the apex of trauma care
The Apex of Trauma Care is distributed semi-annually to trauma physicians, neurosurgeons and their staffs nationally. The publication aims to advance, through education and communication, the field of brain and spinal cord injury medicine. With input from the publication’s advisory council, The Apex of Trauma Care seeks to fulfill this goal by providing its audience with relevant content and distinctive perspectives meant to spur dialogue and provide a collective avenue to link physicians and medical organizations across the country.

Shepherd Center specializes in medical treatment, research and rehabilitation for people with spinal cord injury, brain injury, multiple sclerosis and other neuromuscular conditions. It is one of only a few freestanding rehabilitation facilities in the United States that has an intensive care unit and acute-care capabilities.

Our Mission is to help people with a temporary or permanent disability caused by injury or disease, rebuild their lives with hope, independence and dignity, advocating for their full inclusion in all aspects of community life while promoting safety and injury prevention.
The More You Know

New videos and training sessions offer educational opportunities.

Hypothermia in Treating Acute SCI
Researchers study the effectiveness of early-intervention hypothermia treatment.

Omega-3 Treatment
Studies show benefits of DHA in treating spinal cord and brain injury.

Silent, But Serious Threat
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Features

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Departments

Point of View
High-dose Steroids Debate
Experts offer opinions on the use of methylprednisolone for spinal cord injury patients.

Tech Talk
The More You Know
New videos and training sessions offer educational opportunities.

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Apex: The use of methylprednisolone for treating acute SCI patients has been the subject of controversy for more than two decades. Should it be the standard of care for treating SCI? What other avenues could we explore to develop additional treatment options?

Dr. Young: In 1990, the first double-blind, randomized, placebo-controlled NASCIS trial showed that methylprednisolone significantly improved motor and sensory functional recovery in complete and incomplete SCI patients. It demonstrated that patients who received high-dose methylprednisolone within eight hours of injury recovered approximately 20 percent more function than those who did not. The study was widely publicized and that led to a strong backlash. In 1997, we published a second study that looked at 24 versus 48 hours of methylprednisolone treatment. The data was clear: If patients were treated within three hours, they should get a 24-hour duration dose; if treated within three to eight hours, they should get a 48-hour dose. The three studies concluded that high-dose methylprednisolone should be used within the recommended timing parameters.

Trials do not receive approval and funding from the National Institutes of Health, pass rigorous peer review and get published in major medical journals if the data is not solid. None of the criticism has produced evidence indicating that methylprednisolone has complications if administered within 24 hours. It has been used in millions of patients and is even approved for people with multiple sclerosis. An equally large body of research indicates that it is beneficial for animal SCI.

I would applaud the introduction of a better drug. Unfortunately, more time has been spent criticizing the trials than in finding a better therapy. This debate clearly shows that our country isn’t investing correctly. I don’t begrudge doctors their opinion, but feel they should present methylprednisolone as an option, discuss possible complications and let patients and families decide.

I have started clinical trials in China and Europe with government and private sector support. I also started JustaDollarPlease.org.
asked families affected by chronic SCI to donate a dollar a day to help develop research funding that’s not dependent on politics or profit. We need to give power back to families instead of waiting for the government or drug companies to find solutions.

DR. BAGLEY: There are two main reasons I don’t use methylprednisolone and don’t feel it’s a good idea for acute SCI patients. First, the strength of the clinical data supporting the use of high-dose steroids is marginal. Initial NASCIS findings indicated that there was no benefit. It was only on secondary analysis that they found a subgroup of patients who appeared to benefit from methylprednisolone. That is where the recommendation to use steroids came from. A critical analysis of the patient subgroups brings the data into question. For example, some patients who received placebos early actually did worse than patients who received placebos late. This wouldn’t make sense, because placebos should have no effect. Also, the data doesn’t show a significant motor benefit — sensory yes, but as far as a clinically appreciable difference in patients who received steroids compared with those who did not, the difference is marginal. It’s hard for me to propose an intervention that, based on my interpretation of the literature, I truly believe won’t help and may do more harm than good.

Secondly, based on my clinical experience, steroids are not a benign drug. The complications are significant, especially in this patient population, and in the case of pneumonia or UTI, can be deadly.

