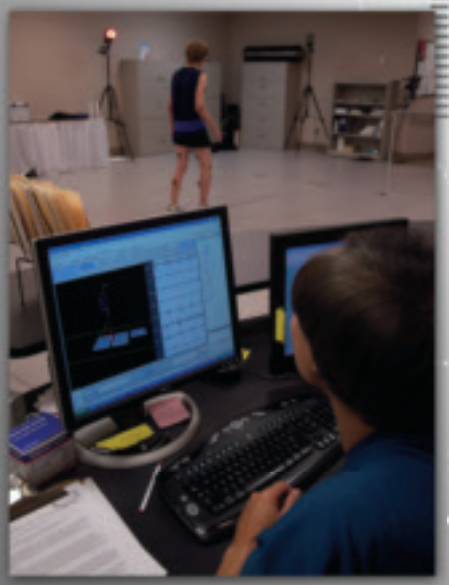
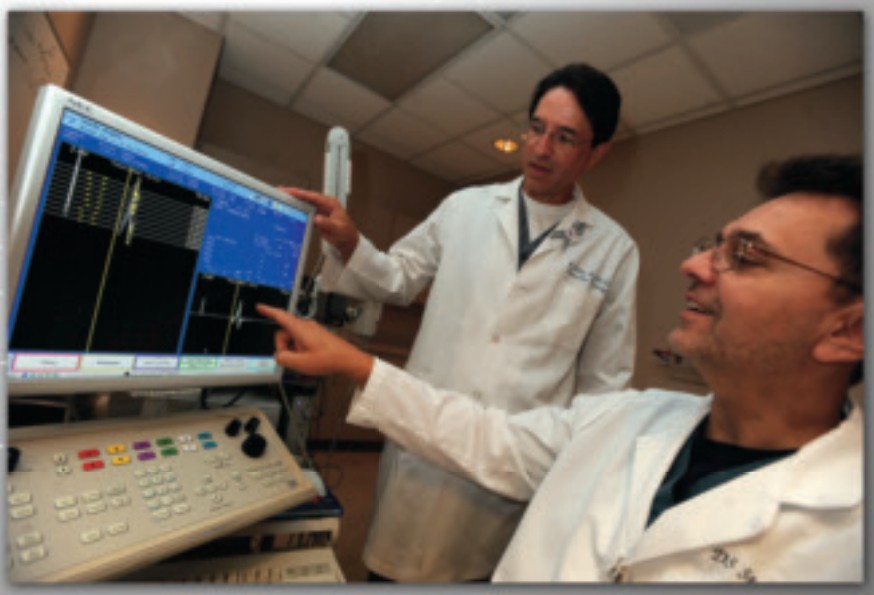
WINTER 2012

WAYS AND MEANS

METHODIST REHABILITATION CENTER





research EDITION

Earl R. Wilson, Founding Chairman

METHODIST REHABILITATION CENTER

Contents

Earl R. Wilson, Founding Chairman

METHODIST REHABILITATION CENTER

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Ways & Means Research Edtion is published by Methodist Rehabilitation Center.

Methodist Rehabilitation Center provides comprehensive medical rehabilitation programs for people with spinal cord and brain injuries, stroke and other neurological and orthopedic disorders. The 124-bed state-of-the-art hospital in Jackson has twice been designated a Traumatic Brain Injury (TBI) Model System site by the National Institute on Disability and Rehabilitation Research and is also the only hospital in Mississippi twice named one of America's best by U.S. News & World Report. Methodist Rehab is one of only two hospitals in the state accepted into the prestigious Council of Teaching Hospitals

Mission Statement | In response to the love of God, Methodist Rehabilitation Center is dedicated to the restoration and enhancement of the lives of those we serve. We are committed to excellence and leadership in the delivery of comprehensive services.

Methodist Rehabilitation Center, 1350 East Woodrow Wilson, Jackson, Mississippi 39216 | www.methodistonline.org | 800-223-6672

Restoring ability and hope through research

Progress in medicine requires translation of emerging discoveries into clinical practice. In the growing field of neurological rehabilitation, bridging this gap is especially challenging. The medical and psycho-social issues are complex. And the patients often require a lifelong continuum of services.

The critical link for effective human research in this branch of medicine is seamless interaction between research scientists, clinicians and patients. This is where we excel.

At Methodist Rehabilitation Center , our goal is to provide objective evidence about what works for whom, when and why, whether we are evaluating promising new therapies or challenging embraced clinical practices. Through day-to-day interaction, our researchers provide clinicians with the best possible evidence to help them select the most appropriate treatment options for the patients.

This publication highlights some of the current research at Methodist Rehab's Center for Neuroscience and Neurological Recovery and its lead investigators. The presented works span many applications, including clinical management of neuromedical complications, development of new methods for assessment and characterization of consequences of neurological injury, and evaluation of new therapeutic approaches for motor and cognitive impairments.

In 13 years since founding the center, Methodist Rehab researchers have published more than 220 manuscripts and book chapters, which helped establish Methodist Rehab as a center of excellence in neurorehabilitation research and patient care. The major funding for our research has been provided by the Wilson Research Foundation at Methodist Rehabilitation Center . Other funding sources over the years have included the Craig H. Neilsen Foundation, federal and state agencies, grants from pharmaceutical and medical equipment companies, the hospital itself and other organizations.

We appreciate the support and collaboration of the entire staff at Methodist Rehab Center. Lastly, we are most grateful to patients who participated in our research and who remain the inspiration for our future efforts.

Mark A. Adams
President and Chief Executive Officer
Methodist Rehabilitation Center

Neurocognitive function after traumatic spinal cord injury

ASSOCIATED BRAIN INJURY MAY BE OVERLOOKED WITHOUT PROPER ASSESSMENT

Spinal cord injury is mainly caused by trauma, such as a motor vehicle accident or fall. The seriousness of a spinal cord injury requires emergency medical treatment to prevent complications and further injury, and there is often less attention to associated conditions.

The growing body of research suggests that persons with spinal cord injury may demonstrate deficits on formal measures of neuropsychological function. That's why researchers at Methodist Rehabilitation Center, led by Samuel T. Gontkovsky, PsyD, recently investigated whether persons with spinal cord injury show problems in auditory learning and memory. These functions are relevant for active participation in rehabilitation programs and acquisition of self-care skills.

The study involved 21 subjects who were evaluated with a battery of neuropsychological tests during inpatient rehabilitation. "Results showed that persons with spinal cord injury may indeed show worse performance on neuropsychological testing despite high ratings of cognition on the commonly used Functional Independence Measure," Gontkovsky said.

The study was carefully designed to control for possible causes of deficits other than traumatic brain injury, such as age-related cognitive decline, side effects of medications, other medical conditions or pre-injury intellectual, educational and occupational status.

According to Gontkovsky, evaluation for possible brain injury among individuals sustaining a traumatic spinal cord injury has been neglected.

"When a person is unconscious at the scene or has sustained a skull fracture, it is apparent that there has been a blow to the head," Gontkovsky said. "However, in cases of mild head trauma, in particular those without a loss of consciousness, traumatic brain injury may be overlooked considering focus on life-saving measures and consequences of spinal cord injury."

"Results of this study suggest the need for routine neuropsychological screening of persons who sustained traumatic spinal cord injury in order to provide appropriate treatment for associated conditions and to identify potential neurocognitive deficits that may impede successful rehabilitation and positive outcomes."

The findings of this investigation will soon be published in Functional Neurology, Rehabilitation, and Ergonomics.

> "These results have direct implications for clinical care and our neuropsychologists routinely provide consultations to patients admitted to our spinal cord injury program."
>
> *—Clea Evans, PhD, director of Methodist Rehab's neuropsychology department*

Intrathecal baclofen for control of spasticity

IS THERE A BETTER WAY TO PROGRAM THE DELIVERY AND DETECT PROBLEMS?

