



11th Annual Research Day

June 10, 1999

University of Kentucky
Department of
Physical Medicine & Rehabilitation

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11th Annual Research Day Agenda

10 June, 1999

Lexington VAMC Auditorium

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

Resident Research Presentations

09:15 – 09:30 am Courtney Hogendorn, MD

09:35 – 09:50 am Ayman Hadhoud, MD

09:55 – 10:10 am Sara Salles, D.O.

10:15 – 10:30 am Jackson Maddux, MD

10:35 – 10:50 am Carmela Osborne, MD

10:55 – 11:10 am Danzhu Guo, MD

11:15 – 11:30 am Gay Richardson, MD

11:35 – 11:50 am Christopher Siodlarz, D.O.

12:00 – 12:30 pm Lunch Buffet

Featured Speaker

12:30 – 1:30 pm **“Managing Health Outcomes of People with Severe
Disabilities”**

Michael L. Jones, Ph.D.
Director, Crawford Research Institute
Georgia Model Brain Injury System
Emory University and Shepherd Center, Atlanta, Georgia

1:30 – 2:15 pm Faculty Poster Presentations: Discussion

2:15 – 2:30 pm Awards and Closing Remarks: David Gater, MD, Ph.D.

PM&R Resident Abstracts 1999

Lower Extremity Blood Pressure Measurement in the Spinal Cord Injured Population: Validity & Reliability (Plan)

Presenter: Courtney T. Hogendorn, MD

Collaborators: David R. Gater, Jr., MD, Ph.D.

Problem: Exercise physiology in the spinal cord injured population is a growing area of interest. As such, the efforts for the establishment of protocols pertaining to the exercise physiology lab and the exercise prescription need to continue to be developed. As with the able-bodied population, careful monitoring of the subject during exercise testing is of paramount importance. One of the primary parameters that is monitored is blood pressure (BP). Arm-crank ergometry has been established as an appropriate mode of exercise for the spinal cord injured population. Unfortunately this makes upper extremity blood pressure measurement problematic. If lower extremity blood pressure measurement can be demonstrated to be valid and reliable then this would greatly ease the monitoring of the exercising spinal cord injured patient.

Hypothesis: Lower extremity blood pressure measurement is reliable and valid when compared upper extremity blood pressure measurement in the spinal cord injured population. **Aim:** Ease the process of exercise testing in the SCI population. **Methods:** Subjects will come from the inpatient spinal cord injured unit at Cardinal Hill Rehabilitation Hospital, outpatient SCI patients from the UK PM&R Department, and the outpatient spinal cord injured clinic at the VAMC. Inclusion criteria: subjects of ages 18-45 male and female who have had traumatic spinal cord injuries at a C5-L2 level and rated as an ASIA A, B or C. Exclusion criteria: heart disease, renal dysfunction, uncontrolled diabetes mellitus and uncontrolled autonomic dysreflexia. Procedures: After informed consent, subjects will be seated upright for ten minutes prior to measurements. BP will be obtained by the investigators sequentially from an ipsilateral arm and leg utilizing 2 different techniques: CardioDyne NBP 2000 automated blood pressure machine and by mercury sphygmomanometer. This will be repeated for 3 total trials. *Key words: Exercise Physiology, Spinal Cord Injury, Blood Pressure Measurement*

Effect of Soft Tissue Releases on Gait Velocity, Cadence and Stride in CP Patients (Paper)

Presenter: Ayman Hadhoud, M.D.

Collaborators: Susan McDowell, M.D.

Problem: Cerebral Palsy (CP) is disorder of movement and posture caused by non progressive lesion or injury that affect the immature brain resulting in motor delay and inefficient gait. CP patients often undergo several surgeries in attempt to improve their function, capacity to perform certain task or to improve their ambulation abilities. No study has looked at the effect of these surgeries on the gait components, in particular, the velocity, cadence and stride. **Hypothesis:** Interventional surgical procedures will correct the musculoskeletal obstacles that prevent the patients from having a normal gait pattern. Comparison of pre and post operative gait components should show the effect of the surgery on the cardinal gait components including velocity, cadence and stride. **Aim:** The primary objective of this pilot study is to determine the outcome of the surgical intervention on the quality of gait of the CP patients. **Methods:** Retrospectively, we looked at cerebral palsy patients with spastic diplegia, who underwent soft tissue releases and have had records of pre and post operative gait lab studies. Measurements of each gait component before and after the surgery will be compared. **Relevance:** Assessing surgical intervention impact on gait parameters in CP patients, particularly velocity, cadence and stride can be used to modify subsequent surgical plans to maximize gait parameters impact. *Key words: Cerebral palsy, Surgical Releases, Gait*