While improvements have been made in field management, early surgical intervention and blood pressure management, we need large, well-designed, multi-institutional studies to look critically at our interventions to see if we’re properly affecting outcomes. We need to look at potential interventions to be able to translate the information. Unfortunately, research dollars are scarce and we don’t have the large patient numbers necessary to get on the public’s radar screen.

DR. TANSEY: During my five years as director of the Spinal Cord Injury Program at Parkland Memorial Hospital in Dallas, I worked with neurosurgeons, orthopedists, critical care physicians, internists, neurologists and psychiatrists to develop methylprednisolone treatment guidelines for our SCI patients. I was dealing with a spectrum of clinical opinions and needed a rational, balanced approach so that everyone would agree to play by the same rules.

We discussed methylprednisolone pros and cons and side effects and considered all types of injuries. We established criteria for when steroids made a difference in functional outcomes and when they didn’t. In a cervical SCI, changing the injury as little as a centimeter could make the difference in whether a patient is able to feed himself or propel his wheelchair. In a mid-thoracic SCI, small changes don’t make a big difference. We made use of a common trauma scale, and patients with high scores due to multiple injuries were not candidates. There was an age cut-off: Patients above or below a certain age didn’t get steroids. And we didn’t give methylprednisolone to anyone with a history of psychosis because high-dose steroids increase the risk of a psychotic event.

Personally, if I had an isolated cervical SCI, I’d want steroids. If I had a mid-thoracic injury with multiple other insults, such as a concomitant brain injury or injuries with a high risk of infection, I wouldn’t want steroids. My functional benefit wouldn’t be as high as the risks involved.

In the past five years, it’s been discovered that giving steroids to patients with brain injuries does more harm than good. A clinical trial was stopped for that reason.

It is a little embarrassing that there’s no easily agreed upon standard of care for acute SCI that appropriately weighs risks against functional benefits. It means we haven’t taken the time and effort to continue to study this problem. It is virtually impossible to study it well, however, because there are many variables. We should be trying other drugs, preferably without as many side effects, but that’s difficult because methylprednisolone is FDA-approved, and that means new drugs under study would probably have to be given on top of methylprednisolone, which might make interpreting the results of those studies difficult. Also, in the 1990s, pharmaceutical companies lost money on neuroprotective trials, and now most won’t invest in this field.

Methylprednisolone may have neurological benefit, but the patient’s overall condition must be considered. Hopefully, practitioners will use judgment instead of just following policy. Unfortunately, medicine tends to be black and white. In reality, there’s a lot of gray.
Trauma physicians are frequently presented with complex cases involving spinal cord injury, brain injury and general trauma patients. Compared with obvious injuries, the silent, yet very real, threat of deep vein thrombosis (DVT) can emerge suddenly and cause significant episodes of pain, cardiac events and even death. Clearly, the current recommendations that DVT be treated aggressively and prevented whenever possible are not only warranted, but necessary to improving patient outcomes.

Trauma patients, particularly those with limited or completely impaired mobility, are at a very high risk for DVT. In fact, pulmonary embolism remains the third leading cause of death for patients with acute spinal cord injury. To that end, it’s necessary that physicians treat not only the obvious traumatic injuries, but also the complications that can quickly arise in their wake.

“Spinal cord injury patients, in particular, are at high risk for DVT. About 40 percent or more will develop DVT, depending on the severity and level of injury,” says Andrew Zadoff, M.D., medical director of the Intensive Care Unit (ICU) and Respiratory Therapy at Shepherd Center in Atlanta. “Almost half of our patients will develop it if we don’t do something about it.”
Often, traumatic injury patients are among the most challenging cases upon initial presentation because of the litany of injuries and long-term concerns that accompany them. Once the patient has been stabilized, the trauma physician must develop a plan for long-term survival.

“DVT is the number one issue that will affect patients in the acute period post-injury,” says Raymond P. Bynoe, M.D., associate professor of surgery at the University of South Carolina School of Medicine. “The immediate period is probably the highest point of concern because the patient is flat on his back, with very little mobilization and can’t move his extremities to pump blood back to the heart.”