For over a decade now, clinicians and researchers at Methodist have conducted a series of studies to assess changes in function after intrathecal administration of baclofen (ITB) for control of spasticity (muscle stiffness) after stroke or traumatic brain injury.

With the ITB technique, a pump is filled with baclofen and surgically implanted below the skin in the abdomen. A catheter extending from the pump and threaded to the spinal canal delivers the drug close to target receptors in the spinal cord. The technique has proven useful in many patients with severe spasticity.

"Although it is possible to independently adjust the dose and concentration of the baclofen, as well as the mode of administration, most clinicians do not take advantage of this potential when trying to arrive to the best clinical response," said Stuart Yablon, MD, research collaborator. "Instead, adjustments are typically limited to dose, with concentration changes implemented mainly to reduce the frequency of reservoir refills."

That's why the researchers at Methodist designed a study to better understand how different ITB settings affect the response of the spinal cord, which leads to clinical benefit.

With support from Medtronic, Inc., the manufacturer of one of the pumps available on the market, the study was conducted at Methodist's neurophysiology lab. Dobrivoje Stokic, MD, DSc, and Antonio Hayes, neurophysiology technologist, recorded the H-reflex, the electrophysiological correlate of ankle jerk, before and after making various adjustments in patients.

The manuscript describing the study results has been submitted for publication.

"Delivering baclofen at a lower concentration resulted in a greater decrease in the H-reflex. A similar effect was achieved after programming the pump to inject a brief bolus of baclofen rather than continuously delivering the same dose at a slow pace," Stokic said.

"Our results provide neurophysiological basis for some anecdotal reports that describe greater decrease in spasticity after lowering baclofen concentration," Yablon said.

"Thus, we may be able to achieve better clinical outcomes by simultaneously adjusting several parameters. Of course, the perfect combination will be different for each patient, but that's what makes this research exciting."

Stokic points out that it's a complex technology, and problems may arise.

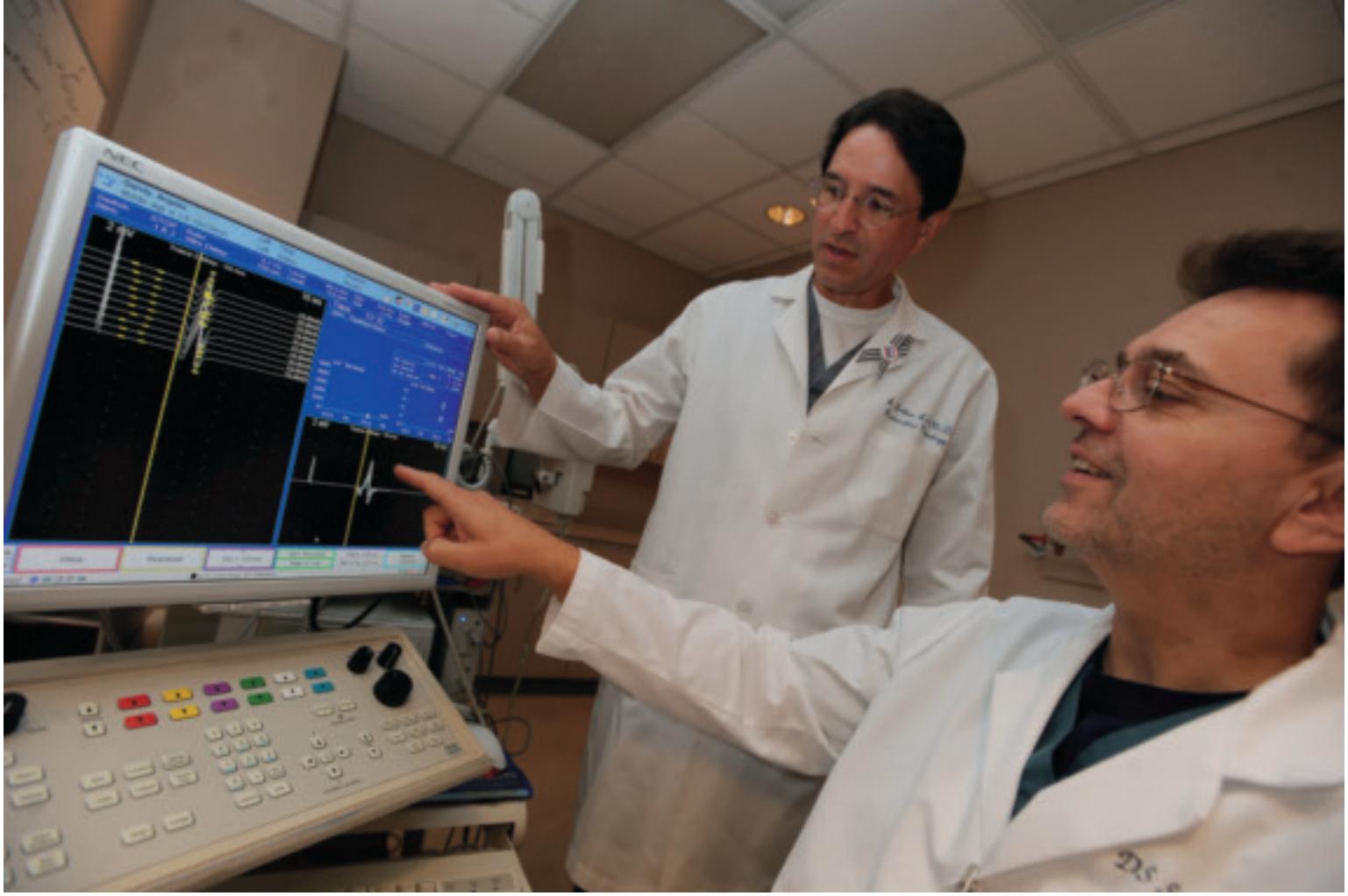
"Any part of the implanted system may fail, so the clinical benefit becomes less apparent or completely absent. The types and rates of different complications vary widely across the literature. Although there are many reports, each typically describes only a few cases, making it difficult to appreciate the scope of the problem."

"That's why we did an extensive review of the literature before analyzing complications in our patients," Yablon said. "That allows us to gauge where we stand in comparison to others."

The literature review was done by Dr. Ivana Stetkarova, chair of the Department of Neurology at the University Hospital in Prague, Czech Republic. Dr. Stetkarova spent three months working at Methodist as a visiting scholar with support from the Wilson Research Foundation. She was joined by Dr. Markus Kofler, professor of neurology from Innsbruck, Austria.

The results of literature review were published in 2010 in Neurorehabilitation & Neural Repair, the official journal of the American Society for Neurorehabilitation and several other national societies around the world.

"We found that catheter complications are most frequent and occurred, on average, in two out of three patients who received the implant. Not surprisingly, the overall reported rates were higher in the centers that followed patients for a longer period of time. And there are places with unusually high and unusually low rates of complications," Stokic said.



From left, Art Leis MD and Dobrivoje Stokic, MD, DSc in the neurophysiology research lab

Zoraya Parrilla directs the brain injury clinical program at Methodist.

"Patients considering this treatment should be aware that complications may occur during the life time of the implanted system and understand what to do in those situations," Parrilla said. "You want to be under the care of experienced clinicians who work at the specialized centers capable of troubleshooting the suspected problems."

And that's where Methodist's researchers and clinicians have excelled over the past decade.

"We use the H-reflex technique as a screening tool to detect whether baclofen is flowing as expected. It is simple, sensitive and useful," Stokic said. "The results are rather straightforward when H-reflex is present – any decrease in the baclofen flow will increase the amplitude of H-reflex. Even patients themselves can interpret the results after several recordings."