PM&R Resident Abstracts 1999 (Continued)

Correlation of Body Composition, Basal Metabolic Rate, Glucose Tolerance to FIM Scores and the Kurtzke EDSS in Patients with Multiple Sclerosis (Plan)

Presenter: Sara S. Salles, D.O.

Collaborators: David R. Gater, Jr., M.D., Ph.D. and Jody Clasey, Ph.D.

Problem: Exercise is seldom prescribed in individuals with progressive Multiple Sclerosis. Relatively few patients with RRMS or 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 to increasing cardiovascular, diabetic, and osteoporosis risk profiles, obesity and reduced aerobic capacity significantly impacts the ability to perform ADLs and community mobility in this patient population. **Hypothesis:** Body composition, Basal Metabolic Rate and Glucose Tolerance will correlate to the increase in the EDSS and the decline in the FIM scores in patients with RRMS and CPMS. **Aim:** The primary objective of this pilot investigation is to quantify the physiologic and functional changes noted in patients with RRMS and CPMS. **Methods:** Twenty volunteers to include 10 healthy able-bodied individuals and 10 individuals with MS will be recruited and tested over a 12-month period. All subjects will participate in hydrostatic weighing, anthropometry, basal metabolic testing, total body water weighing, a DEXA scan, glucose tolerance testing, and a complete neurological examination. FIM and EDSS will be assigned to all test subjects. **Relevance:** Prevention of secondary diseases by identification of underlying risk factors are essential to individuals with Multiple Sclerosis. Appropriate exercise dose parameters will need to be established to avoid physiologic changes that may otherwise be avoided with the use of sustained physical activity. *Key words: Multiple Sclerosis, Body Composition, Basal Metabolic Rate, Glucose Tolerance, FIM, EDSS*

Classification of Abnormal Scapulohumeral Rhythm (Plan)

Presenter: Jackson Maddux, M.D.

Collaborators: Timothy L. Uhl Ph.D. P.T. A.T.,C., Paul V. Brooks M.D., W. Ben Kibler M.D., John McMullen M.S. A.T.,C.

Problem: Scapulohumeral rhythm is the relationship between the arm and scapula as the arm is elevated overhead. This relationship is often affected by injury to the shoulder. Abnormal patterning of scapular movement as the arm is elevated is the observed manifestation of this phenomenon. Currently, there is no common classification system available for clinicians to categorize these abnormalities. **Hypothesis:** We will be able to design a classification system that shall be standardizable and easy to use for clinicians to accurately assess the nature of a patient's shoulder injury. **Aim:** The purpose of this study is twofold: first, to determine the ability of clinicians to correctly classify scapulohumeral rhythm abnormalities. Second, to determine if there are muscle firing pattern abnormalities of the scapular musculature in those individuals with abnormal scapulohumeral rhythm. **Methods:** Participants will be volunteers recruited from Lexington Sports Medicine Center employees and patients. 10 subjects will have no history of shoulder pathology and will demonstrate full range of motion in their shoulder. 40 subjects will have a diagnosed shoulder pathology by the physician investigators. The subjects will stand with their back and to each side in front of a video camera with arms at their side and will be instructed to lift their arms above their head as far as they are able in two planes of motion. The subjects will then have surface electrodes placed over their scapular musculature. Electrical goniometers will also be placed on the humerus and the thorax to monitor shoulder range of motion. The subjects will repeat the same arm movements in the same sequence as was done without the electrodes. The trials will be recorded on a computer for later data analysis. **Relevance:** Observing and recording different patterns of scapulohumeral rhythm will help classify patients' shoulder pathology and this will allow clinicians to better determine the course of a patient's therapy and/ or surgical intervention. *Key Words: Scapulo-humeral, Shoulder Injury, Rotator Cuff*

PM&R Resident Abstracts 1999 (Continued)

Vocational Outcomes Following Spinal Cord Injury (Plan)

Presenter: Carmela Osborne, MD

Collaborators: David Gater, Jr., MD, Ph.D.

