Frontiers In Rehabilitation
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Research, Teamwork, Innovation

Seeking the Pathogenesis of Cancer-Related Fatigue using EEG scans
Dear Colleagues,

I’d like to take this opportunity to thank Vinod Sahgal, M.D., for 15 years of outstanding leadership for our department. Dr. Sahgal, who retired in May, now joins an illustrious list of former Cleveland Clinic physiatrists that includes Walter Zeiter, M.D., and Paul Nelson, M.D.

During his tenure at Cleveland Clinic, Dr. Sahgal established four inpatient rehabilitation units, strengthened the translational research program and elevated the status of our field within the institution. In recognition of his foresight and innovation, he became the first Risman Professor of Medicine, Cleveland Clinic Lerner College of Medicine at Case Western Reserve University, in 2005. This was the first endowed chair at our new medical school.

When Dr. Sahgal retired, he left a strong department with excellent physiatrists, therapists, researchers and engineers to carry on. The two main articles in this issue are a testament to the type of research and patient advocacy for which we are widely recognized. One discusses ongoing research to pinpoint the physical causes of fatigue in cancer patients — a highly distressing symptom affecting a disproportionate number of patients. We hope that identifying the underlying mechanisms will lead to effective treatment.

The second main article is a topic of long-term interest to me: unsafe aftermarket vehicle modifications for disabled drivers. All of us in rehabilitation medicine need to be more aware of this issue. When you read this article, I think you will agree that our patients deserve better.

Sincerely,

Frederick Frost, M.D.
Interim Chairman,
Department of Physical Medicine and Rehabilitation

To refer patients to Physical Medicine and Rehabilitation, call 216.445.7342. More information about our services and research can be found at clevelandclinic.org/rehab.
Mental Power Improves Muscle Strength

A study by Vinoth K. Ranganathan, M.S.E., M.B.A., Vlodek Siemionow, Ph.D., Jingzhi Liu, Ph.D., Vinod Sahgal, M.D., and Guang Yue, Ph.D., explored the potential of using the mind or mental imagery to induce strength increases in healthy young adults. The researchers asked volunteers to refrain from moving their little fingers or elbow flexor muscles, but to think about moving them against a heavy load. At the end of 12 weeks of mental training, the finger muscles had become stronger by 35 percent and the elbow flexor muscles by 13.5 percent. Data analysis showed these strength gains were primarily due to stronger brain signals to the trained muscles.

This study demonstrated that it is possible to gain muscle strength by using mind power alone, without resorting to conventional strength training techniques such as weightlifting.

To expand on the findings from young people to the elderly population, Mr. Ranganathan and his team recently completed an imagery study with healthy men and women over 65. “Older individuals can achieve similar training-induced increases in muscle mass and strength as compared with young subjects,” says Mr. Ranganathan.

This over-65 cohort experienced a gain of 20 percent in elbow flexor strength using mental imagery, with the greatest improvement seen in sedentary participants. These findings may hold promise for the sizable portion of the elderly population that is too weak and fragile to perform physical exercises to maintain body strength.

Contact Mr. Vinoth Ranganathan at 216.444.5917 or ranganv@ccf.org.

Publication

Seeking the Pathogenesis of Cancer-Related Fatigue

Profound, unrelenting fatigue is reported by 50 to 80 percent of patients receiving chemotherapy or radiation. Studies indicate that fatigue, not pain, has the greatest negative impact on quality of life for patients with cancer. Resolving the disease does not always eliminate the symptom; one-third of cancer survivors report chronic fatigue that is not alleviated with rest.

Research on cancer-related fatigue has primarily concentrated on factors that worsen or ameliorate symptoms. For this reason, available treatments are based on such associative factors as depression, coping ability, exercise and low hemoglobin.

Cleveland Clinic researchers have undertaken studies designed to locate the neuromuscular origin of cancer fatigue.

“In advanced cancer patients, fatigue appears to be organic. This may differ from fatigue in survivors, for whom the psychological component plays a prominent role,” says palliative care physician Mellar Davis, M.D. “Understanding the source of cancer fatigue may enable us to find an effective treatment or medication for this debilitating symptom.”

“We are now in the process of analyzing EEG data to locate the source of fatigue in the brain.”

—Vinoth Ranganathan, M.S.E., M.B.A.
The first step

Dr. Davis, Guang Yue, Ph.D., and other researchers in Cleveland Clinic’s Department of Physical Medicine and Rehabilitation made physiological measurements associated with a low-force endurance task to determine whether cancer fatigue is peripheral or central in origin. The endurance task required patients to flex their elbow joint using elbow flexor muscles for as long as possible, while the flexion force and signals from the brain (EEG) and muscles (EMG) were recorded.

“If cancer fatigue during motor performance was primarily muscle-related, patients with cancer would fatigue at the same rate as healthy individuals. We found the force-generating capability (FGC) of the muscles at rest, prior to performing the task, to be similar in both groups,” says Vinoth K. Ranganathan, M.S.E., M.B.A.

The cancer patients reported complete fatigue (i.e., being unable to perform the endurance task any longer) much earlier — within five to six minutes compared with nine minutes for the controls — indicating less endurance. However, the FGC was higher in cancer patients than controls at the end of the endurance task, indicating that the muscle was less fatigued in the cancer patients (severer fatigue, lower FGC or vice versa).

“The reduced endurance with a lower level of muscle fatigue is explained by a decreased ability to drive the muscle to continue the work, which was evaluated using standard physiological means,” says Mr. Ranganathan. Frequency analysis of EMG signals also supported the notion that reduced endurance was not due to muscular fatigue alone.

