

# Neurorehabilitation Updates

Collaborative care, innovative approaches, and research-driven therapies to help patients get back to their lives.



Kennedy Krieger Institute  
UNLOCKING POTENTIAL

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## A Word from the Director

Frank S. Pidcock, MD, Vice President of Rehabilitation at Kennedy Krieger Institute, Director of the Pediatric Rehabilitation Division in the Department of Physical Medicine & Rehabilitation, Johns Hopkins Hospital



In this issue of *Neurorehabilitation Updates*, we explore disorders of consciousness (DOC), which are characterized by severely altered arousal or awareness of the self and the environment. DOC include coma, vegetative state, and minimally conscious state. A case is described of a child with an anoxic brain injury who emerged from a minimally conscious state over a two-month period. Serial standardized assessment of her responsiveness, medications, and spasms provided essential information to her primary rehabilitation team.

Stacy Suskauer, MD, Director of Brain Injury Rehabilitation Programs at Kennedy Krieger

Institute, leads an innovative team that is investigating and refining the way patients with DOC are managed in the inpatient setting. This “low responsiveness team” includes pediatric rehabilitation medicine, neuropsychology, behavioral psychology, and brain injury therapists. Behaviors relevant to return of consciousness are collected in a standardized, detailed manner and analyzed. The low responsiveness team meets weekly to develop recommendations for adjustments to the therapeutic regimen for each patient, based on analysis of the data. Under Dr. Suskauer’s guidance, members of the team have presented widely to professional audiences and been published in several journal articles about DOC patients. They fill a critical gap in our understanding of this fragile neurologic state and bring “best practice thinking” into the discussion about care for these patients.

Other topics covered in this issue include Dr. Suskauer’s connection to the NFL through her work in assessing effects of concussion in athletes and a description of how a popular cultural phenomenon, the Zombie Run, has helped raise money for support of brain injury programs at Kennedy Krieger Institute.

Watch for future issues of *Neurorehabilitation Updates*, in which we will continue to highlight the latest research and treatment options in neurorehabilitation. If you have any questions or would like to learn more about any of our services, please call our **Physician Referral Line** at 443-923-9403.

### Rehabilitation Specialty Programs at Kennedy Krieger Institute

Kennedy Krieger Institute has a wide variety of rehabilitation programs to meet the needs of patients at all levels. For a complete listing, please visit [kennedykrieger.org](http://kennedykrieger.org).

### Pediatric Inpatient Rehabilitation Program

- Brain injury
- Medical rehabilitation
- Pain rehabilitation
- Post-orthopedic surgery
- Spinal cord injury

### Outpatient Rehabilitation Programs

- Brachial Plexus Clinic
- Brain Injury Programs:
  - Brain Injury Early Assessment
  - Brain Injury Responsiveness Program
  - Interdisciplinary Brain Injury Clinic
  - Neurorehabilitation Concussion Clinic
- Community Rehabilitation Program
- Constraint-Induced and Bimanual Therapy Program
- Cranial Cervical Clinic
- Focused Interdisciplinary Therapy Program
- International Center for Spinal Cord Injury
- Limb Differences Clinic
- Orthopedics Clinic
- Pediatric Pain Rehabilitation Clinic
- Phelps Center for Cerebral Palsy and Neurodevelopmental Medicine
- Philip A. Keilty Center for Spina Bifida and Related Conditions
- Physical Medicine and Neurorehabilitation Clinic
- Specialized Transition Program Day Hospital

### Related Services and Clinics

- Aquatic Therapy Program
- Assistive Technology Clinic
- Audiology Clinic
- Behavioral Psychology Program
- Movement Disorder Clinics
- Neuropsychology Outpatient Clinics
- Nutrition and Weight Management Clinic
- Occupational Therapy Clinic
- Pediatric Psychology Clinic
- Physical Therapy Clinic
- Seating Clinic
- Speech and Language Clinic

# Emerging Consciousness in Complex Brain Injury

Charnira Berry is lucky to be alive. At the age of 10, she went into cardiac arrest and sustained an anoxic brain injury. At the hospital, she was non-responsive and needed advanced cardiac life support. Doctors told her family she would likely remain in a vegetative state.