Problem: Following Spinal Cord Injury (SCI), many individuals do not return to work. Those who do return to work may not be employed in the same type of work, or may be working only part-time. The purpose of this study is to determine vocational outcomes following SCI, and the role played by Vocational Rehabilitation in this process. **Hypothesis** Many more individuals could return to employment following SCI than currently do so. **Aim:** The primary objective of this project is to determine pre- and post- injury employment status, as well as the benefits of participation in Vocational Rehabilitation. **Methods:** A questionnaire about vocational outcomes will be sent by mail to SCI persons. Non-responders will receive telephone calls to request participation. The questionnaire will cover basic demographics, pre- and post- injury employment, involvement in Vocational Rehabilitation, and questions concerning reasons for not returning to work. **Relevance:** Determining why SCI persons do not return to work will be of benefit in structuring Vocational Rehabilitation programs to address the needs of the individual, as well as providing information to aid in early intervention for return to school and work. *Key Words: Spinal Cord Injury, Vocational Outcomes, Employment*

Noninvasive Pulsed Radiofrequency Therapy for Carpal Tunnel Syndrome (Plan)

Presenter: Danzhu Guo, MD.

Collaborators: Robert Nickerson, MD; Janet Walker, MD., et al.

Problem: Carpal Tunnel Syndrome (CTS) has an incidence of 0.1% in the general population, Causation has been well established with certain occupations. The 500,000 cases annually account for \$2 billion in health resources. The purpose of this pilot investigation is to determine the efficacy of pulse radiofrequency magnetic fields (PRMF) treatment in the recovery of function and reduction of pain and swelling associated with CTS. **Hypothesis:** The pathology of CTS arises when edematous flexor tenosynovitis compresses the median nerve at the carpal tunnel causing focal demyelination. PRMF has been used primarily for reduction of edema and pain in chronic skin ulceration. By reducing swelling and edema, PRMF will reduce the tissue pressure within the carpal tunnel, resulting in decompression of the median nerve within the carpal tunnel. **Aim:** The primary objective of the pilot investigation is to use a pre-set standard treatment regimen to yield significant improvement in an experimental group comparing it to a placebo group. **Methods:** 100 volunteers, who meet our CTS diagnostic criteria will be recruited, and will be placed in a random, prospective, double blind experimental design. Outcomes will be measured by a functional assessment of motor and sensory function. The Levine self assessment questionnaire will be filled out on three occasions: prior to, immediately after, and one month following the last treatment. **Relevance:** Researchers still believe that more effective and less invasive therapeutic approaches to this problem are necessary. The use of noninvasive, nonthermal pulsed radiofrequency therapy to reduce disability, pain and swelling in mild and moderate CTS is proposed. *Key Words: Carpal Tunnel Syndrome, Pulse Radiofrequency Magnetic Field*

PM&R Resident Abstracts 1999 (Continued)

Aerobic Exercise Intervention and Spinal Cord Injury: the Effect of Graded Exercise on Functional ADL's and Community Mobility (Plan)

Presenter: Gay Richardson, MD

Collaborators: David R. Gater, Jr., MD, Ph.D. and Jody Clasey, Ph.D.

Problem: With the alterations in cardiopulmonary function, autonomic response, and body composition unique to individuals with spinal cord injury (SCI), it is necessary to define specific parameters for exercise prescription which include duration, frequency, and intensity. The purpose of this investigation is to improve aerobic fitness, efficiency of daily activities, and community mobility in the SCI population. **Hypothesis:** After a 10 week exercise session utilizing an arm crank ergometer, there will be a significant increase in distance obtained around a standardized track, decreased time necessary for functional transfers, and decreased time needed to maneuver a standardized ramp when compared to pretest values. We also predict a significant difference in these same values when the exercising group is compared to controls. **Aim:** To determine if there is a dose-related benefit of consistent aerobic exercise in the SCI population which would lead to increased community mobility and greater efficiency when performing daily activities. **Methods:** 8 individuals with motor complete C7-T4 SCI will initially serve as their own controls by undergoing timed ramp and transfer tasks, as well as 12-minute wheelchair push testing. Testing will be performed again after a 3-month period during which they will have maintained only their routine level of activity. Once this baseline has been established, all 8 patients will perform 30 minutes of monitored aerobic exercise 3 times weekly for 10 weeks, after which performance measures will be reassessed. **Relevance:** Due to the significant physiologic changes found after SCI, safe and beneficial exercise parameters must be established in order to standardize exercise protocols in SCI centers around the country, and reliable performance measures are essential to determine efficacy. *Key Words: Spinal Cord Injury, Exercise, Community Mobility, Performance Measures*

