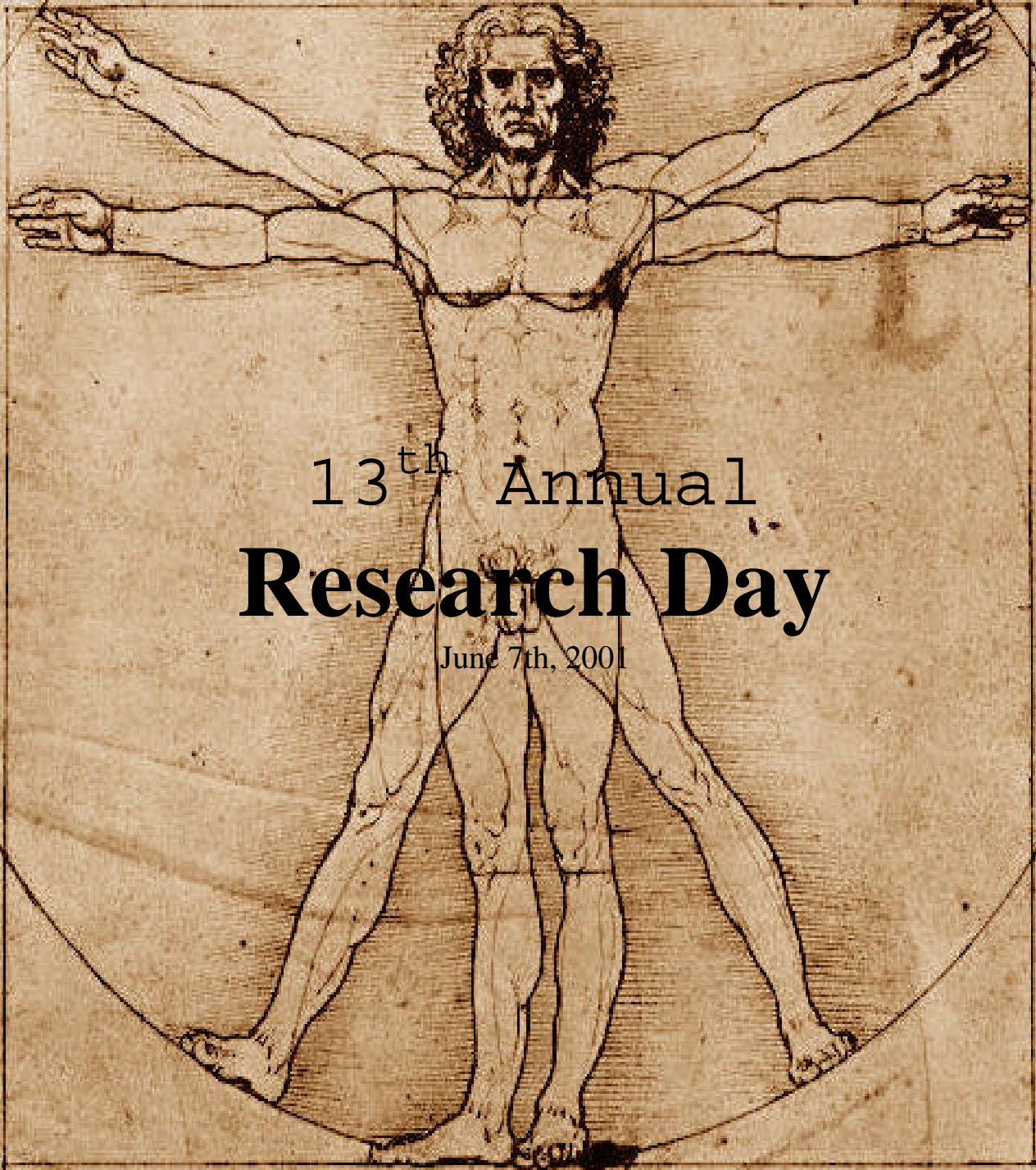


University of Kentucky  
Department of  
Physical Medicine & Rehabilitation

13<sup>th</sup> Annual  
**Research Day**

June 7th, 2001



**University of Kentucky**  
**Department of Physical Medicine & Rehabilitation**  
**Research Day Agenda**

Lexington VAMC Auditorium

08:30 – 0900 am                      Continental Breakfast

09:00 – 09:10 am                      Opening Remarks: David R. Gater, MD, Ph.D.

Resident Research Presentations

09:10 – 09:20                      Fernando S. Branco, MD  
09:25 – 09:35                      Scott R. Akers, MD  
09:40 – 09:50                      Melanie H. Ledford, MD  
09:55 – 10:05                      George A. Bitting, MD  
10:10 – 10:20                      D. Paul Harries, MD  
10:25 – 10:35                      Fernando S. Branco, MD  
10:40 – 10:55                      Danzhu Guo, MD  
11:00 – 11:15                      Lauren Larson, MD

Graduate Student Research Presentations

11:20 -- 11:30                      Ranjaraj K. Goplaraj, MBBS  
11:35 -- 11:45                      Anil Thota, BS  
11:50 -- 12:00                      Joseph Finley, BS

12:05 -- 12:35                      Lunch Buffet

*Featured Speaker*

12:35 -- 1:30                      *The Abc's of Rehabilitation Research Funding: Acquiring a Taste for Alphabet Soup*