After her family sought a second opinion at Johns Hopkins, doctors treated Charnira's underlying heart condition and referred her to the Brain Injury Unit at Kennedy Krieger Institute, which

specializes in increasing the responsiveness of patients who are in a minimally conscious or vegetative state due to acquired or traumatic brain injury.

"It's not uncommon for these patients to have gotten a very poor prognosis," says Beth Slomine, a neuropsychologist and

co-director of the responsiveness program. The program is also directed by Adrianna Amari, a behavioral psychologist, and Stacy Suskauer, a pediatric rehabilitation physician. Dr. Suskauer also leads the Brain Injury Rehabilitation Programs at Kennedy Krieger.

"When patients are admitted, we look very closely for evidence of responses to the environment," says Dr. Slomine. "It takes a careful approach. If you're not watching closely, you might miss subtle signs of responsiveness, and if that happens, patients may not get the rehabilitation they need."

**For patients like Charnira, specialists use a three-tiered approach of medication management, individualized assessment of sleep/wake cycles and responsiveness, and identification of activities, objects, or people that promote responding.**

Charnira, like many patients with brain injuries, was on multiple sedating pain and seizure medications when she was admitted, making it difficult to assess consciousness. Charnira also had frequent myoclonic spasms, further complicating her case.

"Weaning off the medication had to be done very carefully because we didn't want to increase spasms or cause seizures. But at the same time, we wanted her to be more awake," says Dr. Slomine.

Each time a medication was changed, the team systematically observed and charted the effects, which were then used to guide further medication adjustments. As Charnira was weaned from sedating medication, her arousal and responsiveness increased. In this minimally conscious state, Charnira began following some commands, though inconsistently.

At the same time, behavioral psychologists talked with the family to identify items that Charnira might respond to, like a favorite CD, a photo of a favorite teen idol, and a scented cherry lotion that she used before her injury. The team experimented with different stimuli, and tracked

the results. Charnira responded best to voices of her family, so an audio recording of family voices was incorporated into her therapy.

Charnira began emerging into a more conscious state and was able to consistently interact with her environment and others. After several months of rehabilitation, Charnira was medically stable enough to return home. She continued her therapy in the Institute's therapeutic day program and now attends school at Kennedy Krieger. Now 15, Charnira is consistently responsive and can walk with a walker, speak a few words, and communicate with a voice output device.



**Specialists in the Brain Injury Unit brought Charnira back from a minimally conscious state.**

*Charnira continues to receive therapy to meet her needs at Kennedy Krieger Schools.*



## From Bench to Bedside

*Kennedy Krieger's clinicians and researchers are leaders in the worldwide effort to prevent and treat disorders of the brain, spinal cord, and musculoskeletal system. Our investigators continue to break new ground with innovative imaging technology, investigate critical areas, and develop new treatment models and therapies. Selected recent research on brain injury-related topics includes:*

### Functional outcomes in children with abusive head trauma receiving inpatient rehabilitation compared with children with nonabusive head trauma.

Risen SR, Suskauer SJ, Dematt EJ, Slomine BS, Salorio CF.  
*The Journal of Pediatrics*. 2014 Mar;164(3):613-619.e2. doi: 10.1016/j.jpeds.2013.10.075. Epub 2013 Dec 8.

### Functional status of children with encephalitis in an inpatient rehabilitation setting: a case series.

Tailor YI, Suskauer SJ, Sepeta LN, Ewen JB, Dematt EJ, Trovato MK, Salorio CF, Slomine BS.

*Journal of Pediatric Rehabilitation Medicine*. 2013;6(3):163-73. doi: 10.3233/PRM-130248.

### Rationale, timeline, study design, and protocol overview of the therapeutic hypothermia after pediatric cardiac arrest trials.

Moler FW, Silverstein FS, Meert KL, Clark AE, Holubkov R, Browning B, Slomine BS, Christensen JR, Dean JM.

*Pediatric Critical Care Medicine*. 2013 Sep;14(7):e304-15. doi: 10.1097/PCC.0b013e31828a863a.

### Time to follow commands remains the most useful injury severity variable for predicting WeeFIM® scores 1 year after paediatric TBI.

Austin CA, Slomine BS, Dematt EJ, Salorio CF, Suskauer SJ.

*Brain Injury*. 2013;27(9):1056-62. doi: 10.3109/02699052.2013.794964. Epub 2013 Jun 19.

