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A CHARM-ed Beginning:

Neurosurgeon Works on Monitor to Help Patients with Traumatic Brain Injuries

Every day, thousands of people nationwide are hospitalized or treated in emergency rooms as a result of traumatic brain injuries (TBIs), from mild concussions to the most severe cases. Yet the initial incident may not be the sole determining factor in a patient's outcome. Instead, it's what comes in the days after that injury that could have the most impact.

The reason lies in part with the body's normal healing response. With the limited space available in the skull, the accumulation of extra nutrients and fluid in the brain as part of the healing process can cause dangerous swelling, reducing the flow of oxygen-rich blood and injuring parts of the brain not impacted initially.

These secondary injuries often are more damaging than the initial trauma. And because they happen gradually—usually within the first 48 hours, but as long as five days after the injury—knowing the best time for treatment to prevent the swelling has been a challenge.

BY BETH-ANN KERBER

Portraits by John Emerson

“Our goal is to help attending physicians make informed therapeutic decisions during TBI treatments by providing continuous, accurate predictive information,” says William Craelius, PhD, professor of biomedical engineering at Rutgers.

“Treatments exist, but it is difficult to predict when they should be applied, since we don’t fully understand what triggers the swelling. As a result, treatment often comes too late,” says Shabbar F. Danish, MD ’01, assistant professor of neurosurgery at Robert Wood Johnson Medical School.

Frustrated by a lack of real-time measures to predict such swelling and eager to find a way to improve outcomes for his patients, Dr. Danish sought a solution in his work as a mentor for students in the senior design project curriculum of the Department of Biomedical Engineering at Rutgers, The State University of New Jersey.

Dr. Danish presented Alex Krasner, then a Rutgers undergraduate, with the challenge: create a device and the software that could provide such real-time data. The end result was a prototype that serves as the basis for the Continuous Hemodynamic Autoregulation Monitor (CHARM).

Now Dr. Danish is serving as coinvestigator with William Craelius, PhD, professor of biomedical engineering at Rutgers, on a three-year, $539,000 grant from the New Jersey Commission on Brain Injury Research (NJCBIR) to further develop this prototype.

Testing the Clinical Application

“This study expands on the senior design project work and will put it to use in the clinical environment. It is about perfecting the CHARM unit and giving clinicians data they can follow to better treat these patients,” notes Dr. Danish, who is also the director of stereotactic and functional neurosurgery at the medical school and director of the Gamma Knife Center at Robert Wood Johnson University Hospital.

Once developed, CHARM units will be installed in the critical care units at Robert Wood Johnson University Hospital and JFK Medical Center—where Steven V. Escaldi, DO, clinical assistant professor of physical medicine and rehabilitation and medical director, Outpatient Spasticity Clinic at JFK Johnson Rehabilitation Institute, will assist with providing and interpreting patient data for the study. The unit will be developed at Rutgers' Biomechanics and Rehabilitation Engineering Laboratory, where Krasner is studying for his master of science degree under the supervision of Dr. Danish and the laboratory's director, Dr. Craelius.

"Our goal is to help attending physicians make informed therapeutic decisions during TBI treatments by providing continuous, accurate predictive information," says Dr. Craelius, the study's principal investigator.

By developing an intelligent monitor of blood supply to the brain that will help guide therapeutic interventions after TBI, the researchers are hoping to develop a method to predict the swelling up to an hour before it occurs, Dr. Craelius adds.

Understanding the Process

Under normal circumstances, the body is able to maintain a relatively constant flow of blood to the brain due to the protective process known as autoregulation. However, after a traumatic brain injury, that ability is often lost. If there's too little pressure, the brain tissue can become ischemic (not enough blood flow); too much, and the intracranial pressure increases. Either can mean secondary injuries resulting in disability or even death.

The CHARM units are designed to continuously monitor the brain's ability to autoregulate cerebral pressure, so that information can be reported efficiently to clinicians during treatment, resulting in better clinical interventions, Dr. Craelius says.

"The actual values and their potential meanings are known, but there has not been a well-established way to collect the data and perform real-time analysis. This device would allow us to do that," Dr. Danish adds.

Though in its earliest stages—the NJCBIR grant began in June—this research addresses a growing problem in the state, as well as nationwide. Between 12,000 and 15,000 New Jersey residents suffer brain injuries from traumatic events each year, of which 1,000 are fatal, NJCBIR statistics indicate. In addition, approximately 175,000 people in the state currently live with disabilities resulting from TBIs.

In comparison, nationally, at least 1.7 million TBIs occur each year, with 237,000 people hospitalized with moderate to severe TBI and 52,000 resulting deaths, according to the Centers for Disease Control and Prevention—a mortality rate of about 3 percent, compared to New Jersey's 7 percent.

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The Power of Collaboration

This new research collaboration epitomizes the synergies inherent in the closer ties now between the medical school and Rutgers—combining the expertise of the neurosurgeons and physiatrists involved in the clinical care of patients who have TBIs with engineers' technical expertise needed to create the device and develop the software program to achieve the project's goals.

And it is a natural outgrowth of the clinical and research missions of the medical school.

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