The physiological basis and the recording protocol have been published in several reports and two books over the past decade, most recently in "Spasticity: diagnosis and management," published by Demos Medical.

"The technique is useful because it is so sensitive that even subtle changes in baclofen flow can be reliably detected," Yablon said. "In fact, changes in H-reflex often precede clinical symptoms so we can detect and rectify the problem sooner."

Nurse practitioner K.K. Ramsey works in the spasticity clinic at Methodist and is herself a pump recipient.

"I have experienced firsthand the benefits of recording H-reflex. When I was not sure whether my pump and catheter were working properly, a quick trip to the lab provided the answer and in my case, I was ready for another surgery."

"When I came to Methodist Rehab from the University of Miami three years ago, I was unaware of the usefulness of H-reflex technique for managing patients with a baclofen pump," Parrilla said. "Now, before considering any changes to the system, I want to know what the H-reflex says. I hope other physicians soon follow suit."

Pros and cons of medication after brain injury

SOME NEGATIVE SIDE EFFECTS MAY HINDER RECOVERY

Pharmacological agents are the first-line treatment for many of the consequences of acquired brain injury, such as seizure and reduced attention or concentration.

For example, anticonvulsant agents are prescribed to decrease seizure frequency and limit cognitive impairment that may result from abnormal electrical activity in the brain. Although drugs are effective, negative side effects can interfere with the patient's participation in therapy.

"Side effects of these medications can make rehabilitation more difficult, as they can cause fatigue, sleep problems, restlessness and reduced mental functioning," said Samuel T. Gontkovsky, PsyD, a Methodist Rehab scientist.

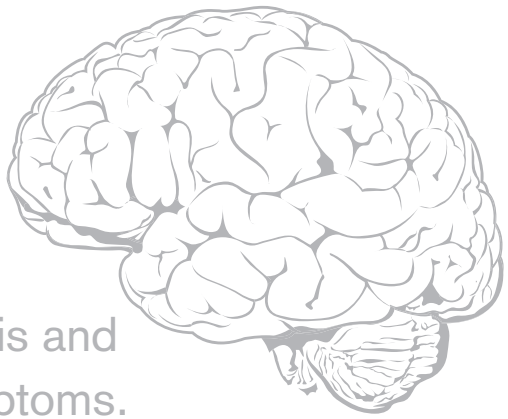
"The research in this area is not aimed at disputing the benefits of these medications; rather my goal is to identify the most appropriate agents and dosages that successfully manage symptoms while minimizing side effects that can interfere with participation in physical, occupational and speech therapy.

"Sedation, dizziness and vertigo are especially common with antiepileptic drugs. Memory disturbance, distractibility, and attention problems can also be found. Moreover, the commonly prescribed Depakote (divalproex sodium) may result in mild to moderate psychomotor and mental slowing. The rehabilitation team should be aware of these side effects and not ascribe symptoms to brain injury itself."

In addition to examining the potential negative side effects of common medications, Gontkovsky continues to build on his past work showing the beneficial effects of drugs, such as methylphenidate, in improving the neurocognitive functioning of individuals following brain injury.

"The research shows, for example, that use of methylphenidate in persons with certain kinds of acquired brain injury may significantly improve learning, immediate memory, and language functioning as measured by formal neuropsychological tests," Gontkovsky said.

The results of Dr. Gontkovsky's work in this area have been presented at the annual meeting of the Association for Psychological Science, published in the Journal of Cognitive Rehabilitation and Clinical Drug Investigation, and are scheduled for publication in the new Nova Science textbook, Advances in Medicine and Biology (Vol. 48).



> "It is challenging if not impossible for clinicians to provide optimal treatment without proper diagnosis and accurate identification of neuropsychological symptoms. That's what attracted me to this line of research."

—Samuel T. Gontkovsky, PsyD, scientist

Assessment of cognitive and emotional functioning during rehabilitation

NEW TESTS MAY BETTER IDENTIFY PROBLEMS ASSOCIATED WITH BRAIN INJURY

Brain injury can result in a host of neuropsychological impairments, such as difficulties with attention, learning, memory, language and problem solving. Disturbed emotions, personality and behavior are also common and can lead to depression, anxiety, irritability, impulsivity and agitation.

Accurate identification of the psychological disturbances after brain injury is critical in order to develop appropriate treatment plans and achieve successful rehabilitation outcomes. That's why researchers and test developers constantly strive to improve testing methods.

Methodist Rehab scientist, Samuel T. Gontkovsky, PsyD, in collaboration with other investigators from Florida, Missouri and Michigan, seeks to find better ways to evaluate the symptoms of patients commonly seen in the rehabilitation setting.

"It is challenging if not impossible for clinicians to provide optimal treatment without proper diagnosis and accurate identification of neuropsychological symptoms," said Gontkovsky. "That's what attracted me to this line of research."

Many new assessment measures are developed for specific use within a particular setting or with a specific population. Further research is necessary to validate the utility of these tests in other settings or with other populations.

"A test developed and proven to identify neurocognitive deficits in individuals with multiple sclerosis, for example, may or may not be useful in identifying similar deficits in persons with traumatic brain injury," Gontkovsky said. "Researchers must examine the various psychometric properties of the test within a given environment or patient population before it can be used routinely by clinicians."

"For example, my research suggests that the newly developed State-Trait Personality Inventory, which still remains in the research phase of development, seems to be better for evaluating depression in persons with traumatic brain injury than more traditional measures of emotional status."

The results thus far of this research have been presented at the annual meeting of the American Psychological Association and the International Neuropsychological Society, as well as published in the Journal of Cognitive Rehabilitation and the Journal of Clinical Psychology.

Breaking the light

A SIMPLE AND USEFUL WAY TO ASSESS GAIT ON THE TREADMILL

For more than a decade, Methodist Rehab has used the weight-supported treadmill for re-training gait after stroke, brain injury or spinal cord injury.

The harness attached to the support system serves to take off some of the patient's weight and, in combination with proper treadmill speed, allows re-training gait in a safe and convenient environment.

Over a decade ago, rather than purchasing an off-the-shelf weight-support system, Methodist researchers and engineers designed a unique solution suited to the needs of patients and for research purposes. The design team included engineering students at Mississippi State University in Starkville, Miss., as a part of their senior design project.

And this tradition continues.

"We wanted to be able to record steps while a patient undergoes the training," said Dobrivoje Stokic, MD, DSc, administrative director of research at Methodist. "The mandate was to have a reliable system that requires no attachments to the patient, does not interfere with therapy and is easy for researchers to use."

John Chow, PhD, director of the motion analysis lab at Methodist, explained that there are many ways to record gait while walking on a treadmill, but not with these specifications. "The closest match was the treadmill with force sensors underneath, but this was more than what we wanted and quite expensive."

The researchers turned to Robert Hirko, PhD, the director of Methodist Biomedical Engineering Department and a Carnegie Mellon University graduate. Hirko has decades of teaching experience and developed several lab instruments in the past.

"We looked at multiple options before choosing the light curtain system," Hirko said. "It consists of a transmitter that projects an array of infrared light beams to a receiver, similar to those used to prevent elevator doors from closing when an object is present."

The transmitter in the front and the receiver in the back are aligned with the light beams running just above and parallel to the treadmill surface. As the patient steps on the treadmill, the light beam is interrupted and the electrical signal generated is recorded on the computer. Two sets permit independent right and left step detection.

The researchers conducted a validation study to determine how the light curtain device compares to other options, such as contact foot switches placed under the shoes, as well as video-based motion analysis which requires placing markers on the body. The results were published in Gait and Posture, the official journal of the International Society for Posture and Gait Research.

"Our light curtain system stood up to the expectations," said Dr. Chow, the lead author on the paper. "It reliably detected when feet were on and off the treadmill. At slow speeds typical for our patients, it performed just as well or better than the other two systems."

