

## Rehabilitation

### Offers a Full Life After Limb Loss

**F**or patients who lose a limb, amputation is just the first challenge—most then face a long road of recovery with a prosthesis. A comprehensive program in amputee rehabilitation led by **Marlis Gonzalez-Fernandez**, vice chair of clinical operations, helps patients avoid amputation becoming a lifelong disability.

One goal of the program is to help each patient use an appropriate prosthesis as soon as possible. The first step is a postsurgical appointment immediately after the amputation has healed. During that appointment, a multidisciplinary team that could include rehabilitation physicians, physical and occupational therapists and prosthetists, based on the patient's needs, meets with the amputee and family members to help select the best prosthetic device.

"The work we do can't be separated from the life that person wants to live," explains Gonzalez-Fernandez. "You can imagine that the prosthesis for a 20-year-old who has been injured in combat and wants to walk again might be different from a geriatric patient who had a limited capacity to walk before an amputation happened."

Patients have a wide range of prosthetic technologies to choose from. While prosthetics decades ago were only body-powered devices, many available today are technologically advanced, with sensors that enable the device to mimic the original limb's function.

For example, prosthetic legs may include knees with microprocessor computers that use information from the other leg or the environment to move accordingly. Other prosthetic knees have accelerometers that allow wearers to change speed quickly without the knee buckling, or gyroscopes that help maintain balance. Robotic ankles can also aid in preventing falls on unstable terrain, such as gravel. Such components are appropriate for patients who want to maintain a high level of activity on a daily basis.

Similarly, high-tech hands—some developed in part by Johns Hopkins University's Applied Physics Laboratory—are providing unprecedented

control. To help control these devices, Johns Hopkins is one of a few hospitals that offer a technique called targeted muscle reinnervation (TMR). This surgical intervention re-routes nerves that once controlled the hand, making it possible for people who have undergone upper-limb amputations to have better, more intuitive control of electronic prostheses.

In addition to the services provided after amputation, the rehabilitation program provides pre-amputation evaluation for patients such as those who need an amputation for tumors or infections. By seeing patients before surgery, Gonzalez-Fernandez says, she and her colleagues can help patients better cope with the loss by understanding the options available for rehabilitation. She helps to shift the focus from the amputation to the functions that required use of the limb. This way, she can determine the best device that will allow the patient to continue performing activities.

"Although we can't give them back their leg or their arm, losing a limb doesn't have to limit what they do in life," Gonzalez-Fernandez says. "When we get patients back to doing the things they really love, we've done our job."

Marlis Gonzalez-Fernandez helped Andrew Rubin prepare for an amputation and then supported him throughout his rehabilitation. He is now training for a triathlon.



Watch Marlis Gonzalez-Fernandez discuss this 47-year-old patient who underwent a below-the-knee transtibial amputation at [bit.ly/MarlisCaseStudy](http://bit.ly/MarlisCaseStudy).







**Pablo Celnik**  
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There are many extraordinary developments taking place across the Johns Hopkins Rehabilitation Network that I want to share.

The Sheikh Khalifa Stroke Institute launched in February 2018 with locations in Baltimore, Maryland, and Abu Dhabi in the United Arab Emirates. The institute will comprise two centers: one devoted to stroke detection and diagnosis directed by neurologist Argye Hillis and the other devoted to treatment, recovery and rehabilitation, which I will direct.

In addition, we recently opened a new noninvasive brain stimulation program, one of the few programs of its kind in the country. Recognized experts in the field of neurologic rehabilitation provide a variety of brain stimulation techniques paired with evidence-based rehabilitation for neurological conditions such as motor, language, cognitive and movement disorders.

We are also recruiting patients with a spinal cord injury to participate in a brain-computer interface study. This research project will use electrodes to read brain signals and aims to allow participants to control a highly advanced prosthetic robotic arm, video game-like programs, quadcopters, wheelchairs or other devices solely with their thoughts.

The cover of this issue depicts another novel program that helps patients who have had, or will have, an amputation. The goal is to restore patients to the same level of function they had before the amputation. Marlis Gonzalez-Fernandez matches patients with advanced prostheses to fit their particular lifestyle. She focuses not on the amputation, but on maximizing the use of the prostheses.