The threat of excessive bleeding during post-trauma surgeries typically precludes physicians from immediately administering blood-thinning medications. In fact, head injury patients often require the opposite effect via blood-clotting prophylaxis to eliminate life-threatening brain bleeds. Once the need for surgery has passed, bleeding has ceased and scans rule out intracranial hypertension, it becomes far more feasible for prophylactic measures to be incorporated into the DVT prevention plan. Dr. Bynoe says patients with both head and orthopedic injuries are of special concern.

“If they have both (head and orthopedic injuries), they are at a greater risk of DVT because they have an injury to the extremity,” Dr. Bynoe explains. “For these and other patients, you have to be constantly looking at each case individually.”

As with most complex medical conditions, DVT prevention and treatment requires management on a specific, case-by-case basis, although guidelines are critical in the development of a comprehensive care plan.

Upon initial admission at Shepherd Center, brain and spinal cord injury (SCI) patients undergo ultrasound of the lower extremities to pinpoint any blood clots. Patients’ legs are then measured daily to ensure that swelling/edema, one of the main indicators of DVT, is not present. Repeat ultrasounds are then ordered when leg swelling or other possible DVT-related complications, such as fever, pain and heart-rhythm abnormalities, indicate a possible clot.

Of course, careful monitoring alone is not enough to contain the threat of DVT. Sometimes, patients are fitted with a vena cava filter, which does not prevent DVT from occurring, but is very effective at keeping clots from traveling up to the lungs and causing pulmonary embolism. More often, sequential compression stockings (also known as graduated or pneumatic compression stockings) are employed in the acute and/or rehabilitative stages to encourage blood flow in the extremities. In fact, a 2008 study published in The Journal of Spinal Cord Medicine found that knee-length compression stockings (21 mm/Hg) helped to reduce venous capacitance in SCI patients, thereby reducing the risk of DVT.2

“Typical studies show that 50 percent of patients will develop DVT in the thighs and pelvis. The use of low-molecular weights reduces that number to about 15 percent.”

ANDREW ZADOFF, M.D.,
MEDICAL DIRECTOR OF THE INTENSIVE CARE UNIT
AND RESPIRATORY THERAPY AT SHEPHERD CENTER
The Prophylactic Component

Prophylactic medications should become a component of DVT prevention and care as soon as possible following a traumatic event. Traditionally, heparin, a well-known and commonly used anticoagulant, has been the go-to medication for DVT management. But recent studies indicate that low-molecular-weight heparin is even more effective at minimizing DVT risk. When used for preventative purposes, low-molecular weights are administered in low doses, with higher doses reserved for treatment of known clots.

“Typical studies show that 50 percent of patients will develop DVT in the thighs and pelvis,” Dr. Zadoff says. “The use of low-molecular weights reduces that number to about 15 percent.”

Although there certainly is a time and a place for the use of other anticoagulants (see sidebar), the promise of low-molecular weights in conjunction with other preventative measures is clearly producing data that points toward the use of this medication as a standard in the management of DVT.

Other signs indicate that low-molecular-weight heparin is preferable to heparin for long-term anticoagulant prophylaxis needs. The collection of hard data is under way at Shepherd Center, but preliminary findings reveal that patients given low-molecular-weight heparin are at significantly less risk of developing heparin-induced thrombocytopenia (HIT). Often swiftly and physically devastating, HIT can cause stroke, heart attack, loss of limbs and even death. Fondaparinux is believed to be even more ideal in the prevention of HIT, but the drug’s much higher cost often prevents its use unless necessary.

In addition to significantly affecting the quality of a patient’s life, improved DVT management measures are poised to reduce certain costs across the board. By better managing incidents, or preventing them outright, patients and hospitals can avoid some of the costs associated with frequent blood checks, ultrasounds, follow-ups, evaluations and the myriad other complications that arise from dangerous clots.
Lessons from the battlefield are saving lives at home.

The nation followed the progress of U.S. Rep. Gabrielle Giffords with awe as she gave a thumbs-up sign, spoke her first words and worked through her rehabilitation. She survived a devastating brain injury from a close-range gunshot wound while also becoming an example of strength, hope and the potential for functional recovery. Out of the public eye, a similar scenario plays out daily among American troops who have sustained traumatic brain injuries from blasts and shrapnel in Iraq and Afghanistan. In fact, the lessons learned from the battlefield have enhanced trauma care and revealed techniques that lead to greatly improved outcomes.
“We’re more aggressive about treating more severe brain injury,” says A. Tyler Putnam II, M.D., section chief of Critical Care Surgery and medical director of the Neurotrauma Intensive Care Unit at the Carilion Clinic in Roanoke, Va. “We’ve seen a very significant rate of return to positive neurological function.”