David R. Gater, MD, Ph.D.  
Director, U Kentucky SCI Exercise Laboratory  
PM&R Research Director, U Kentucky College of Medicine  
Research Associate, Lexington VAMC

*Graduate Student Research Presentations (Continued)*

1:35 -- 1:50                      Adrienne L. Janowiak , BS  
1:55 -- 2:10                      Eric C. Hartman, MS  
2:15 -- 2:30                      Junli Ou, BS

2:30 – 3:15 pm                      Faculty Poster Presentations: Discussion

3:15 – 3:30 pm                      Awards and Closing Remarks

## PM & R Resident Abstracts 2001 (plans)

### Lower Body Positive Pressure on the Exercise Response in Individuals with Spinal Cord Injury

**Presenter:** Fernando S. Branco, MD

**Collaborators:** David Gater, MD, Ph.D., Craig Winsor, M.S.

**Problem:** Circulatory hypokinesia is a significant factor limiting work capacity for individuals with spinal cord injury (SCI) due to insufficient vascular tone despite increasing work requirements associated with graded exercise. Abdominal binders and standard leg wrappings are commonly used to provide improved venous return, and subsequently cardiac output associated with greater work capacity. In assessing work capacity, it is unclear whether graded exercise testing should be performed with or without these assistive devices, and to what extent they may alter peak oxygen consumption ( $VO_{2Peak}$ ). **Hypothesis:** The use of abdominal binders and leg wraps (ABW) in graded exercise testing (GXT) will significantly improve  $VO_{2Peak}$  in persons with complete paraplegia. **Aim:** The objective of this study is to compare  $VO_{2Peak}$  in persons with paraplegia under conditions of ABW versus no assisted venous return (NABW). **Methods:** Twenty individuals with motor complete T6-L2 SCI will be recruited over twelve months and screened for CAD, COPD or diabetes.  $VO_{2Peak}$  with standard Arm Crank Ergometry (ACE) will be determined on separate occasions (at least 48 hours apart) under conditions of ABW and NABW in random order of assignment. **Relevance:** GXT for persons with SCI should optimize  $VO_{2Peak}$  and minimize circulatory hypokinesia to maximize patient safety under standardized testing conditions. *Key Words: Spinal Cord Injury, Exercise Response, Lower Body Pressure.*

### Comparison of Functional Outcome of Synvisc® Versus Celestone® Injections in the Treatment of Patients With Osteoarthritis of the Knee: A Randomized Double Blinded Prospective Study.

**Presenter:** Scott R. Akers, M.D.

**Collaborators:** Gerald V. Klim, D.O., Paul V. Brooks, M.D.

**Aim:** To compare functional outcomes in patients with severe osteoarthritis of the knee after treatment with intra-articular Celestone® versus intra-articular injection of Synvisc®. **Methods:** Randomized, double blinded, prospective study. Clinical observer and patient will be blinded to the treatment received. A course of treatment will consist of three intra-articular injections of Synvisc® or one injection of Celestone® followed by arthrocenteses at one week intervals in the target knee. Outpatient university musculoskeletal physiatry practice. As yet undetermined number of adult patients referred to an outpatient university based musculoskeletal physiatric practice. Patients must be ambulatory (assistive devices allowed), diagnosed with OA of the target knee of at least three months duration according to the American college of Rheumatology (ACR) criteria, pain from OA requiring frequent use of analgesics or NSAIDs for at least 3 months before enrollment, and any acute disease or trauma leading to secondary OA of the target knee must have occurred at least five years before study entry. All patients must be capable of understanding, signing and dating an informed consent form. **Outcome measures:** Primary measurement instrument will be the patients Functional Independence Measure score as outlined by the Uniform Data System for Medical Rehabilitation, which will be assessed by a licensed physical therapist before entering the study and then again at twelve weeks. Patients will also be required to complete the SF-36 Health Survey prior to the first injection and again at their twelve week follow up.

## PM & R Resident Abstracts 2001 (plans)

### Assessment of Caloric Needs in Amyotrophic Lateral Sclerosis (ALS)

**Presenter:** Melanie H. Ledford, MD

**Collaborator:** Edward J. Kasarskis, MD, PhD

**Problem:** Malnutrition due to caloric deficiency is very prevalent in ALS during the course of the disease. Profound weight loss, muscle weakness and muscle atrophy are prominent features which produce progressive disability and early death. Since the precise cause(s) of malnutrition in ALS has not been adequately studied using modern technology, it is unknown whether caloric deficiency is due solely to inadequate intake, or could be due to increased expenditure of calories, or both of these mechanisms. Gastrostomy is frequently recommended but guidelines on the degree of caloric deficiency requiring it nor the amount of caloric replacement needed to correct the malnutrition are forthcoming. **Aim:** Our goal along with three other centers is to examine caloric requirements to identify caloric deficiency early in the course of the disease, plan for timely nutritional intervention, and predict the need for gastrostomy by objective nutritional criteria rather than simply by the presence of dysphagia. **Methods:** We will estimate daily caloric intake and expenditure in ALS patients and compare with those in age- and gender-matched healthy controls from our database (cross-sectional analysis), and measure daily caloric intake and expenditure in ALS patients periodically over 12 months to examine the effects of progressively increasing disease severity and changes in body composition and physical activity level on caloric requirements (longitudinal analysis). 56 patients (28 males and 28 females), 14 at each site age range 40 - 75 with ALS will be recruited. Techniques used will be resting metabolic rate (RMR), measurement of body composition with DEXA, forced vital capacity, ALS functional rating scale (ALSFRS), leisure time physical activity questionnaire, short-form-36 (SF-36) questionnaire, and caloric intake.