Shoulder Strengthening for Impingement Prophylaxis in Paraplegia (Plan)

Presenter: Christopher J. Siodlarz, D.O.

Collaborators: David R. Gater, Jr., MD, Ph.D., Denise A. Gater, M.S.

Problem: Up to 70% of the Spinal Cord Injured population experiences shoulder pain post-injury. Impingement syndrome is the most common diagnosis. The primary consequences of chronic shoulder pain for the paraplegic is the loss of Independence, i.e. mobility and activities of daily living and an increased need for medical care and hospitalizations. Many studies have recommended the development of prevention and treatment programs for pain syndromes, but to date, few studies have been reported in the literature. **Hypothesis** The purpose of this study is to provide a structured 12 week progressive resistance scapular stabilization program to yield improvements in strength, range of motion, pain, endurance and to decrease the incidence of shoulder injury. **Methods:** Twenty subjects will be recruited for this randomized controlled prospective study who have spinal cord injuries between T7-L5 complete or incomplete and are at least six months post-injury. We will employ the Wheelchair User's Shoulder Pain Index (WUSPI), standard goniometry techniques for range of motion testing, isokinetic strength testing and fatigue studies using a Cybex II Isokinetic dynamometer with dual channel recorder and a Biodex Upper Extremity Chair. The following statistical analysis will be performed: modified 2x2 factorial experimental design; two-tailed, two sample t-test and statistical significance will be determined at 0.05 level. **Relevance:** If such a program is employed on a national scale, it could significantly reduce the social and financial costs attributed to upper extremity overuse injuries. *Key Words: Rotator Cuff Impingement, Scapular Stabilization, Exercise, Paraplegia*

PM&R Faculty Posters 1999

Fitting the Functional Neuromuscular Stimulation System to the User - an Approach to Improved Motor Function in Spinal Cord Injured Adults

Presenter: James J. Abbas, Ph.D.

Collaborators: JoAnne Riess, M.S., Pankaj Kataria, Xia Zhang, Eric Hartman, Susan McDowell, M.D.

Problem: While advances in medical care and assistive technology have improved the outlook for individuals with thoracic level spinal cord injury, functional capabilities are still limited by motor impairments. Many research groups have investigated the use of functional neuromuscular stimulation (FNS) to restore lower extremity motor function to individuals with thoracic level spinal cord injury. Due to several limitations, however, these efforts have not yet led to widespread clinical use of electrical stimulation systems. One important limitation is that stimulation values must be custom fit for each user an FNS system. The process for custom fitting is time-consuming and often ineffective. **Hypothesis:** Our approach to addressing this problem involves a two-stage hypothesis: 1) that adaptive control algorithms can improve the ability of the FNS user to achieve a desired posture; and 2) that improved postural control does indeed result in enhanced ability to perform functions while standing. **Methods:** We have developed adaptive algorithms to automatically customize stimulation parameters for a particular individual, thus providing an efficient method for 'fitting' the stimulation system to the user. This approach has been evaluated in computer simulation studies using mathematical models and in experiments on human subjects. **Results:** Both the simulation studies and the experimental studies have indicated that the adaptive control system can provide improved control of posture and movement. Future work will focus on determining if the improvements in control will result in an enhanced ability to perform functions while standing. *Key Words: Spinal Cord Injury, Functional Neuromuscular Stimulation, Standing, Adaptive Control.*

Glucose Tolerance and Body Composition in Spinal Cord Injury

Presenter: David R. Gater, Jr., MD, Ph.D.

Collaborators: Jody L. Clasey, Ph.D. and J.W. Yates, Ph.D.