The intense blasts of improvised explosive devices have made traumatic brain injury the signature injury of the wars in Iraq and Afghanistan. The military responded by placing neurosurgeons in the field, where they performed decompressive craniectomies on the most severely brain-injured soldiers to prevent damage from swelling. (Physicians performed a similar procedure on Giffords.) They also increased the reliance on tourniquets to stop bleeding in the extremities, a primary cause of battlefield deaths.

“We were doing everything we could to control the damage in theater,” says Dr. Putnam, who served as chief of the Intensive Care Units/Critical Care Service with the 332nd Expeditionary Medical Group based at Balad Air Base in Iraq and later as chief of General and Specialty (Trauma) Surgery at Landstuhl Regional Medical Center in Landstuhl, Germany.

Severely injured troops are flown by a U.S. Air Force Critical Care Air Transport Team (CCAT), which is essentially an intensive care unit in a jet, to Landstuhl, the largest American-operated hospital and first U.S.-certified trauma center outside the United States. The U.S. Department of Defense tracks the care from injury to rehabilitation through its Joint Theater Trauma Registry. As physicians determine which interventions produce the best outcomes, surprises emerge.

STOP THE BLEEDING, REPLACE THE BLOOD
For many years, the standard of trauma care called for administering standard intravenous salt solutions to swiftly restore circulating blood volume. In combat, where severe blood loss is the primary cause of mortality, the military has begun using more concentrated hypertonic (3 to 5 percent) saline solution, which is lighter-weight and leads to reduced edema.

This hypernatremia is considered optimal for traumatic brain injury. In civilian care, comatose patients are routinely placed on a hypertonic saline drip, Dr. Putnam notes. “Neurosurgeons believe the injured brain tissue responds better to a hypertonic environment,” he says, adding that such a mechanism has yet to be validated at the cellular level.

195,547 MILITARY PERSONNEL AROUND THE WORLD WERE DIAGNOSED WITH A TRAUMATIC BRAIN INJURY BETWEEN JANUARY 2000 AND SEPTEMBER 2010.1

MULTIDISCIPLINARY APPROACH TO REHABILITATION
SHARE Initiative provides model for TBI care.

After U.S. Marine Sgt. Justin Richardson was hit by the blast of a grenade in Iraq, he struggled with headaches, dizziness and vertigo. He was diagnosed with post-traumatic stress disorder (PTSD), but when he returned home, he learned that his tough, new mission of recovery included yet another obstacle – mild traumatic brain injury (mTBI).

Recovering from TBI requires intensive rehabilitation in myriad areas, from occupational and physical therapy to counseling and coaching in coping skills. The U.S. Department of Defense is developing Defense Centers of Excellence for Psychological Health & Traumatic Brain Injury to address the unique issues of these injured troops. But the military also is realizing that it has much to learn from the civilian experience in brain injury treatment.

For months, Richardson lived with other service members and veterans as part of the SHARE (Share Hope and Recovery Excellence) Initiative at Shepherd Center in Atlanta. SHARE is focused solely on service members with TBI and SCI. Richardson received daily therapy, as well as pain management for headaches, help with sleep problems, compensatory strategies for memory problems and emotional support. Eventually, Richardson was able to return to school and manage daily activities. To date, Shepherd has helped 167 service members such as Richardson.

Shepherd focuses on survival beyond the patching up of injuries. “Trauma facilities save lives. Rehabilitation facilities give people their lives back,” says Darryl Kaelin, M.D., medical director of Shepherd’s Acquired Brain Injury Program and the SHARE Initiative.

As with medical treatments, early intervention produces the best outcomes. Once service members are in the rehabilitation program, a case manager makes sure their needs are being met – even following up for a year after discharge. “The sheer intensity drives the program to be as successful as it is,” Dr. Kaelin says.