### Physical Abilities and Mobility Scale: reliability and validity in children receiving inpatient rehabilitation for acquired brain injury.

Trovato MK, Bradley E, Slomine BS, Salorio CF, Christensen JR, Suskauer SJ.

*Archives of Physical Medicine and Rehabilitation*. 2013 Jul;94(7):1335-41. doi: 10.1016/j.apmr.2012.12.004. Epub 2012 Dec 16.

### Update on pharmaceutical intervention for disorders of consciousness and agitation after traumatic brain injury in children.

Suskauer SJ, Trovato MK.

PM & R. 2013 Feb;5(2):142-7. doi: 10.1016/j.pmrj.2012.08.021. Review.

### Examining acute rehabilitation outcomes for children with total functional dependence after traumatic brain injury: a pilot study.

Kramer ME, Suskauer SJ, Christensen JR, DeMatt EJ, Trovato MK, Salorio CF, Slomine BS.

*The Journal of Head Trauma Rehabilitation*. 2013 Sep-Oct; 28(5):361-70. doi: 10.1097/HTR.0b013e31824da031. PMID:22613944

For a list of additional recent rehabilitation research at Kennedy Krieger Institute, please visit [rehabilitation.kennedykrieger.org](http://rehabilitation.kennedykrieger.org).



## Zombie Run Partnership Helps Kids with Brain Injuries & Disorders at 30+ Runs Nationwide

Kennedy Krieger is the national charitable partner of The Zombie Run—a unique series of 5k obstacle races held around the country from March through November.

Participants and teams can support research and care for kids battling brain injuries and disorders nationwide. For more information, visit [kennedykrieger.org/Brain](http://kennedykrieger.org/Brain).





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## Advances in the Management of Birth Brachial Plexus Palsy

Management of infants and children with birth brachial plexus palsy (BBPP) has changed significantly over the past two decades. Innovative neurosurgical and orthopedic techniques including nerve grafting, nerve transplants, and complex muscle transfers are now available. Post-surgical rehabilitation integrated into the treatment program is recognized as a key to success for many children. Kennedy Krieger Institute uses a comprehensive and multidisciplinary approach to BBPP management. The team includes a neurosurgeon, a plastic surgeon, an orthopedic surgeon, occupational therapists, and a pediatric physiatrist with expertise in the treatment and management of BBPP. Evaluations and treatment recommendations are available by calling **443-923-9403** or emailing [findaspecialist@kennedykrieger.org](mailto:findaspecialist@kennedykrieger.org).



## New Physician Joins Spinal Cord Injury Program

Kennedy Krieger Institute is pleased to announce the addition of Philippines G. Cabahug, MD, to the Institute's International Center for Spinal Cord Injury.

Dr. Cabahug comes to Kennedy Krieger after a residency in physical

medicine and rehabilitation at the Johns Hopkins University School of Medicine, where she served as chief resident from 2011 to 2012. Dr. Cabahug's research interests include spasticity management and aging in spinal cord injury, and the use of vibration plates in spasticity management.

## NIH Awards NFL Funds to Institute to Study Concussion Biomarkers

The National Institutes of Health (NIH) announced that a research study at Kennedy Krieger Institute is among eight projects to receive financial support to answer some of the most fundamental questions about traumatic brain injury. Under the direction of principal investigator Stacy Suskauer, MD, director of the Brain Injury Rehabilitation Program at Kennedy Krieger, this new research study will focus on assessing youth sport-related concussion and recovery using somatosensory processing.

The study is funded by the NIH in partnership with the National Football League (NFL), which donated \$30 million toward research studies on injuries affecting athletes, especially traumatic brain injuries.

Currently, there is no objective tool or test to reliably identify concussions, or to predict who will recover quickly, who will develop long-term symptoms, and who will develop progressive brain degeneration, called chronic traumatic encephalopathy (CTE).

Dr. Suskauer and her colleagues will investigate whether somatosensory system information processing (SSIP) could be used as a biomarker for concussion and recovery in youth aged 13-17. The researchers will also investigate whether changes in SSIP are related to differences in certain brain chemicals after head injury.

More information about the study is available at [participateinresearch.kennedykrieger.org](https://www.kennedykrieger.org/participateinresearch).

*Dr. Suskauer (right) with a research participant using a device to measure somatosensory processing after concussion.*