"The system is remarkably convenient; it simply monitors steps as the training takes place, and the patient and therapist don't have to do anything out of the ordinary."

Stokic affirmed the instrument's research and clinical value.

"We used the light curtain system in the pilot study and found that a person with chronic brain injury can improve symmetry of walking after only three or four treadmill training sessions," Stokic said. "In future studies, we plan to examine our stroke patients as soon as they are ready to start gait therapy, with emphasis on treadmill training compared to over-ground training. We suspect that starting with the treadmill first may lead to better outcomes."

"After we gain some experience, we will turn again to Dr. Hirko. We think that the same principle can be used in therapy as a real-time feedback to help patients improve their stepping pattern."

Characteristics of gait after acquired brain injury

WHERE TO DRAW THE 'THIN LINE' BETWEEN IMPAIRMENT AND ADAPTATION

Stroke and traumatic brain injury (TBI) survivors walk slower than healthy people, often five to ten times slower. And the way they walk is much less efficient. Stride is shorter, steps may be asymmetrical and varied.

In a study published in Brain Injury, the journal of the International Brain Injury Association, researchers at Methodist Rehab examined whether changes in gait after acquired brain injury are related to slower than usual walking speed.

"Existing research has compared the faster gait of healthy people to the slower gait of impaired people, and it is not a fair comparison," said John Chow, PhD, director of the motion analysis and human performance lab at Methodist.

"What has not been shown is to what extent changes in gait are simply due to walking slower as opposed to being the result of brain injury," Chow said.

Heather Maloney is a research physical therapist who assisted in the study.

"As a therapist, I also question whether changes in gait after stroke or TBI are true impairments that we should try to correct with therapy, or if the changes represent the best possible adaptation to a new condition that we should leave alone," she said.

The researchers used high-speed cameras in the motion analysis lab to examine 31 patients with walking impairment, and 31 healthy control subjects. The patients were asked to walk at their preferred speed, whereas healthy subjects walked at both the preferred speed and at a very slow speed. This allowed an appropriate comparison.

"We found many gait deviations in patients, such as shorter strides and wider steps, regardless of whether the comparison was made to healthy people walking at preferred or very slow speed. Therefore, such changes can be ascribed to brain injury," Chow said.

"We also found no difference in step length and foot velocity between patients and controls, indicating that they are related to slower walking, rather than the injury itself."

The study also examined muscle stiffness (tone) in the relaxed legs of patients before the gait analysis.

Dr. Dobrivoje Stokic, MD, DSc, is administrative director of research at Methodist.

"From a physician's standpoint, it is also important to determine whether increased stiffness in the leg muscles of patients is related to gait and then to consider treatment options to hopefully improve gait," Stokic said.

"What we found, however, is that the relation between gait and muscle stiffness in patients was weak at best. A few stronger correlations were hard to explain. This does not mean that stiff muscles do not contribute to impaired gait in patients; the problem lies in the difficulty to assess muscle tone during gait. Thus more research in this area is necessary to appreciate whether treatment of muscle stiffness can improve gait in the patients after stroke or traumatic brain injury."

"An interesting finding of this project was that many changes in gait were found on what appears to be the normal side after stroke or less affected side after traumatic brain injury. Such changes likely represent an adaptation to a new condition," Maloney said.

"These results are important implications for ambulatory people who consider treatment for lower limb spasticity," said Zoraya Parrilla, director of Methodist's brain injury program and outpatient spasticity clinician. "Evidently, the results of laboratory gait evaluation should be taken into account."

> Existing research has compared the faster gait of healthy people to the slower gait of impaired people, and it is not a fair comparison.

— John Chow, PhD, director of the motion analysis and human performance lab at Methodist

Does spasticity affect gait after acquired brain injury?

NEW INSIGHT TO THE ONGOING CONTROVERSY

After an injury or disease that affects the central nervous system, muscle stiffness (resistance to stretch) is common. Movements are slower, more effortful and less precise. And it is a problem for millions who have suffered from a stroke, traumatic brain injury, spinal cord injury or multiple sclerosis.

It's a complex problem. Often described broadly as 'spasticity' or muscle over-activity, the muscles resist stretching, and there can be abnormal co-activation between muscles acting in the opposite directions at the joint.

"There is still a controversy as to how different components of spasticity affect movements of arms and legs," said John Chow, PhD, director of the Motion Analysis and Human Performance Laboratory at Methodist. "This is especially unclear during walking, so we designed a study to revisit this issue."

"Addressing this controversy is clinically relevant," said Stuart Yablon, MD, research collaborator. "It would be useful to come up with a set of markers that would indicate which components of spasticity are present or predominant during walking so the clinicians can select the most appropriate treatment."

The researchers evaluated the gait of 22 patients after stroke or traumatic brain injury and 22 aged-matched healthy subjects walking at comparable speeds. They used sensors to record activity in the main leg muscles. In the first round of analysis, the focus was on the activity in the ankle joint muscles during stance phase of gait when the calf muscles are stretched.

The results will appear in Clinical Neurophysiology, the official journal of the International Federation of Clinical Neurophysiology.

"We found limited evidence that the activity in stretched calf muscles of patients is abnormally increased during the stance phase of gait," Chow said.

"However, what we did find is that the co-activation between anterior and posterior leg muscles was increased on the more affected side and prolonged on the less affected side of patients, particularly during the time of shifting the weight from one leg to the other."

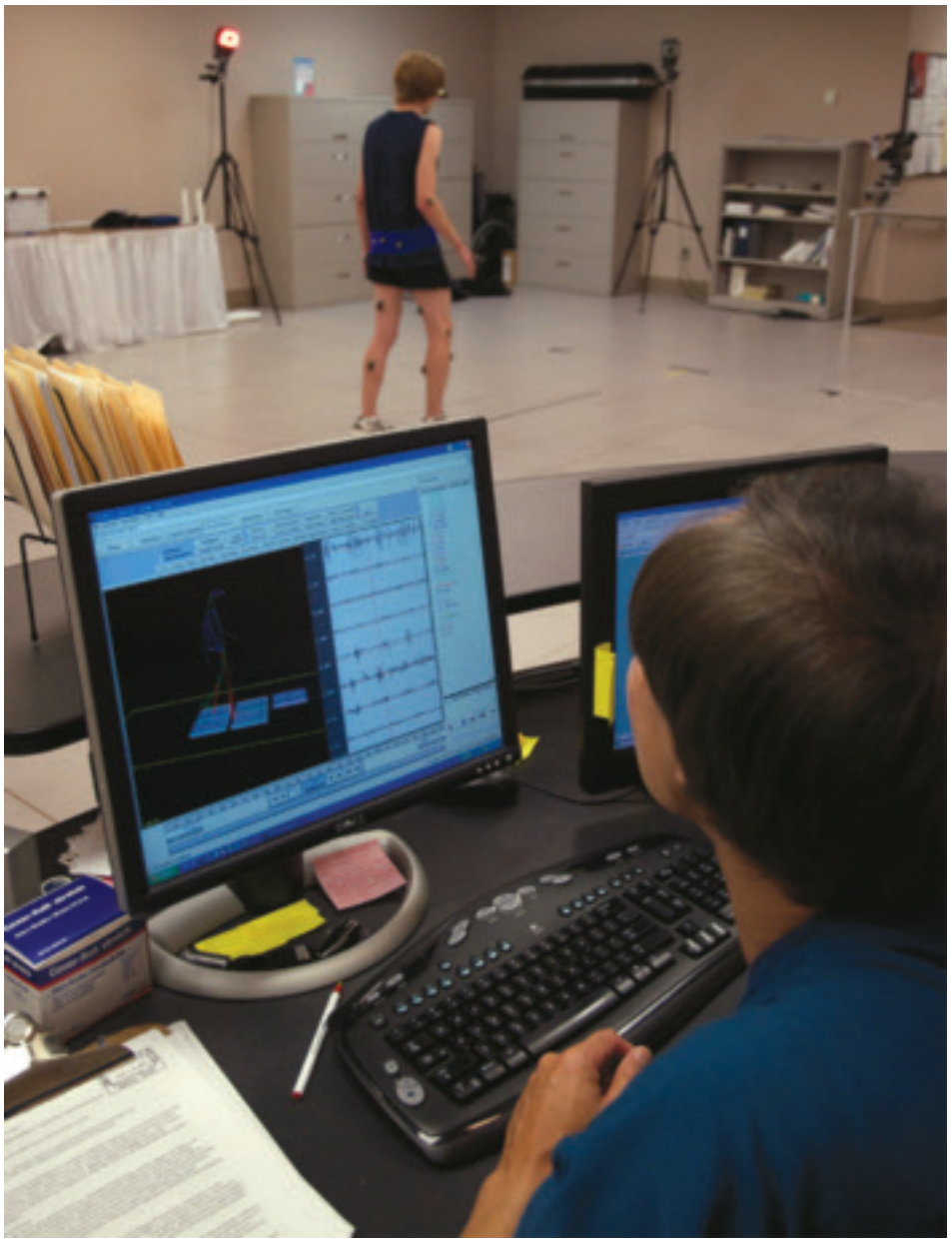
Dr. Dobrivoje Stokic, MD, DSc, administrative director of research at Methodist, elaborates: "The current results suggest that changes in gait after brain injury cannot be attributed to excessive stretch activity in calf muscles as some have proposed. In this study, what distinguished patients from control subjects was the co-activation between the opposing ankle muscles, which we interpreted as an adaptation to stabilize the ankle joint during step transition."