For more information about the SHARE Initiative, visit shepherd.org/share.
The Clinical Practice Guideline of the Joint Theater Trauma System calls for 250 cc of 3 percent saline solution administered over 10 to 15 minutes to patients with severe head injury with signs of intracranial hypertension. That is followed by 50 to 100 cc every hour.3

With swift intervention, the military has a 90 percent survival rate for severely head-injured troops who have a Glasgow Coma Scale (GCS) score of 6 to 8. (Survival is lower for those with very low GCS scores that range from 3 to 5.)4

Survival in trauma care also hinges on the treatment of coagulopathy. “The number one killer in the battlefield — probably for as long as mankind has been alive — is bleeding,” says U.S. Air Force Lt. Col. Raymond Fang, M.D., director of trauma at Landstuhl Regional Medical Center. Military medical teams have become very aggressive in controlling hemorrhages and restoring lost blood.

Damage control resuscitation — administering packed red blood cells, fresh frozen plasma and platelets in a 1:1:1 ratio that mimics whole blood — is a potentially life-saving response for patients who have sustained a severe injury and have significant blood loss, low blood pressure and acidosis.5 “It’s become the standard of care for very severely injured patients,” Dr. Fang says.

In civilian medical care, patients who need massive transfusions typically receive large volumes of crystalloids and red blood cells with lesser amounts of plasma and platelets. That practice is changing — largely because of the military experience. A 2008 study of 466 civilian patients who had massive transfusions demonstrated better survival rates with the 1:1:1 ratio.6

The use of recombinant Factor VIIa for coagulopathy also has been controversial. Earlier in the wars in Iraq and Afghanistan, military medical responders favored Factor VIIa as an important part of anti-coagulopathy. In a records review, the Combat Support Hospitals in Iraq found that severely injured troops given Factor VIIa required a lower volume of blood products, but the impact on survival was not as clear.7

In the field, the use of Factor VIIa has recently declined, Dr. Fang says. “We’re giving the blood components that contain Factor VIIa — as opposed to [giving it] separately as medication,” he adds.

REGISTRY AID RECOVERY EFFORT
There is nothing in our civilian life that compares to the forces exerted on troops in an improvised explosive device (IED) blast — a wave of very high pressure followed by a second wave of displaced air, which can cause serious brain injury even with visible damage. Often, flying shrapnel creates serious injuries, as well.

But civilian patients still sometimes sustain severe head trauma from falling or gunshots, and they are benefiting from the advances in medical treatment of combat wounds. In fact, trauma surgeons and vascular surgeons visit Landstuhl and other military medical facilities to learn firsthand about the center’s life-saving techniques.

The Joint Theater Trauma Registry has provided a remarkable account of interventions and outcomes, giving military physicians better information about what works and what doesn’t.

“What the military showed very effectively, very rapidly, is how a registry could improve care,” Dr. Putnam says. “It reinforced how valuable registries are.”

Now in civilian practice, Dr. Putnam makes use of some of the techniques he employed in Iraq. For example, he recently treated a 60-year-old man who had fallen on ice and sustained a head injury. The patient was monitored overnight in the Neurotrauma Intensive Care Unit, where he began to show signs of brain swelling. The civilian neurotrauma surgical team performed a decompressive cranietomy to relieve the pressure.

The man was still in the range of moderate brain injury (9 or 10 on the Glasgow Coma Scale) when he was transferred to Shepherd Center in Atlanta for rehabilitation. With intensive therapy, the patient has a chance for functional recovery and a return to involvement in his community. That is the greatest encouragement for a trauma physician, Dr. Putnam says. “When we hear a positive outcome, that’s very uplifting and a huge morale builder for our entire team,” he adds.

1 IN 5
TROOPS RETURNING FROM AFGHANISTAN OR IRAQ REPORTED THAT THEY EXPERIENCED A PROBABLE TRAUMATIC BRAIN INJURY.8

3 www.usaism.add.army.mil/jtsp/html
8 www.rand.org/pubs/research_briefs/RR8937/index2.html
"WE DECIDED TO DEVELOP THE VIDEOS AS A WAY TO EDUCATE FAMILIES SO THEY'D FEEL A LOT MORE COMFORTABLE IN THE TRAUMA CARE SETTING AND AFTERWARD."