“Together, the findings suggest that the elbow flexor muscles in cancer patients still had the capability to continue the endurance task, but the patients were unable to voluntarily activate these muscles any longer, a sign of central fatigue,” he says.

Eliminating peripheral sources

Voluntary movements are initiated in the brain and executed by sending signals through the spinal cord to the respective muscles across the neuromuscular junction (NMJ). Signal transmission through the NMJ can be studied by stimulating the motor nerve, proximal to the NMJ, and recording the evoked EMG response, distal to the NMJ. When the signals are incompletely transmitted to the muscle, the EMG response appears smaller. In this study, the EMG response in cancer patients was significantly lower both before and after the fatigue task, suggesting poor NMJ transmission.

“ Interruption of signal transmission across the neuromuscular junction indicates the problem (fatigue) occurs mainly at the central level, rather than at the peripheral (muscular) level,” says Mr. Ranganathan. “This finding is significant. We are now in the process of analyzing EEG data to locate the source of fatigue in the brain.”

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Publication

Analysis Reveals Problems with Aftermarket Vehicle Modifications

Modifying vehicles for disabled drivers is a lucrative business, but not necessarily one that benefits those who need the modifications. A study conducted at Cleveland Clinic has found that many aftermarket motor vehicle adaptations are linked to reports of equipment malfunctions and accidents.

“We have known for years that some of these products are unsafe,” says Frederick Frost, M.D., interim Chairman of the Department of Physical Medicine and Rehabilitation. “This study confirmed that this industry needs to be carefully scrutinized. Our patients deserve better.”

Persons using high-tech steering systems were 79.4 times more likely to report accidents and 238 times more likely to report malfunctions.

Recurrent problems

When a person applies for disability through the Ohio Rehabilitation Services Commission, an expert evaluator assesses the person’s ability to drive and recommends appropriate vehicle modifications. The state pays for these modifications, which can cost thousands of dollars per vehicle.

Over time, recurrent problems with certain modifications became apparent. The state’s consulting firm, which had extensive files on vehicle adaptations, suggested Cleveland Clinic perform an independent analysis of the data.

Cleveland Clinic conducted a retrospective analysis on motor vehicle modifications for 2,150 disabled people. The initial analysis found that those with spinal cord injury, specifically tetraplegia, were significantly more likely to report traffic accidents and vehicle malfunction. The database was subsequently reorganized and stratified, leaving 827 cases that were divided into nine categories of adaptations based on complexity and function.

Cleveland Clinic researchers found that persons using high-tech steering systems such as joysticks were 79.4 times more likely to report accidents and 238 times more likely to report malfunctions than those without such equipment. Less complex steering systems such as tri-pins also were associated with accidents and malfunctions. Lowered floor modifications, major structural changes, occupant protection devices and simple gas-brake hand controls were not significantly associated with adverse outcomes.

Interestingly, the cost of vehicle adaptations was found to be significantly higher among persons who reported accidents (median $27,572) and malfunctions (median $28,365). “The breakdown occurs in very expensive, high-end, highly complicated vehicle modifications. The more you paid, the worse your outcome was,” says Dr. Frost.

“The Ohio Rehabilitation Services Commission has been very supportive of our work. They want good things to come of this study,” he says. “This is one of the times you seek more government control of private industry.”
Root of the problem

According to Dr. Frost, one reason the problem has never been corrected is that vehicle modifications for disabled drivers often are funded by the government, not the end user. When something goes wrong, the equipment manufacturer may blame the vendor, who may blame the driver’s educator, who may blame the driver.

“There is a disincentive for people to complain, because disabled drivers are terrified that someone will declare their driving unsafe and revoke their license. Without a car, they cannot go to work,” he says.

The problem continues to occur because cases involving unsafe modifications are settled out of court. In cases where a lawsuit is compelling, makers have been known to declare bankruptcy and reopen under a different name.

Simpler is better

According to Dr. Frost, many simple, inexpensive devices are perfectly reliable and safe. They include hand controls, special mirrors, left-sided accelerators and spinner knobs. Many can be purchased on new cars and also are available on rental cars. Problems are more likely to occur with aftermarket adaptations.

“If we accept that some of our engineering efforts are failures, we are more aware of our limits as rehabilitation professionals. The bottom line is that the higher the technology and cost, the higher the risk for accidents and malfunctions,” says Dr. Frost.

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Publications


Education

Visiting physicians

Visitors from countries around the world are welcomed to our department throughout the year to observe our practices and techniques of treatment.

Resident education

Our department supports a physical medicine and rehabilitation (PM&R) residency partnership with MetroHealth Medical Center/Case Western Reserve University. PM&R residents spend three months of their residency focusing on tertiary care hospital rehabilitation consultations, chronic pain management, medical care of spinal disorders, and prosthetics and orthotics training. Residents benefit from the magnificent educational and research resources available at Cleveland Clinic.

Medical students

Medical student rotations and externships are tailored to meet the interest and needs of first- through fourth-year medical students. Opportunities for research and clinical training are available in areas related to disability and the therapy disciplines, musculoskeletal rehabilitation, spine rehabilitation, pain management and electrodiagnosis. Most rotations last four weeks. The broad scope of training available at Cleveland Clinic brings students from around the world to our campus.

Continuing medical education

Formal educational offerings include accredited monthly PM&R grand rounds series, resident journal club, chairman’s teaching rounds as well as special endowed lectures sponsored throughout the year.

For more information, please call 216.445.2006.