A quest to prevent falls and save lives

The national importance of fall prevention

"If our research can save even one life, it will all be worthwhile," said Thurmon Lockhart, an associate professor in the Grado Department of Industrial and Systems Engineering in Virginia Tech's College of Engineering, discussing his efforts to find ways to prevent falls among the elderly.

John Sutphin, a resident of the Southwest Virginia Training Center, a facility that hosts individuals with cognitive disabilities, is suited up in the slip-and-fall harness in Lockhart's Locomotion Research Laboratory. A data study found that the number of falls and resulting deaths among the center residents were comparable to the number among people in nursing homes. Training center residents were tested in the locomotion lab and Lockhart and his students devised exercise routines aimed at reducing the number of falls.

Capitol Hill agrees with Lockhart about the critical importance of this type of research. The U.S. Congress recently passed and President Bush signed Senate Bill 845, the Safety of Seniors Act of 2007, which directs the Secretary of Health and Human Services to expand research programs related to preventing elder falls.

"This legislation is timely," Lockhart said. "Falls and resulting deaths have been increasing." Falls are the leading cause of accidental deaths in the United States among people over the age of 75 and the second leading cause for those aged 45 to 75, according to the National Safety Council, and the number of fatalities due to falls increased steadily from 14,900 in the year 2000 to 17,700 in 2005.

Since coming to Virginia Tech and founding the Locomotion Research Laboratory, Lockhart — who is an affiliate faculty member of the Virginia Tech Center for Gerontology and the Virginia Tech-Wake Forest University School of Biomedical Engineering and Sciences — has devoted much of his time to learning how to prevent falls by investigating the relationship between aging and falling.

About five years ago in the lab, with funding from the Centers for Disease Control and Prevention and the National Institutes of Health, Lockhart and his student research assistants began suiting up young and old volunteers in a harness and a network of sensors that test musculoskeletal and neuromuscular changes and biomechanical responses during slips and recoveries.

As a test subject walks along an experimental platform in Lockhart's lab, the sensors monitor muscle and joint activities in the feet, ankles, legs, hips, and arms. At a random moment, a student quietly sprays a slippery substance on the platform behind the subject. On the way back, the subject slips and goes through the motions of recovery (an actual fall is prevented by the harness)

All the data from the monitoring sensors is fed into a computer model, providing information about the subject's gait while walking and the motions involved during slipping and recovery. Much of the success of the data collection is the result of the work of industrial and systems engineering Ph.D. student Jian Liu, from China, who for three years has been developing new and improved computer models for the lab.

"An important factor in our research is understanding the intrinsic changes to gait and balance brought about by aging," Lockhart said. "As we age our walking gait changes. For example, we might take slower and shorter steps, making a higher velocity contact impact with our heels — which in turn seems to make slipping and falling more likely."

Linda Frazier, a volunteer in Lockhart's Locomotion Research Laboratory, is outfitted with motion sensors and a wrist monitor system that can detect gait instabilities that might lead to falls. Working on a National Institute on Aging-sponsored project with AFrame Digital Inc., Lockhart and graduate student Jian Liu developed the wrist monitor for tests in the locomotion lab and in nursing homes. The ultimate goal is a comfortable monitor that can alert wearers and caretakers of potential falls.

Solving the mysteries of stability and mobility

A number of projects focused on elder falls have followed those earlier studies. Lockhart collaborated on an investigation of the "dynamic stability" differences between fall-prone and healthy adults with the late Kevin Granata, a professor of engineering science and mechanics and co-director of the Musculoskeletal Biomechanics Laboratory, who died on April 16, 2007.

"Our study showed that the fall-prone group demonstrated poorer dynamic stability — or stability while walking — than healthy elders and young adults," Lockhart said. "One interesting finding was that stability was not influenced by walking speed." Walking, as Lockhart pointed out, is actually controlled falling — and much depends on the stability of a walker's gait.

John Lach, an associate professor at The University of Virginia, is developing special accelerometers (sensors that detect changes in speed and direction of motion) for another of Lockhart's projects.

"Subjects wearing the accelerometers will be monitored in daily living simulations in the locomotion lab," Lockhart explained. "They'll sit, stand, simulate kitchen chores, and other activities associated with all areas of the home." The tests also will include induced falls on the harness platform.

In June 2007, Lockhart traveled to Sweden at the invitation of researchers at the University of Gothenburg to begin collaboration on an International Mobility Index. The Swedish research group, which includes Nobel Laureate Arvid Carlsson, has been collecting data on mobility since the 1970's.

The goal is to develop an index that can be accessed around the world and will enable health care providers to determine how likely people are to fall, as well as indicate specific problems such as brain atrophy, Lockhart said. His job, back at the locomotion lab, will be to devise a system with sensors and a computer network that can test and measure levels of mobility.

For more information on this topic, e-mail Lynn Nystrom, or call (540) 231-4371.

Multimedia

In Lockhart's Locomotion Research Laboratory data is collected from human subjects on the test platform, slipping while equipped with motion sensors and a harness.

View a slip experiment with a volunteer (MOV | 3MB)

Then, the data is transferred to a computer model of the slip.

View the slip experiment model (MOV | 2MB)

Staggering numbers

"As many as 50 percent of people over [age] 75 will either die or be forced to enter institutional care because of falls," said Lockhart.

"About one-third of the elderly living at home fall each year and one in 40 are hospitalized. Of those admitted to the hospital, only about 50 percent will be alive one year later. What I want to find out is why these falls happen."

Related research

Trip recovery With funding from the National Institute for Occupational Safety and Health and other agencies, Michael Madigan, an associate professor of engineering science and

mechanics at Virginia Tech, has been investigating the causes and prevention of trip-related falls among the elderly.

One mystery Madigan and his students have studies in the Kevin P.Granata Musculoskeletal Biomechanics Laboratory is what happens during attempted trip recovery.

"A significant number of falls occur even though people of all ages are able to take a step after tripping to recover their balance," said madigan. "But do older people have to use a larger portion of their strength in an attempt to recover?"

Read more about Madigan's research

Distance vision As we age, the lens of our eyes become less flexible and less able to see objects clearly at various distances. This loss, called presbyopia, can reduce driving performance and increase the risk of automobile accidents.

"Presbyopia can pose real safety problems for elderly drivers who find it difficult to read instrumentation and dashboard control panel displays, like the 'door ajar' symbol," said Lockhart, who has conducted research on the problem for Toyota Motor Co.

Read more about this project

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