"These results suggest that targeting calf muscles to improve walking may not be the best approach for people like those we studied," said Dr. Yablon. "And more work is needed to see how different treatments affect co-activation before we can say whether co-activation is detrimental or beneficial for patients."

Future work will broaden this study to include the thigh muscles, as well as evaluating the swing phase of gait. The overall results are expected to assist clinicians in selecting the most appropriate treatment for improving gait after brain injury.

> "The current results suggest that changes in gait after brain injury cannot be attributed to excessive stretch activity in calf muscles as some have proposed. In this study, what distinguished patients from control subjects was the co-activation between the opposing ankle muscles, which we interpreted as an adaptation to stabilize the ankle joint during step transition."

— Dobrivoje Stokic, MD, DSc, administrative director of research at Methodist



John Chow, PhD, in the motion analysis lab


BIODEX
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How well can people hold steady muscle contraction after stroke?

RESEARCH SUGGESTS IMPAIRMENT IN BOTH QUADRICEPS MUSCLES SOON AFTER STROKE

After suffering a stroke, a primary goal of therapy is for the patient to regain basic functional activities, such as going from lying down to sitting and standing or getting in and out of a car. As easy as it may sound, to complete these tasks requires rather substantial effort and a great deal of muscle strength.

Regaining those basic activities are important goals in therapy, but what about tasks that require fine muscle control, low and steady muscle contraction over a short period of time? Examples might include carrying a tray with a glass of water, or walking, which requires the patient to support the whole body on one leg while taking the step with the other leg.

Hundreds of tasks important to quality of life require us to sustain fine-muscle control for a brief period of time.

The standard way to test a patient's strength is to ask the patient to maximally activate the muscle and record the result.

Researchers at Methodist Rehab approached it from a different angle. In daily life, low and steady muscle contraction is needed far more often than the maximal contraction. Yet fine gradation of muscle contraction has really not been examined in people after stroke.

In the first of a series studies, researchers led by John Chow, PhD, director of the Motion Analysis and Human Performance Laboratory at Methodist, examined fine gradation of force produced by the quadriceps muscle, the thigh muscle that mainly supports the body during walking.

The study included 30 patients who had suffered a stroke recently, and 20 age-matched healthy subjects. Each participant was asked to maintain a steady level of force over several short intervals. Researchers calculated the steadiness of muscle contraction with special instruments attached to the leg.

"The results were rather surprising," said Dr. Chow. "Not only did we find that thigh muscle contraction is less steady on the paralyzed side within two to three weeks of the stroke, but some unsteadiness was also found on what is typically considered the normal side."

Although surprising, a few previous studies reported bilateral changes in different aspects of motor function after a stroke. Changes in the normal side can be explained by the fact that the brain activity is altered in both hemispheres after stroke.

"There is much we have yet to determine, but our findings are immediately clinically relevant because patients and therapists should not assume that only one side of the body is affected early after stroke when it comes to maintaining a steady muscle contraction. So the therapy program should be geared toward both sides," said Dr. Dobrivoje Stokic, MD, DSc., administrative director of research at Methodist.

The results of the first study are published in the Journal of Applied Physiology, the publication of the American Physiological Society.

"Further research on this subject is needed," said Dr. Chow.

"Sensory function needs to be carefully examined since some preliminary observations suggest that impaired sensation may account for these results. We also want to find out if this limited ability to produce steady contraction changes over time. To do this, we plan to examine the same patients later in recovery."

Chow continued, "Of clinical relevance is to find out if these results are in some way related to activities of daily living, such as gait in terms of symmetry and variability. Also, we don't know whether our findings are specific to the muscle studied or if such changes can also be found in other muscle groups, such as the arm muscles. Our next study in this series will examine the biceps muscle in the arm and changes associated with different interventions."

2010-11 Publications & Presentations

(Methodist Rehab researchers' names in red)

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Publications

1. **Chow JW, Hirko RJ, Hemleben ME, Stokic DS**. Light curtain for detecting footfall instants during treadmill walking -an exploratory study. *Gait and Posture 2010;31:403-406.*
2. **Chow JW,** Yablon SA, Horn TS, **Stokic DS**. Temporospatial characteristics of gait in patients with lower limb muscle hypertonia after traumatic brain injury. *Brain Injury 2010;24:1575-1584.*
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6. **Gontkovsky ST,** Alexander, K, and Beatty, W. W. Neuropsychological sequelae of essential tremor: A differential comparison with Alzheimer's disease and Parkinson's disease. Brain *Research Journal 2010.*
7. Horn TS, Yablon SA, **Chow JW**, Lee JE, **Stokic DS**. Effect of intrathecal baclofen bolus injection on lower extremity joint range of motion during gait in patients with acquired brain injury. *Archives of Physical Medicine and Rehabilitation 2010;91:30-34.*
8. Levy CE, Buman MP, **Chow JW**, Tillman MD, Fournier KA, Giacobbi P, Jr. Use of power assist wheels results in increased distance traveled compared with conventional manual wheeling. *American Journal of Physical Medicine and Rehabilitation 2010;89:625-634.*
9. Martz E, Levnih H, **Gontkovsky ST, Stokic DS**. Psychosocial responses to spinal cord injury as predictors of pressure sores. *International Journal of Clinical and Health Psychology 2010;10:203-223.*
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12. Saulino MF, Yablon SA, Mober-Wolf E, **Chow JW, Stokic DS.** Intrathecal baclofen for spasticity. In: Brashear A, Elovic EP (eds). Spasticity: diagnosis and management. *New York: Demos Medical, 2010:229-242.*
13. Stetkarova I, Yablon SA, Kofler M, **Stokic DS**. Procedure- and device-related complications of intrathecal baclofen administration for management of adult muscle hypertonia: a review. *Neurorehabilitation and Neural Repair 2010;24:609-619.*
14. **Stokic DS**. Spasticity 30 years later: The truth is still in the eye of the beholder *[Editorial]. Clinical Neurophysiology 2010;121:1789-1791.*
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Orthotics & Prosthetics division gets involved in research

A NEW LOOK AT MOTOR FUNCTION IN PROSTHESIS USERS

The Orthotics and Prosthetics (O&P) division of Methodist Rehabilitation Center has recently joined forces with the research arm of Methodist, The Center for Neuroscience and Neurological Recovery, with the addition of a new research associate, Charla Howard.