Problem: Spinal cord injuries (SCI) predispose to glucose intolerance and insulin resistance, presumably due to changes in body composition and skeletal muscle dysfunction, placing SCI individuals at greater risk for diabetic retinopathy, nephropathy, gastropathy, neuropathy and coronary artery disease. In the able-bodied, marked improvements in glucose tolerance have been reported in response to both aerobic and resistance exercise, with variable changes in insulin sensitivity. These changes have been associated with body composition changes in the able-bodied. The purpose of this pilot investigation was to determine the relationship between glucose tolerance and body composition in SCI Adults. **Hypothesis:** Glucose intolerance is directly related to % Body Fat (%BF) in SCI adults, and inversely related to Fat-free Body Mass (FFM). **Aim:** The primary objective of this pilot investigation was to assess oral glucose tolerance in persons with C7-T4 Motor Complete SCI and to determine its relationship with body composition. **Methods:** 5 persons with C7-T4 Motor Complete SCI were admitted overnight to the U of Kentucky GCRC. 3-hour Oral Glucose Tolerance Tests were performed from 0800-1100 after an 8-hour fast, with glucose and insulin levels determined at rest and 30-minute intervals. Body composition was assessed in each individual by 4-Compartment modeling using hydrodensitometry, DXA scan, and Bioelectrical Impedance Analysis. **Results:** Glucose Area Under the Curve (AUC) was significantly correlated ($r^2=0.84$, $p<0.05$) with %BF, and the glucose:insulin ratios appeared elevated compared to able-bodied (AB) controls. **Relevance:** The strong relationship between glucose intolerance and body composition implies that reducing %BF in persons with SCI may improve glucose intolerance. *Key Words: Spinal Cord Injury, Glucose Tolerance, Body Composition*

PM&R Faculty Posters 1999

Error In Assessing Spinal Cord Injured Individuals Using Traditional Body Composition Methodologies. (Poster)

Presenter: Jody L. Clasey, Ph.D.

Collaborators: Brad Rogers, B.S., J.W. Yates, Ph.D., David R. Gater, Jr., MD, Ph.D.

Problem: Traditional research and field methods of assessing body composition have often been generated and cross-validated using healthy able-bodied individuals. These methods assume that the proportions and densities of the primary constituents of the fat-free body (FFB) (mineral, protein and water) are known, additive and stable over time. Spinal cord injury results in significant changes to one or more of these FFB components and thus introduces an undetermined amount of error to body composition estimates. **Aim:** The purpose of this study was to determine the validity of total body percentage fat estimates from dual-energy x-ray absorptiometry (DXA %Fat; Lunar Inc.), hydrodensitometry (UWW %Fat; Siri, 1956), bioelectrical impedance analysis (BIA %Fat; RJL model 101), and anthropometry (J&P %Fat; Jackson and Pollock, 1978 & 1980) against a criterion 4-compartment body composition model (4-Comp %Fat; Heymsfield et al, 1990) in 8 (4 men and 4 women) spinal cord injured adults (age: 38.6±14.8 yrs). **Methods:** The 4-Comp %Fat required measurements of total body density from UWW, total body bone ash using DXA, and total body water estimated by BIA. Repeated measures ANOVA and regression analyses were employed to determine the error in assessing %Fat using traditional body composition methodologies. **Results:** Our findings are listed in the following table.

	X ± SE	Range	r	TE (%)
4-Comp %Fat	34.6 ± 4.1	23.5 – 58.6		
DXA %Fat	37.8 ± 4.6	25.4 – 63.1	0.93#	5.6
UWW %Fat	34.9 ± 5.0	19.4 – 57.0	0.90#	13.6
BIA %Fat	30.9 ± 4.3	19.0 – 57.1	0.86#	10.0
J&P %Fat	15.5 ± 2.7*	7.1 – 26.3	0.72*	21.5

*p < 0.05 vs 4-Comp %Fat #p < 0.01 vs 4-Comp %Fat TE = Total Error

Relevance: All traditional methods of estimating %Fat were significantly correlated with 4-Comp %Fat measurements and the small mean differences suggest that the estimates provide valid measures of %Fat. However, the large TE demonstrated that substantial individual variability exists when estimating body composition using these methods. Thus, until regression based equations specifically generated from SCI adults are available use of these methods should be avoided to report baseline %Fat or the effect of treatment or intervention on body composition. *Key Words: Spinal Cord Injury, Body Composition, Body Fat*