I am thrilled with all the innovations across our department. As always, if we can help with any physical medicine and rehabilitation needs, please let us know: **443-997-5476**.



Researchers from Johns Hopkins and the Kennedy Krieger Institute are investigating whether earlier transfers to rehabilitation from the pediatric intensive care unit lead to pediatric patients returning home sooner. Above, occupational therapist Yun Kim helps a patient improve fine motor skills.

## Can Rehabilitation in the PICU Result in **Better Outcomes, Improved Patient Experience?**

Over the last decade, Johns Hopkins researchers have found that patients in the adult intensive care unit benefit from increased activity and mobility. Getting patients up and moving sooner leads to shorter lengths of stay, fewer readmissions and improved patient outcomes. Now, researchers want to find out if the same applies to patients in the pediatric intensive care unit (PICU).

“If these patients receive rehabilitation services early on during their PICU admission when their medical status has stabilized, we believe that a more successful transition to their next phase of recovery in an inpatient rehab unit has the potential to improve their eventual outcome,” says **Frank Pidcock**, director of pediatric rehabilitation in the Johns Hopkins Department of Physical Medicine and Rehabilitation and vice president of rehabilitation at the Kennedy Krieger Institute. “Incorporating therapy services that are sensitive to neurorecovery at the PICU bedside, especially for patients with brain disorders, may shorten PICU length of stay and result in earlier implementation of therapies in a rehabilitation setting.”

This investigation began as a quality improvement

project at Johns Hopkins Children’s Center led by Beth Wieczorek, manager of nurse practitioners, and **Sapna Kudchadkar**, pediatric critical care medicine physician, with Pidcock’s collaboration. The goal was to increase the amount of early mobilization activities as well as the involvement of physical and occupational therapists with patients who had a stay of at least three days in the PICU.

Over the course of the one-year initiative, occupational therapy consultations increased by 15 percent and physical therapy consultations grew by 12 percent by the patients’ third day in the PICU. The average number of mobilizations doubled from three to six per day per patient, including active bed positioning and ambulation. Most importantly, there were no adverse events associated with early mobilization. The results were published in December 2016 in *Pediatric Critical Care Medicine*.

Upon completion of the pilot project, clinicians implemented the practices as standard procedure in the Johns Hopkins PICU. An important unanswered question is whether early mobilization in the PICU can affect the short- and long-term functional outcomes in critically ill children. ■

### AFTER A ONE-YEAR INITIATIVE

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## Advanced Technologies for Injured Runners

As recreational running has grown in the U.S., the practice for treating injured amateur runners with physical therapy has stayed roughly the same. But seven years ago, the Johns Hopkins Rehabilitation Network started the Johns Hopkins Running Program to offer all runners the same advanced technology and resources that were once only available to elite and professional athletes. Today, these services—which aim not only to facilitate healing but also to avoid future injuries—are available to runners at various Johns Hopkins facilities in Maryland.

The program is a collaboration between physical therapists, physiatrists, sports medicine physicians and orthopaedic surgeons. Experts include sports medicine internist **Sameer Dixit** and new sports medicine physiatrist **Mark Ellen**, who specializes in the nonoperative treatment of strains, sprains, tears, bursitis, tendinitis and more.

“Much of the technology we use was previously only provided at university gait labs to professional athletes due to its cost,” explains Ken Johnson,

“With market competition increasing and the cost for technology decreasing, we’ve been able to offer this extremely sophisticated analysis to the general patient population.”

-KEN JOHNSON



physical therapist and director of ambulatory rehabilitation therapy services at the Johns Hopkins Rehabilitation Network. “With market competition increasing and the cost for technology decreasing, we’ve been able to offer this extremely sophisticated analysis to the general patient population.”

This new equipment includes an instrumented treadmill equipped with more than 7,000 sensors in the deck for initial and progress evaluations. While patients run, these sensors and special LED sensors worn on the body capture hundreds of data points on variables including cadence, stride length

and impact stress. The treadmill also has cameras for high-speed motion analysis that record at a rate of 100 frames per second, allowing clinicians to examine minute changes in body position and impact stress that can have a significant influence on how muscles are activated and recruited.