### Legislative Changes on Vocational Outcomes in Persons with Spinal Cord Injury

**Presenter:** George A. Bitting, M.D.

**Collaborators:** David Gater, MD, PhD; David Musick, Ph.D.

**Problem:** Following Spinal Cord Injury (SCI), results of studies evaluating return to work have been varied. Estimates of employment range from 16-59%, but are generally accepted to be less than 50%. Vocational outcomes for persons with SCI in rural regions of the country have not been well described. A previous study by our group suggested that environmental, educational and economic barriers to vocational rehabilitation (VR) in rural settings may negatively impact vocational outcomes for persons with SCI. **Aim:** The objectives of the current investigation will be to 1) evaluate the role of benefits/incentives in determining whether the individuals return to work following injury, and 2) determine the impact of recent changes in social security/disability laws on vocational outcomes. **Methods:** A questionnaire will be developed and mailed to all individuals newly entered in the regional SCI database over the past 5 years (n=150). Questionnaire items will include patient demographics, pre- and post-injury employment rates, financial disincentives and patient involvement with Vocational Rehabilitation. Non-responders and those who incompletely return the questionnaire will be contacted by telephone for survey completion. **Relevance:** Determination of the factors involved in poor return to work rates following SCI in this region will assist health care and VR providers modify programs to more fully address and meet the needs of these individuals. *Key Words: Vocational-Rehab; SCI (Spinal cord injury); SSI-Disability*

## PM & R Resident Abstracts 2001 (plans)

### **Nerve Conduction Changes Following Carpal Tunnel Decompression in Diabetic and Non Diabetic Patients - A Pilot Study**

**Presenter:** Paul Harries, MD

**Collaborators:** R. Nickerson, MD; P. Blazer, MD; J. Lawton, MD

**Problem:** Carpal tunnel syndrome is the most common form of peripheral nerve compression. Diabetic patients develop carpal tunnel syndrome more frequently than non-diabetic patients. This is often described as the "double crush phenomenon". Several studies have reported good clinical results following carpal tunnel decompression in diabetics. **Aim:** We plan to compare the Nerve Conduction changes seen pre and post operatively in diabetic and non-diabetic patients. **Method:** Ten diabetic and ten non-diabetic patients will be recruited for this pilot study following their carpal tunnel syndrome surgery having had their initial NCS performed in our department. Patients will have NCS performed at 2 weeks and 3 months following surgery. **Relevance:** We hope by this study to obtain a better understanding of the physiological changes responsible for carpal tunnel syndrome in those patients with Diabetes. *Key Words: Diabetes, diabetic, median neuropathy, carpal tunnel syndrome, nerve conduction.*

### **Epidemiology Of Current Treatment for Sexual Dysfunction in Spinal Cord Injured Patients**

**Presenter:** Fernando S. Branco, M.D.

**Collaborators:** Susan McDowell, MD; Michael S. Lynch, PhD; David Gater, MD, PhD

**Problem:** Sexual dysfunction is common among people with chronic illness and disability. Unfortunately most patients receive, at best, psychological treatment if they can verbalize their needs. Most health care professionals are undertrained and underequipped to address sexual concerns. Spinal Cord Injured (SCI) patients have been the focus of several studies due to mostly intact cognition and young age of injury. Most studies emphasize the treatment of penile erectile dysfunction, with minimal emphasis on satisfaction or female needs. **Purpose:** This study will be a prospective survey of the efficacy of different treatments for sexual dysfunction in patients with spinal cord injury. **Methods:** Patients will have an initial interview to evaluate their sexual needs and goals. The OPEN SLOW (Open Ended Sexuality Limited Organizing Worksheet) will be used. An objective scale of sexual satisfaction will also be given to participants. After a full evaluation that will include a physical examination, patients will be counseled as to their therapeutic options. They will include marriage and sexual counseling, topical and oral pharmacotherapy, Vacuum Erection Device (VED), penile injection, surgery options. **Relevance:** Some authors have suggested that virtually all patients with SCI are affected in the sexual realm. The shame and embarrassment regarding disorders of sexual nature prevent most patients and health care workers from addressing a comprehensive assessment or treatment. *Key Words: Spinal Cord Injury, Sexual Dysfunction, Treatment*