Howard has an undergraduate degree in Biological Engineering from Mississippi State University and now is pursuing a graduate degree in Bioengineering and a prosthetist certification.

"It is exciting to be able to pull together a multi-disciplinary team," said Dobrivoje Stokic, MD, DSc, administrative director of research.

"There is a lot of potential in this area and we are getting involved at a good time. The combined resources of our departments promise to bring about useful and exciting discoveries."

Chris Wallace, director of Methodist O&P, has always seen the value of research and has been planning for years to establish a research line.

"Validating clinical practice and developing new ways to understand how amputees interact with a prosthetic device are the two main goals of our research venture," Wallace said. "We are excited about the opportunity to excel in both areas."

"It is great working with both clinicians and researchers," Howard said. "The research team is very knowledgeable about different methods for studying persons with disabilities, whereas our O&P group has deep clinical experience. It has been a lot of fun bringing such insightful people together."

The first endeavor by the O&P research team was supposed to be a simple project that would validate a generally understood premise.

Instead, something more exciting happened. "In this very first project, we ended up making discoveries that surprised us all," Howard said.

The project explored how amputation affects lower limb laterality in prosthesis users. Laterality refers to the preferential or dominant use of one side of the body, such as how most people prefer to write or throw a ball. This side preference also translates to the lower limbs, directing which foot people prefer to use to kick a ball or stomp on a bug. Typically, the foot used to perform these tasks is on the same side of the body as the preferred hand and is consistent across a variety of tasks.

It is widely believed that, despite strong preference in able-bodied persons, prosthesis users would alter their performance in order to avoid standing on the prosthetic side. This assumption is even the basis of some therapy techniques.

"We designed a study to examine these traditional assumptions and hypothesized that the assumptions would hold true," Howard said.

The study included 31 amputees and 19 able-bodied control subjects who were asked to perform 11 goal-oriented tasks involving their legs. The tasks were designed to require a specific motion in common tasks, such as kicking a ball, pressing a pedal to open a garbage can or wiping the floor.

"The results surprised us," Howard said. "Whereas the able-bodied people expectedly used the dominant leg in these tasks, the prosthesis users repeatedly switched between the prosthetic and intact leg. The switch to standing on the prosthetic leg was even more apparent when tested in parallel bars that provided opportunity for arm support. These findings were particularly evident among the people who were fitted with a prosthetic leg a long time ago.

"This study is exciting because it shows how conventional wisdom may not be supported by research findings and may have implications for clinical practice."

The study will increase awareness among clinicians about greater than anticipated use of the prosthetic leg for standing, even in difficult daily tasks.

"We plan to integrate these results into our training programs that encourage practicing different tasks with both intact and prosthetic legs in a variety of settings," Wallace said.

> It makes for a really practical research project. How often do we just walk and not engage in other activities? More often we are walking while talking to a friend, thinking about what we have to do that day or just looking for our keys. Dual task allows us to get a more realistic examination of how people walk during the day.

— Charla Howard, research associate

Walking while Talking

The depth of collaboration between clinicians and researchers is clearly seen in the most recent project tackled by the group. Dual tasking, the formal way of examining if someone can walk and chew gum at the same time, has been found very useful. In certain populations, the elderly, people with Parkinson's disease and stroke survivors, dual-task assessments were able to predict a risk for fall.

"To our surprise, dual task has not been utilized in studying people with a leg prosthesis. It did not take long to recognize its potential in the prosthetic field," Stokic said.

Howard elaborated, "It makes for a really practical research project. How often do we just walk and not engage in other activities? More often we are walking while talking to a friend, thinking about what we have to do that day or just looking for our keys. Dual task allows us to get a more realistic examination of how people walk during the day."

"We want to put our subjects in realistic situations that are not too challenging, but require sufficient concentration to complete other tasks while walking," Howard said.

The add-on tasks include subtracting by 7s, spelling words backwards and sorting through keys, all while walking.

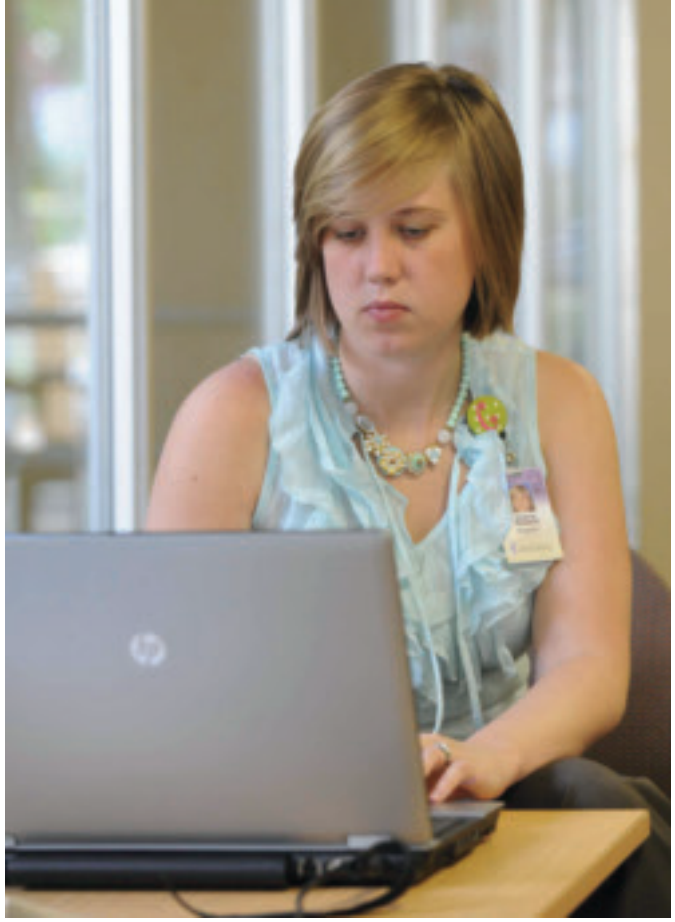
"The goal is to see if adding these tasks to walking alters the gait of prosthetic users, compared to able-bodied people," Stokic said. "Our hope is that it will increase the ability to detect changes in walking during the processes of rehabilitation and as adjustments to the prosthesis are made."

It is not just the researchers who enjoy the projects. The subjects of the studies, mostly prosthetic patients from the Methodist O&P clinics, appreciate it.

"I love having an opportunity to participate in these research studies in hopes that it might help to make a difference for other amputees in the future," said Lynn Gaddis, research participant and MRC employee. "I am amazed at the technological advances that I have witnessed since becoming an amputee. I like knowing that I can now contribute even more when the research is at my clinic."

The O&P research effort at Methodist is young, but the team has big plans to make its mark on the prosthetic and rehabilitation community.

"There are many research avenues for us to pursue," Wallace said. "We've already discovered that some of our commonly held assumptions may not be entirely correct. We need to look for new explanations that will help us help these patients with prosthetics to live as productive lives as possible."



Charla Howard with a research subject

The nature of weakness after traumatic brain injury

POSSIBLE DAMAGE TO PERIPHERAL NERVES SHOULD NOT BE OVERLOOKED

Restoration of motor functions after traumatic brain injury (TBI) requires a team of specialists and timely diagnosis of various motor impairments. One challenge for clinicians is to identify the cause of muscle weakness, which can be due to TBI itself or caused by damage to peripheral nerves.