Patients also benefit from hand-held devices that measure strength, Johnson says. While traditional assessments rely on a therapist’s skill to assess strength and gauge the extent of imbalances, studies have shown that even the most experienced clinicians can miss strength imbalances as great

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## Rehab Targeted to Medically-Complex Transplant Patients Shows Promise



A pilot project for patients with major functional decline who receive a kidney or liver transplant shows promise for positive medical outcomes. Started in August 2017 at The Johns Hopkins Hospital, the project targets medically complex patients who are in the acute hospital for early, intensive rehabilitation.

The approach starts with a physician, surgeon or other member of the primary care team who works with a physiatrist to identify a high-risk patient soon after the transplant. Traditionally, transplant patients are not evaluated by a physiatrist until preparing to transfer to a comprehensive inpatient rehabilitation program, which may not take place until several weeks into a hospital stay.

“We are anticipating the recovery path for the patient as soon as possible, which guides us throughout their hospital stay,” says physiatrist **Kenneth Silver**. “The goal is to ensure patients get on the road to recovery quicker.”

Each day, rehabilitation therapists work with the patient to speed activity and mobility as well as coordinate the overall rehab care with the physiatrist. Team meetings with the physiatrist, rehab advanced practitioner and the physical and occupational therapy staff take place several times

per week to review and plan the patient’s recovery.

“There is evidence that when patients are more mobile and doing activities of daily living in the hospital, their outcomes improve,” says occupational therapist Annette Lavezza.

The team also attends the transplant division’s multidisciplinary rounds, during which patient progress is discussed and any related rehabilitation plans are modified.

“Despite the patients’ functional deficits and limited activity, providing more frequent therapy earlier in the process appears to be having positive outcomes,” says Silver. “This project will attempt to formally measure those outcomes.”

The focus on early rehabilitation seems to be having an effect on patient satisfaction. Richard Allison, who had a kidney transplant, says, “The rehabilitation therapists began to show me that there is a way to get better. Thanks to them, I improved immensely . . . my stay at rehab was short lived. I am now home and getting better every day.”

Among other factors, the pilot will analyze the approach’s impact on length of stay as well as functional improvements that allow patient to go home earlier. ■



## Advanced Technologies for Injured Runners

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as 30 percent between different sides of the body. Tools such as the ones Johnson and other therapists use in the running program offer a truly objective measurement.

While patients are recovering, another technology allows them to ease back into running with a lower level of impact and strain. Johnson and his colleagues often have them run for a few sessions on an anti-gravity treadmill as they recover, instead of running at full impact right away. The treadmill supports as much as 40 to 50 percent of their body weight.

New treatment techniques also help speed healing, Johnson adds. Clinicians in the program use instrument assisted soft tissue mobilization with special tools that are contoured to every body shape, and machines that apply negative pressure to improve blood

flow, decongest swelling and reduce scar tissue. Additionally, a device that delivers low energy myoacoustic pressure waves helps strengthen the resiliency of bones and joints, and the mobility of fascia, muscle and tendon, helping to improve exercise ability over time.

Together, Johnson says, these tools—combined with feedback from the treadmills and an evidence-based exercise program—are helping to get injured runners off the couch and back on the road. “For me,” he says, “there’s no greater feeling than to receive a call or an email from a patient saying that they’ve returned to running injury-free, are setting personal best times, and that they couldn’t have done it without us.” ■

To learn more about the Johns Hopkins Department of Physical Medicine and Rehabilitation, visit [hopkinsmedicine.org/pmr](http://hopkinsmedicine.org/pmr).

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# Restore

A newsletter from Johns Hopkins  
Physical Medicine and Rehabilitation

#### Johns Hopkins Medicine

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This newsletter is one of the many ways we seek to enhance our partnership with our referring physicians. Comments, questions and thoughts on topics you would like to see covered in upcoming issues are always welcome.

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Johns Hopkins  
Physical Medicine  
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