## PM & R Resident Abstracts 2001 (reports)

### Preliminary Report of Pulsed Radiofrequency (PRF) Therapy for Carpal Tunnel Syndrome (CTS)

**Presenter:** Danzhu Guo, MD

**Collaborators:** Robert Nickerson, MD, Janet Walker, MD, Betty Siskin, PhD

**Objective:** To determine the efficacy of PRF treatment in recovery of function and reduction of pain associated with CTS. **Hypothesis:** Reduction in edema of flexor tenosynovitis could be used to reduce the severity of CTS symptoms. **Design:** Prospective, double blind pilot study, which was part of multicenter study. **Methods:** Six patients with diagnosed CTS who met the inclusion criteria were randomly assigned to the placebo and the active groups with active and inactive PRF applied externally to the affected wrists respectively. Subjects were treated three times per week for two weeks with each session of ½ hour. **Outcome Measures:** Pretreatment and posttreatment Levine questionnaire, grip strength, pincer/key pinch strength, and digital sensibility by Semmes-Weinstein monofilament test. **Results:** The average score of pretreatment Levine questionnaire was higher ( $3.3\pm 0.5$ ) in the active group than in the placebo group ( $2.9\pm 0.9$ ), which was consistent with the electrodiagnostic results. There was 24% improvement with Levine score in the active and 35% in the placebo. In the active group there was an 18% decrease in grip strength and 23% decrease in pincer strength, whereas the placebo group had an 18% improvement in grip strength and 13% decrease in pincer strength in comparing pretreatment with posttreatment results. An average improvement of 6% with key pinch strength occurred in the active treatment group, whereas 3% improvement was observed in the same variable in placebo group. Digital sensibility with Semmes-Weinstein monofilament test revealed two subjects from placebo group and one from active group initially had diminished light touch, which improved to normal sensibility after treatment. Other three subjects had no improvement with digital sensibility. **Conclusion:** These findings did not show any improvement in the signs and symptoms in active group. Explanations include PRF is not at sufficient level, inadequate duration and frequency, or more severe cases assigned to the active group. Small patient population in this study may be insufficient to detect the real effect of PRF to CTS. *Key Words: Carpal Tunnel Syndrome; Pulsed Radiofrequency Field; Rehabilitation.*

### Reliability of Clinical Measurements Compared to Measurements on Radiographs in Patients With Legg-Calve-Perthes Disease

**Presenter:** Lauren Larson, MD

**Collaborators:**

**Aim:** The purpose of this study was to determine if a correlation exists between measurements of maximum hip abduction recorded by a physical therapist and those measurements obtained from radiographs in children diagnosed with Perthes disease. **Methods:** Patients with Perthes disease often receive numerous xrays, not only to monitor the stages of the disease, but also to follow their range of motion (ROM) progress. The goal was to decrease the quantity of radiographs taken. This was a retrospective review of patients diagnosed with unilateral Perthes disease who were admitted to Shriner's Hospital for rehabilitation from 1990 to 2001. Maximal hip abduction and/or von rosen views were measured on xrays using a protractor. These values were compared with maximal hip abduction measurements recorded by a physical therapist.

## Student Abstracts, PM & R Research Day 2001 (plans)

### Reliability of the COSMED K4b<sup>2</sup> in Exercise Testing

**Presenter:** Rangaraj K. Gopalraj, MBBS

**Collaborators:** Michelle Erway, Tiffani M. White, Adrienne Janowiak, Craig Winsor, MS, Jody L. Clasey, Ph.D & David R. Gater, M.D., Ph.D

**Introduction:** Respiratory parameters obtained during submaximal and maximal exercise testing provide insight into human physiology with applications in sports medicine, rehabilitation, clinical exercise testing, cardiology, research and nutrition. In order to be useful for laboratory purposes, the ideal unit should be noninvasive, portable, and reliable. The COSMED K4b<sup>2</sup> is a portable unit used to analyze respiratory gases in efforts to determine the efficiency of the cardiorespiratory system and metabolic requirements. **Hypothesis** The COSMED K4b<sup>2</sup> will show repeatable values when used to analyze respiratory gases of subjects performing standard exercise tasks. Energy costs will not vary between individual testing sessions, however variability will be evident between subjects. **Aim:** The primary aim of this study is to test the reliability of the COSMED K4b<sup>2</sup> to analyze respiratory gases. Mechanical compatibility of the COSMED K4b<sup>2</sup> and computer systems will also be evaluated. **Methods:** Submaximal and maximal testing on the arm crank ergometer (ACE) and the treadmill using standard graded exercise testing (GXT) protocols will be performed on five subjects. Two identical tests will be performed with each subject under standardized test conditions within 48 hours. **Relevance:** The COSMED K4b<sup>2</sup> has undergone few reliability tests. If proven to be reliable, it will be used in future research projects in which cardiac, respiratory, and metabolic parameters are assessed. *Key Words: Oxygen consumption, graded exercise test, reliability*

### Kinematic and Electromyographic analysis of treadmill walking after locomotor training in a rodent model of incomplete spinal cord injury.

**Presenter:** Anil Thota, BS

**Collaborators:** Elizabeth Knapp, MS; Brian Thompson, Annika Quick, MS; and Ranu Jung, PhD

**Aim:** Our long-term goal is to assess the role of locomotor training on motor function recovery after incomplete spinal cord injury. **Methods:** In the proposed project, treadmill-walking training will be provided to rats with contusion or sham injury. At different times post injury, quantitative measures of locomotor function will be obtained from hindlimb kinematics and electromyography (EMG) of selected muscles during treadmill walking. Kinematic analysis allows the quantitative evaluation of joint and limb movements. A reflective marker, video motion capture system will be used to track joint angle trajectories and limb positions. EMG recordings indicate presence of active muscle control by the nervous system. They will provide information on duration and intensity of muscle activity. Pairs of Teflon-insulated multi-stranded fine wires will serve as a bipolar electrode and will be inserted in the selected muscle with a curved hypodermic needle to entrap the muscle belly between a tiny restraining disk attached at the distal end of the electrode wires and a knot at the proximal end. The inter-electrode distance will be approximately 5 mm and the active surface electrode will be approximately 3mm. The wires will be routed subcutaneously to a head mounted multipin connector connected via a cabling system to an EMG amplifier. The EMG data will be correlated to the kinematic data. Both sets of data will be analyzed using signal processing and non-linear dynamics techniques, such as auto/cross correlation, spectral analysis and limit cycles, to determine rhythmicity of movement, coordination of joints and energy components of muscle activity.