That's why researchers at Methodist Rehab reviewed the records of more than 130 patients with TBI who were referred for electrodiagnostic testing to Art Leis, MD. Leis is a neurologist with certification in electrodiagnostic medicine and a senior scientist at Methodist's Center for Neuroscience and Neurological Recovery.

"It may be challenging to sort out the causes of muscle weakness after TBI because brain injury can mask evidence of damage to peripheral nerves," said Stuart Yablon, MD, study collaborator. Yablon formerly served as brain injury clinical program director and a senior scientist at Methodist.

Medical records were independently reviewed by Dr. Srbislav Stevanovic, a physiatrist from Rehabilitation Clinic in Belgrade, Serbia, who spent a month working on this project as a visiting scholar sponsored by the Wilson Research Foundation.

"This was a unique experience for me and great opportunity to participate in this research because I am both a TBI clinician like Dr. Yablon and an electromyographer like Dr. Leis. I was able to appreciate the challenges and significance of the problem from both angles," said Stevanovic.

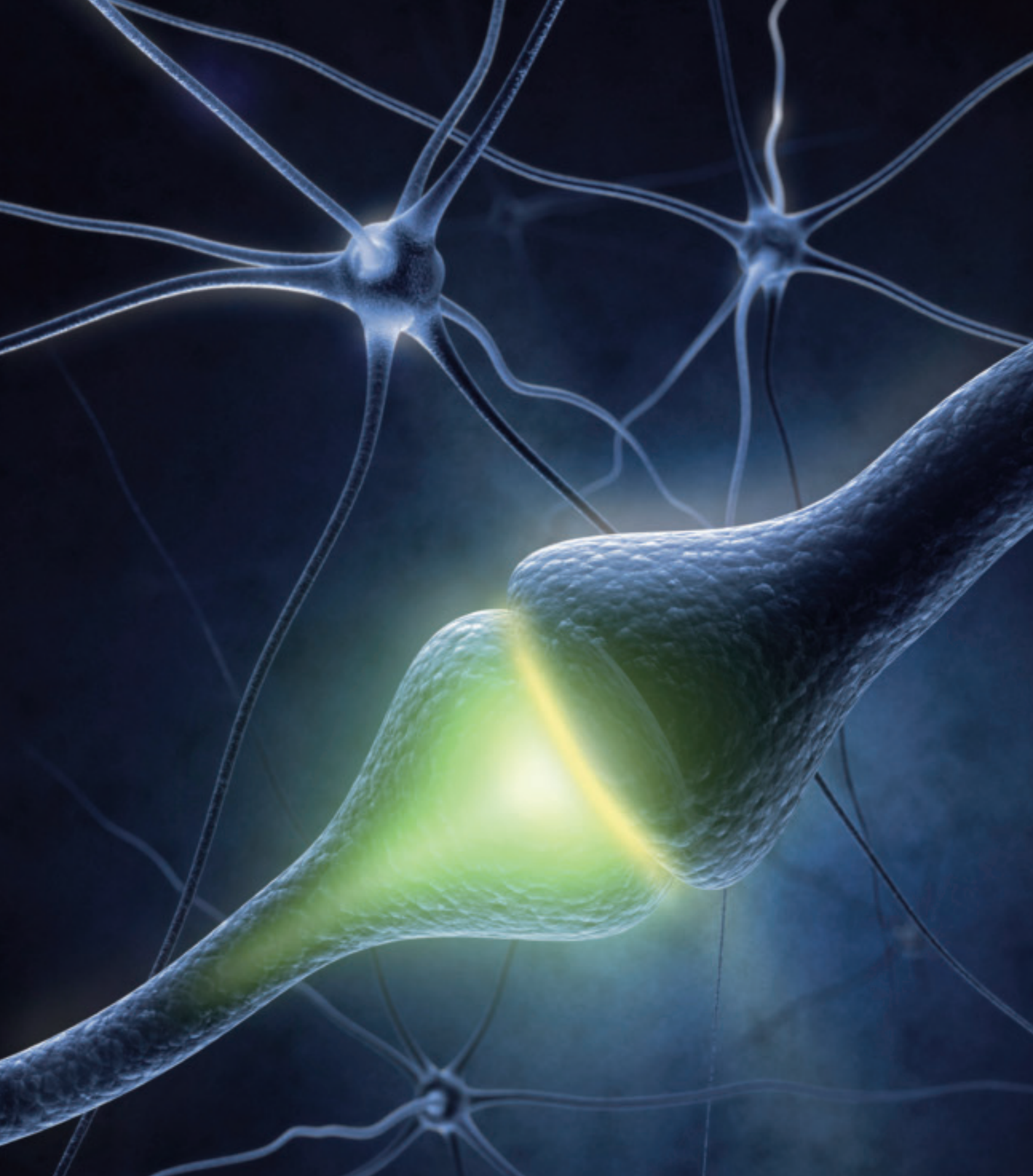
"Damage to peripheral nerves was found in two thirds of patients referred for EMG evaluation, and most of this damage was severe," Leis said. "Although plexopathy and radiculopathy are known to be associated with trauma, the high incidence of focal neuropathies indicates other possible causes and warrants further investigation."

The results were submitted for presentation at the 7th World Congress of Neurorehabilitation in Melbourne, Australia in May of 2012.

"We were able to identify some factors that seem associated with a higher incidence of damage to peripheral nerves after TBI, such as the associated limb fracture and a history of systemic disease, alcohol or tobacco use," said Dobrivoje Stokic, MD, DSc, administrative director for research at Methodist. "Prompt referral to a specialist can save time and alter the course of recovery."

These results suggest that clinicians should watch carefully for clues because damage to peripheral nerves can be masked or misinterpreted as a consequence of TBI, whether early or later in the course of recovery.

> "Although plexopathy and radiculopathy are known to be associated with trauma, the high incidence of focal neuropathies indicates other possible causes and warrants further investigation."
>
> *—Art Leis, MD, senior scientist*



> "The preliminary results are very much in agreement with observations made by patients who reported increased ability to use their affected arm in daily life."

—Jennifer Sivak, research occupational therapist

Armeo®Spring may extend recovery beyond outpatient therapy

BUT IS IT ABOUT NEW TECHNOLOGY OR DO WE STOP THERAPY TOO SOON?

Stroke patients thought to have reached a plateau in conventional outpatient therapy are seeing continued progress after participating in Armeo®Spring therapy to improve arm function.

These encouraging results come from an ongoing pilot study designed by Methodist researchers to evaluate the long-term impact of the Armeo®Spring system. The system pairs an assistive movement device with a computer gaming program.

In 2010, Methodist became one of only six centers in the Southeast – and the only one in Mississippi – to offer the new therapy that helps patients with arm paralysis or weakness due to stroke, brain or spinal cord injury. Now its research findings may play a role in determining treatment protocols for different types of patients and therapy settings.

"The research about the usefulness of devices like Armeo®Spring is in its infancy," said Dobrivoje Stokic, MD, DSc. "Even though the device is being introduced to clinical settings, there are many unknowns. It's important to know who are the appropriate candidates, when is the best time to start therapy, what is the optimal dose and the specifics of treatment."

Stokic said Armeo®Spring is based on the principles of activity-based therapy. In an engaging, problem-solving environment, patients do high repetitions of goal-oriented, life-like movements that become progressively more difficult. Exercise that includes a variety of related movements, the so-called distributed practice approach, results in better motor learning than simple repetition of the same movement.

Methodist Rehab has provided Armeo®Spring therapy to 30 patients as part of acute inpatient rehabilitation. The pilot research study, however, is focused on long-term outcomes.

"We are interested to find out if Armeo®Spring therapy may improve arm function beyond that achieved after completion of a typical outpatient therapy program," Stokic said.