LARRY BOWIE, SHEPHERD CENTER DIRECTOR OF PUBLIC RELATIONS AND MARKETING
OMEGA-3s CAN AID TREATMENT OF BRAIN AND SPINAL CORD INJURY

Newly injured patients and their families now have access to two new DVDs, Understanding Brain Injury and Understanding Spinal Cord Injury, produced by Shepherd Center and created by KPki, an Atlanta-based communications firm. The series, available online and on DVD, educates viewers about brain injury and spinal cord injury (SCI), offers advice on coping and outlines possible functional expectations for the future, says Larry Bowie, Shepherd Center director of Public Relations and Marketing. The series originated from focus groups held at Shepherd Center with families of patients. “We heard over and over that they wanted more information about their new injury — they felt they couldn’t get enough information,” Bowie explains. “We decided to develop the videos as a way to educate families so they’d feel a lot more comfortable in the trauma care setting and afterward.” Shepherd Center partnered with the American Trauma Society, the National Spinal Cord Injury Association, the Brain Injury Association of America and the Christopher & Dana Reeve Foundation to raise awareness of and distribute the series. “When newly injured people are looking for more information, they often contact these organizations for information,” Bowie says, adding that the DVDs will be among the materials those groups plan to provide. “In talking with doctors and case managers, we’ve learned that this is a piece of information they wholeheartedly welcome,” Bowie says. “We believe these videos are the most comprehensive ones of their type. They’re a great tool.” The videos are available at: www.spinalinjury101.org and www.braininjury101.org.

RESEARCHERS STUDY EFFECTIVENESS OF HYPOTHERMIA IN TREATING ACUTE SCI

In a study conducted by the University of Miami’s Department of Neurosurgery in 2009 and 2010, induced moderate hypothermia proved an effective early-intervention treatment in spinal cord injury (SCI) for 14 selected patients. “We believe cooling reduces many of the secondary injury mechanisms felt to be important in these pathologies,” says W. Dalton Dietrich, Ph.D., scientific director of the Miami Project to Cure Paralysis. “It affects multiple injury mechanisms like a therapeutic cocktail.” Researchers at The Miami Project are pursuing a $10 million grant from the National Institutes of Health to conduct a 17-center randomized trial to test the safety and efficacy of hypothermia in people with acute SCI. If approved, patient recruitment could start immediately, Dr. Dietrich says. Meanwhile, studies of hypothermia are ongoing at the University of Miami using institutional research protocols. Researchers are optimistic about their findings. “But we really need to move this field forward with the multi-center trial,” Dr. Dietrich adds. “That’s the gold standard.”

Nearly 1 in 50 are living with paralysis. 1,275,000 have SCI in the U.S. 60 to 75 percent of spinal cord injuries in children occur in the cervical section.

3 Children’s Hospital Boston www.childrenshospital.org/az/Site1150/mainpageS1150P0.html.
6 Cherfils J, Clermont Y. Docosahexaenoic acid (DHA) and hippocampal plasticity. Prog Brain Res. 2009; 176:187-206.
ROBOTIC EXOSKELETAL DEVICES SHOW PROMISE

TEXT BY MELANIE LASOFF LEVS

In March, Shepherd Center researchers began studying the safety and efficacy of eLEGS, a wearable exoskeletal bionic device created by Berkeley Bionics to assist users in standing and walking. Shepherd Center is one of several sites collaborating with the Berkeley, Calif.-based company to conduct an investigational study of eLEGS and develop training protocols, says Donald Peck Leslie, M.D., medical director of Shepherd Center.

Using robotics to aid mobility in people with SCI is a relatively new concept. Two other devices are in development — ReWalk by Israel-based Argo Medical Technologies and a wearable, powered orthosis designed by Vanderbilt University mechanical engineers, who are evaluating the device in collaboration with Shepherd Center researchers and patients.

Dr. Leslie is particularly hopeful about the prospects of eLEGS. “It’s untethered and lightweight — with carbon fiber and titanium parts,” he explains. The device is powered by a lithium ion battery pack and attaches directly to the user. eLEGS “is close to a natural human gait,” Dr. Leslie says. “As we work to help improve it, it will be even better.”

Researchers hope people with SCI will become mobile more quickly using eLEGS, says Sarah Morrison, program director of Shepherd’s SCI Program. “If a person has a motor complete SCI, this device can get an individual up and walking within a one- to two-hour training period,” she notes. “Traditionally, with knee-ankle-foot orthotics (long leg braces), it would take many weeks of training (to train a patient to walk).”