## Student Abstracts, PM & R Research Day 2001 (plans)

### Regulating the Center of Pressure while Standing

**Presenter:** Joseph Finley, M.S. Candidate

**Collaborators:** Jason Gillette, PhD., JoAnne Riess, M.S., James J. Abbas, PhD.

**Aim:** The long-term goal of this work is to develop techniques to provide individuals with spinal cord injury with the ability to control posture while standing with electrical stimulation. The ability to regulate center of pressure (COP) can be used as a measure of stability in postural control. The proposed studies will investigate the use of COP as a controlled variable during stance. **Methods:** A set of experiments using able-bodied subjects will be conducted in order to better understand how COP is controlled. This understanding will then be applied to developing a system to control posture in persons with spinal cord injury. In the experiment, the subject will stand on two force plates and view their COP on a display. The subjects will be asked to move their COP to a specified target on the screen. After evaluating COP control in able-bodied subjects, COP control in spinal cord injured (SCI) subjects will be evaluated. These experiments will be similar to the able-bodied experiments except that the SCI subjects will have the aid of parallel bars and will use functional neuromuscular stimulation (FNS) to activate muscles of the lower extremities. Several different forms of control strategies for adjusting stimulation values will be evaluated.

### Bone Mineral Density Measures in College Female Athletes Participating in Weightbearing Vs. Nonweightbearing Sports

**Presenter:** Adrienne L. Janowiak, B.S.

**Collaborators:** Jody L. Clasey, PhD; David R. Gater, MD, PhD

**Problem:** Decreased bone mineral density of the total body and specific regions threatens both the quantity and quality of life of women by predisposing them to osteoporosis and subsequent fractures. Past research has demonstrated that women participating in high impact, weight bearing physical activity often experience favorable bone remodeling due to their athletic participation. In contrast, women participating in non-weightbearing physical activity may experience these phenomena to a lesser degree. **Aim:** The purpose of this study was to examine bone mineral density (BMD;  $\text{g/cm}^2$ ) measures in female intercollegiate athletes currently participating in weightbearing ( $n=14$ ) vs. non-weightbearing ( $n=11$ ) sports. **Methods:** Total body and regional bone scans were performed using DXA (Lunar DPX-IQ) and group mean comparisons were used to compare BMD values of athletes participating in weight bearing vs. non-weightbearing sports. **Results:** Results were significant at the total body and hip regions. No significant relationships were found for the spine and forearm regions.

	Weightbearing ( $X \pm SE$ )	Non-weightbearing ( $X \pm SE$ )
BMD Total Body ( $\text{g/cm}^2$ )	1.250 $\pm$ .020*	1.197 $\pm$ .013
BMD Hip (total; $\text{g/cm}^2$ )	1.199 $\pm$ .044*	1.059 $\pm$ .025
BMD Hip (neck; $\text{g/cm}^2$ )	1.220 $\pm$ .041*	1.092 $\pm$ .018
BMD Spine ( $\text{g/cm}^2$ )	1.282 $\pm$ .045	1.171 $\pm$ .026
BMD Forearm (radius UD; $\text{g/cm}^2$ )	388 $\pm$ .022	.353 $\pm$ .006

\*Weightbearing BMD > Non-weightbearing BMD;  $p < 0.05$

**Conclusion:** The results demonstrated significant differences in BMD of the total body and hip regions between the athletes participating in the weightbearing and non-weightbearing sports. These relationships demonstrate the influence of weightbearing activity on BMD. Specifically, BMD of the hip appears to be the region most affected by weightbearing sport activity.

## Student Abstracts, PM & R Research Day 2001

### Adaptive Linearization of Agonist/Antagonist Muscle Systems

**Presenter:** Eric C. Hartman, M.S.

**Collaborators:** R.J. Triolo, PhD; J.J. Abbas, PhD

**Problem:** Functional Neuromuscular Stimulation (FNS) is an assistive technology where paralyzed muscles are activated by pulses of electrical current and used to perform a functional task. FNS has been used to restore hand grasp, bladder and bowel control, standing, and stepping. **Aim:** The long-term goal of this research is to improve the functionality of FNS systems by providing users with an enhanced ability to adjust their standing posture in a task-dependent manner. Our approach is to use adaptive filtering techniques to compensate for musculoskeletal system nonlinearities such that the overall system input/output properties (user command to posture) are linear from the standpoint of the user. An adaptive neural network algorithm is presented that specifies stimulation to an agonist/antagonist pair of muscles to control system outputs. In experiments with a person with thoracic level spinal cord injury, the quadriceps muscles were configured as antagonists using an instrumented pulley assembly. The system's goal was to specify the pulley angle and the rope tension (used as an indicator of co-stimulation). **Results:** Results are presented from five days of testing. The controller achieved a statistically significant performance improvement in only 18 training steps and continued to improve throughout each session (153 training steps) despite muscle fatigue. Experiments with additional subjects are planned to further evaluate this control strategy. **Conclusion:** Clinically, this algorithm may be applicable in FNS standing systems to allow the user to more accurately and reliably specify their standing posture.