The study patients attend Armeo®Spring therapy twice a week for 12 weeks. The evaluations are done to determine outcomes immediately after completion of 12 weeks of training, as well as six and 12 weeks later to determine persistence of outcomes.

The preliminary results indicate improvements in scores on Fugl-Meyer test, Action Research Arm test, and Stroke Upper Limb Capacity Scale after 12 weeks of therapy. Even more remarkable is that these improvements in arm function not only persisted after stopping therapy, but further functional improvements were noted.

"The preliminary results are very much in agreement with observations made by patients who reported increased ability to use their affected arm in daily life," said Jennifer Sivak, an occupational therapist involved in the project. "One of the patients reported holding a laundry basket with both arms for the first time, while another one was able to pick a baseball off the ground."

Stokic said the patients' experiences bring to light some important questions. "One thing that we have to consider is that outpatient therapy will typically conclude when the patient is considered to reach a 'plateau' in major functional activities," he said. "But has the patient's arm function truly peaked, did patients just adapt to the exercise program provided, or are we misled by assessments that make us believe that there is no room for further improvement? These questions will have to be revisited because we saw further functional gains after Armeo®Spring therapy in patients who presumably reached a plateau in conventional outpatient therapy."

"These results provide evidence of prolonged recovery after stroke and suggest that we should consider extending outpatient therapy for some patients," said Alyson Jones, MD, director of Methodist's stroke program.

The feedback-reward aspect of Armeo®Spring and its role in achieving functional gain also merits study. As one patient put it, "It is rewarding and motivating when you see that you do better over time, even a little bit better."

"Markers of brain cell inflammation and death that were released in the spinal fluid were higher in people infected with West Nile virus than in healthy subjects or patients with neurological diseases that do not produce inflammation."

—Art Leis, MD, senior scientist

West Nile virus infection may be more invasive than originally thought

NEW EVIDENCE SUGGESTS THAT BRAIN CELLS CAN BE AFFECTED EVEN IN MILD CASES

Years after recovery from the acute phase of West Nile virus infection, many people report excessive fatigue, sleep disruption, impaired memory and mood changes. Such symptoms may be experienced by the full range of West Nile patients, those who originally manifested with only a mild, flu-like form of the disease, as well as those who suffered severe neurological problems during the acute phase.

"These symptoms are difficult to attribute directly to West Nile virus infection," said Art Leis, MD, a senior scientist at Methodist Rehab and clinical professor of neurology at the University of Mississippi Medical Center. "They appear in many other diseases or just with aging. And more importantly, there is no specific treatment."

Methodist Rehab's groundbreaking work in the understanding of West Nile Virus infection has led to collaboration with Dr. Axel Petzold, internationally recognized expert from the University College of London's Institute of Neurology in London, United Kingdom.

Dobrivoje Stokic, MD, DSc, administrative director of research at Methodist, attended the conference where Petzold presented on the usefulness of analyzing proteins that are released to the spinal fluid and blood as a result of brain disease. From this conference, a rich collaboration formed.

The Mississippi Department of Health provided more than 150 samples of spinal fluid and blood that were sent to London for blind analysis. These results were later combined with the clinical data to complete the study at Methodist.

The first paper described findings in the spinal fluid and was published in 2010 in Muscle & Nerve, the official journal of the American Association of Electrodiagnostic Medicine.

"Markers of brain cell inflammation and death that were released in the spinal fluid were higher in people infected with West Nile virus than in healthy subjects or patients with neurological diseases that do not produce inflammation," Leis said.

"What came as a surprise was these markers were abnormally high in a large proportion of patients regardless of whether they had obvious neuroinvasive disease or just West Nile virus fever."

"It has been a great experience to expand my research into the area of West Nile virus disease," Petzold said. "Working with Dr. Leis and Dr. Stokic made me realize that the scope of this disease is still not fully appreciated."

In the follow-up study, the blood samples from other West Nile patients were identically analyzed and the results were similar. The biomarkers of brain inflammation were abnormally high in the blood in about half of the patients with neuroinvasive disease and about one-third of patients who only experienced a mild flu-like illness. This paper will soon appear also in Muscle & Nerve.

"The elevated biomarkers in both spinal fluid and blood of patients presenting with West Nile fever implies that the nervous system is invaded in a much higher proportion of patients than anticipated by clinical and epidemiological data," Stokic said.

"We hypothesize that this 'milder' form of neuroinvasive disease could be the substrate for symptoms observed in a high proportion of these patients," Leis said. "These symptoms are often vague, difficult to evaluate and treat, and receive little, if any, medical attention. Therefore, we hope that our findings will raise awareness about these not well studied issues that may severely interfere with quality of life in West Nile Virus survivors."

Dr. Leis concluded. "The overall findings suggest that many cases classified as West Nile fever may be neuroinvasive despite the absence of overt neurological deficits. This provides a compelling argument for reviewing the criteria used to distinguish neuroinvasive from non-neuroinvasive West Nile virus disease."

"As a dental hygienist, I always wondered how difficult it is for people with disabilities to maintain proper oral care. That's what prompted me to propose for my doctoral thesis a study of oral health in people with spinal cord injury."

—Amy L. Sullivan, PhD, Associate Professor at the University of Mississippi Medical Center, School of Health Related Professions, Dental Hygiene

Oral health is inadequate after spinal cord injury

STUDY IDENTIFIES LESS SUSPECTED RISK FACTORS

One of the main goals of rehabilitation after spinal cord injury is prevention and treatment of secondary complications that may arise years after injury, such as pressure sores or urinary tract infections. Less attention is paid to other health issues that can make these complications worse or more frequent.

"As a dental hygienist, I always wondered how difficult it is for people with disabilities to maintain proper oral care. That's what prompted me to propose for my doctoral thesis a study of oral health in people with spinal cord injury," said Amy L. Sullivan, now PhD and Associate Professor at the University of Mississippi Medical Center, School of Health Related Professions, Dental Hygiene in Jackson, MS.

Sullivan did not have to look far. She turned to researchers at Methodist Rehab who agreed to conduct a joint study.

"Admittedly, oral health is not among the top ten issues when it comes to care of people with spinal cord injury," said Dobrivoje Stokic, MD, DSc, administrative director for research at Methodist. "It comes at no surprise then that the scientific literature on this topic is scarce."

The researchers evaluated teeth and gums of 92 people with spinal cord injury, including residents of Methodist Rehab's long-term residential facility for persons with severe disabilities. To identify risk factors for poor dental health, they related the oral health to the ability of the subjects to use their arms or use of mouth sticks instead; use of tobacco, life satisfaction and other factors.

"We confirmed what I suspected, that people with spinal cord injury are disproportionately likely to have more gum disease, tooth cavities and missing teeth," said Sullivan.

"What came as a surprise was that oral habits, such as tobacco or mouth-stick use, turned out to be significant risk factors for worse dental health, compared to the subjects' ability to use their arms."

Stokic points out that this is consistent with research findings of many secondary complications after spinal cord injury.

"This study provides further evidence that psycho-social factors are more important for maintaining health than the ability to personally carry out daily activities, like cleaning teeth." Stokic said. "The results also point to the critical role of caregivers at home and institutional settings for people who need assistance with these activities of daily living."

"The results of this study are significant for managing patients after spinal cord injury," said Samuel Grissom, MD, medical director and spinal injury program director at Methodist. "The gum disease and cavities can be a source of bacteria that can spread throughout the body, infect other organs, or slow down healing."

According to Sullivan, provision of dental care to people with spinal cord injury is particularly challenging considering environmental barriers and access to dental care.

"Specialized set-up and additional training are needed to better appreciate and serve the needs of this unique population," she said. The manuscript describing the results of this study is in preparation.

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