### Adaptive Control of Cyclic Movements in a Multi-Segment System Using Functional Neuromuscular Stimulation

**Presenter:** Junli Ou, M.S. Degree Candidate

**Collaborators:** JoAnne Riess, M.S., James J. Abbas, Ph.D.

**Problem:** Functional neuromuscular stimulation (FNS) is a rehabilitation technology currently used for people with neurological disorders. It applies low level current to neuromuscular system to activate paralyzed muscles in order to perform a specific task or restore functions. For people with incomplete spinal cord injury (SCI), motor recovery is more likely in the first several months post-injury than other times, due to reorganization of spinal and supraspinal neural circuitry. Recent evidence suggests that treatment that induces locomotor movements can promote the recovery of voluntary control. Partial body weight support (PBWS) during locomotion on a treadmill has been used in locomotor training therapy. **Hypothesis:** Combined therapy that uses FNS to assist in generating locomotor movements may lead to improvements in PBWS locomotor training. The effectiveness of this FNS-assisted locomotor training approach may strongly depend on the ability of the FNS system to control movements accurately and repeatably. In previous work, we developed the adaptive Pattern Generator/Pattern Shaper (PG/PS) controller and demonstrated that it effectively controlled cyclic single-joint movements. **Aim:** The objective of this study was to evaluate the ability of the PG/PS controller to control cyclic stepping-like movements in a multi-segment system. **Conclusion:** Results have indicated that the PG/PS control system automatically customized stimulation patterns to generate the desired cyclic movement, thus suggesting that it may be a useful component of a system for FNS-assisted locomotor therapy in people with incomplete SCI. In the future studies, pilot data will be collected for PG/PS controlled walking movement on treadmill with PBWS system.

## Posters, PM & R Research Day 2001

### Bone Density Measures in Spinal Cord Injured (SCI) Adults

**Presenter:** Jody L. Clasey, Ph.D.

**Collaborators:** AL Janowiak, B.S.; CE Winsor, M.S.; J Riess, M.S.; J Abbas, PhD; DR Gater, MD, PhD

**Problem:** Spinal cord injury (SCI) often results in significant decreases in bone mineral density (BMD), specifically in skeletal regions most affected by paralysis. Past research has indicated that bone loss below the level of paralysis is rapid during the first few months, followed by a steady state in the rate of loss achieved by 2 yrs postinjury. In contrast, upper extremity (trunk and arms) BMD may decrease initially and then experience significant increases due to greater weightbearing activity required for transfer and community mobility. **Aim:** The purpose of this study was to determine the BMD of the lower (legs) and upper extremities (trunk and arms) of 19 (15 men and 4 women) motor complete SCI (C7-L2) adults (age:  $38.2 \pm 10.4$  yrs), and determine the relationship between regional BMD and time since injury. **Methods:** Total body bone scans were performed using DXA (Lunar DPX-IQ) and national normative values of regional BMD were used to compare % Matched measures with the SCI subjects. **Results:** Regression analysis of % Matched leg BMD to the log of time since injury resulted in a significant linear relationship ( $r = -0.73$ ;  $p < 0.01$ ). No significant relationships were found for % Matched arm or trunk BMD and time since injury.

	$X \pm SE$	Range	% Matched*	% Matched*
BMD Legs ( $g/cm^2$ )	$0.963 \pm 0.235$	0.632 – 1.442	$72.3 \pm 3.4$	45 - 99
BMD Arms ( $g/cm^2$ )	$1.107 \pm 0.031$	0.859 – 1.286	$115.6 \pm 2.4$	99 - 136
BMD Trunk ( $g/cm^2$ )	$0.977 \pm 0.029$	0.794 – 1.170	$99.3 \pm 2.3$	84 - 115
Time Since Injury (yrs)	$9.8 \pm 2.5$	0.6 – 35.3	-	-

\*% Matched: Matched for gender, age, weight, and ethnic

The results demonstrated a significant decrease in BMD over time in the region most affected by paralysis. **Conclusion:** The lack of relationship between time since injury and the BMD in the arms and trunk regions may be a result in the diversity in level of SCI, the primary use of electric versus manual wheelchair propulsion for mobility, and the physical activity levels of this group of SCI adults.

### Cross-Sectional Gait Analysis Of Subjects With Amyotrophic Lateral Sclerosis

**Presenter:** Jon Frank, B.S.

**Collaborators:** E. Kasarskis, MD, PhD; D. Gater, MD, PhD; R. Shapiro, PhD; and Jean McCrory, PhD

**Introduction:** Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative disease that leads to weakness, decreased motor control, and decrements in daily functions such as walking, and ultimately results in death. Although sufferers of ALS are able to remain independent as long as they are able to ambulate, there is a paucity of information describing ALS patient ambulation. The **purpose** of this study was to compare kinematic gait parameters of ALS patients with those of a normal population. **Methods:** Five ALS subjects and 4 healthy control subjects underwent a gait analysis. All subjects were fitted with retro-reflective markers in accordance with the Cleveland Clinic Marker Set and completed 5-10 walking trials at a self selected pace while 3-D video data were collected. **Results:** The most striking differences occurred in knee flexion, where there were differences at heel strike, stance, toeoff, and swing. At heel strike, the ALS subjects exhibited  $20.35^\circ$  of flexion while the normal group were actually hyperextended at  $-1.38^\circ$ . During stance, the ALS group showed less range of motion in sagittal knee kinematics than normal subjects. Finally, the ALS subjects had more knee flexion ( $20.52^\circ$ ) at toeoff than normals ( $2.45^\circ$ ). **Conclusions:** Patients with ALS exhibited a change in knee kinematics compared to a normal healthy population. Because maintaining the ability to ambulate is crucial to the lifestyle of ALS patients, this information will be helpful in the development of medications and physical therapy protocols that allow them to do so. *Key Words: gait, ALS, function*

## Posters, PM & R Research Day 2001

### Standing with Functional Neuromuscular Stimulation as Compared to Able-bodied Quiet Standing

**Presenter:** Jason C. Gillette, Ph.D.

**Collaborators:** JoAnne Riess, M.S., James J. Abbas, Ph.D.

**Problem:** Functional neuromuscular stimulation (FNS) systems have been utilized to restore the ability to stand in individuals with spinal cord injury (SCI). One goal in the design of FNS systems is to provide the user with the ability to perform reaching tasks while standing. Previous studies have indicated that using a tandem foot placement provides biomechanical benefits during upright reaching in able-bodied subjects. **Aim:** Therefore, the goal of this study was to compare the stability of normal, wide, and tandem foot placements in able-bodied subjects and in a subject with SCI during quiet stance. **Methods:** Kinematic data were collected by tracking reflective markers and ground reactions were measured using force platforms during quiet stance in five able-bodied and one SCI individual. **Results:** Anterior/posterior center of pressure (COP) excursions were similar between the SCI subject and the able-bodied subjects, while medial/lateral COP excursions were statistically different. Thus the combination of hand support and stimulation appeared to better mimic the intact system stiffness in the sagittal plane than in the coronal plane. Similar vertical ground reactions were found for each stance, which indicated that alternative foot placements did not hinder the SCI subject's ability to bear weight on the lower extremities. Furthermore, the SCI subject displayed increased vertical ground reaction values when his COP was more closely aligned with the medial/lateral midline. **Conclusion:** Further trials with the SCI subject may indicate whether decreases in required hand support are possible with additional standing experience and/or with different combinations of muscle stimulation. *Key Words: Standing, center of pressure, neuromuscular stimulation*

### Basal Metabolic Rate, Body Composition and Functional Measures for Basal Metabolic Rate, Body Composition and Functional Measures for Adults With Multiple Sclerosis Versus Healthy Adults

**Presenter:** Sara S. Salles, D.O.

**Collaborators:** Jody L. Clasey, Ph.D. & David R. Gater, M.D., Ph.D.

**Introduction:** Few patients with Relapsing Remitting Multiple Sclerosis (RRMS) or Chronic Progressive Multiple Sclerosis (CPMS) participate in sustained physical activity. These individuals are at increased risk of obesity with associated heart disease, glucose intolerance, and reduced aerobic fitness. In addition, obesity and reduced aerobic capacity significantly impacts the ability to perform activities of daily living (ADLs) and community mobility in this population. **Hypotheses:** 1) Basal Metabolic Rate (BMR), Glucose metabolism and lipid profiles are significantly altered in those individuals with Multiple Sclerosis (MS). 2) Traditional methods for determining body composition will introduce significant error in persons with MS when compared to the current gold standard of a 4-compartment model. 3) Kurtzke EDSS values are inversely related to fat mass, BMR and HDL cholesterol but directly related to the percent of body fat, total and LDL cholesterol and glucose intolerance in persons with MS. 4) Functional Independence Measures (FIM) values are directly related to fat-free mass, BMR and HDL cholesterol but inversely related to percent body fat, total and LDL cholesterol, and glucose intolerance. **Aim:** The objectives of this pilot investigation are to quantify the physiologic and functional changes noted in patients with MS. **Methods:** Twenty volunteers will be recruited. Subjects will participate in hydrostatic and total body water weighing, anthropometry, BMR testing, DXA scan, glucose tolerance, and a neurological examination. FIM and EDSS will be assigned to all subjects. **Relevance:** Metabolic Rate, body composition, and functional parameters used to assess individuals with MS require strict methodology in order to accurately assess interventional modalities. *Key Words: Multiple Sclerosis, Body Composition, Basal Metabolic Rate, Glucose Tolerance, FIM, EDSS*

## Posters, PM & R Research Day 2001

### Enhancing the Educational Viability of an Inpatient PM&R Consult Service at an Academic Center

**Presenter:** David W. Musick, Ph.D.

**Collaborators:** Robert B. Nickerson, MD; Susan McDowell, MD; David R. Gater, MD, Ph.D.

**Aim:** Resident physicians in PM&R are required to rotate on a consultation service. This study examines the "critical mass" of consult opportunities as a key component of a rehabilitation training consultation service in an academic hospital. **Methods:** We examined patient data from an inpatient consultation service over three academic years, looking at two models of service delivery: full time consultant model (one clinician responsible for service) versus rotating consultant model (several faculty responsible for service on selected days). **Results:** A total of 1035 consultations occurred during the 33-month study period. Referrals increased dramatically with the institution of a full time consultation model during the 15th month (mean=41/month vs. 23/month). 80% of referrals were from surgery (62%) or neurology (18%); however, 57% came from only fifteen physicians. Most frequent primary diagnosis categories were brain injury, stroke, SCI, trauma, orthopedic and cardiac related. 50% of all patients were discharged to acute inpatient rehabilitation or home. **Relevance:** The effectiveness of an inpatient consultation rotation in educating PM&R resident physicians appears to be highly dependent on the service delivery format of a given program. Further studies are needed to understand referral patterns and specific challenges to effective residency education in these settings. *Key Words: rehabilitation consultation; resident education*

### The Effect of Aerobic Exercise on Endurance and Community Mobility in Spinal Cord Injured Adults.

**Presenter:** Gay A. Richardson, MD

**Collaborators:** Jody L. Clasey, Ph.D.; J.W. Yates, Ph.D.; David R. Gater, MD, Ph.D.

**Problem:** Roughly 25% of relatively young patients with paraplegia demonstrate aerobic capacity that is barely sufficient to meet the demands of independent living, and their ability to sustain independence as they age is questionable. The purpose of this investigation was to improve endurance and community mobility in SCI adults. **Hypothesis:** After 10 weeks of exercise utilizing an arm crank ergometer, there would be a significant increase in the distance achieved around a standardized track and decreased time required to maneuver a standardized ramp when compared to pretest values. **Aim:** To determine if the regimen of exercise used in this study is sufficient to increase community mobility and provide greater efficiency when performing daily activities. **Methods:** 5 individuals with motor complete C7-T4 SCI, after initially serving as their own controls, underwent timed ramp and wheelchair push. Testing was performed at the beginning and end of a 3-month period in which individuals maintained their routine level of activity. Once this baseline was established, subjects performed 30 minutes of monitored aerobic activity 3 times weekly for 10 weeks. Performance measures were then repeated and compared to pretest values. **Results:** After completing 10 weeks of prescribed aerobic exercise, subjects improved the distance achieved during a 12-minute push around the standardized track by an average of 25.8% (+/-16.8%) and improved the time needed to maneuver the standardized 50-foot ramp by 11.5% (+/-28.8). A high standard deviation in the results of the ramp test was due to shoulder soreness in one of the subjects on the final day of testing. **Relevance:** Due to the significant physiologic changes found after SCI, safe and beneficial exercise parameters such as those outlined in this study must be established in order to standardize exercise protocols in SCI centers around the country. *Key Words: Spinal Cord Injury, Exercise, Community Mobility, Performance Measures*

## Posters, PM & R Research Day 2001

### Motor Firing Patterns of Scapulohumeral Rhythm

**Presenter:** Jackson Maddux, M.D.

**Collaborators:** Tim Uhl, Ph.D. P.T. A.T.,C.; Brian Zeller, MS, A.T.,C.; W. Ben Kibler, M.D.; Paul V. Brooks, M.D.

**Problem:** Scapular dysfunction is commonly present in association with glenohumeral pathology. One role of the scapula is to provide a movable base to maintain glenohumeral joint integrity and provide optimal length for function of the rotator cuff musculature. Loss of motor control of scapular rotators hampers rehabilitation of glenohumeral pathologies. **Purpose:** To determine if there are muscle firing pattern abnormalities of the scapular musculature in those individuals with glenohumeral pathology and abnormal scapulohumeral rhythm, as compared to normal subjects. **Methods:** Subjects: Ages: 21-52 (normal subjects); 21-49 (abnormal subjects). Subjects with no history of shoulder pathology and demonstrate full range of motion in their shoulder are classified as normal subjects. Projected number is 15 in this group, presently have 7. Subjects with a clinical diagnosis of rotator cuff impingement, glenoid labral tear, or acromioclavicular sprain that present with abnormal scapulohumeral rhythm are classified as abnormal scapulohumeral rhythm. Projected number in this group is 15, presently have 6. Subjects are excluded from this study if they had a previous fracture in the shoulder girdle, adhesive capsulitis, or previous surgery to either shoulder. Subjects are also excluded if they had bilateral symptoms of shoulder pain. All subjects are asked questions regarding their history of shoulder injuries and shoulder dominance. The subjects are asked to move their arms through a complete range of motion to assure that they meet the inclusion criteria. The subjects stand with their back and to each side in front of a video camera with arms at their side for 10 seconds. The subjects are instructed to lift their arms above their head as far as they were able in two planes of motion, the frontal and 45° anterior to the frontal plane. This was repeated three times in each plane. Subjects elevate and lower their arms at a constant rate of 45°/sec. The subjects are instrumented with bipolar surface electrodes placed over their upper trapezius, lower trapezius, and serratus anterior bilaterally. Electrical goniometers are aligned with midline of the humerus and the thorax to monitor dynamic shoulder range of motion. Subjects perform maximal voluntary isometric contractions for each muscle group using a standard manual muscle test position. The subjects perform bilateral arm elevation and lowering in the exact same manner as described above. The kinematic data from the electrical goniometer and electromyographic data is analyzed over 20° intervals throughout elevation and lowering. **Results:** Results and Conclusions are forthcoming. The information gained from this study will hopefully increase our understanding of abnormal scapulohumeral rhythm and its relationship to glenohumeral pathologies. **Relevance:** It is hoped that this method will provide a dynamic electromyographical assessment of scapular and rotator cuff musculature to document progression through rehabilitation.