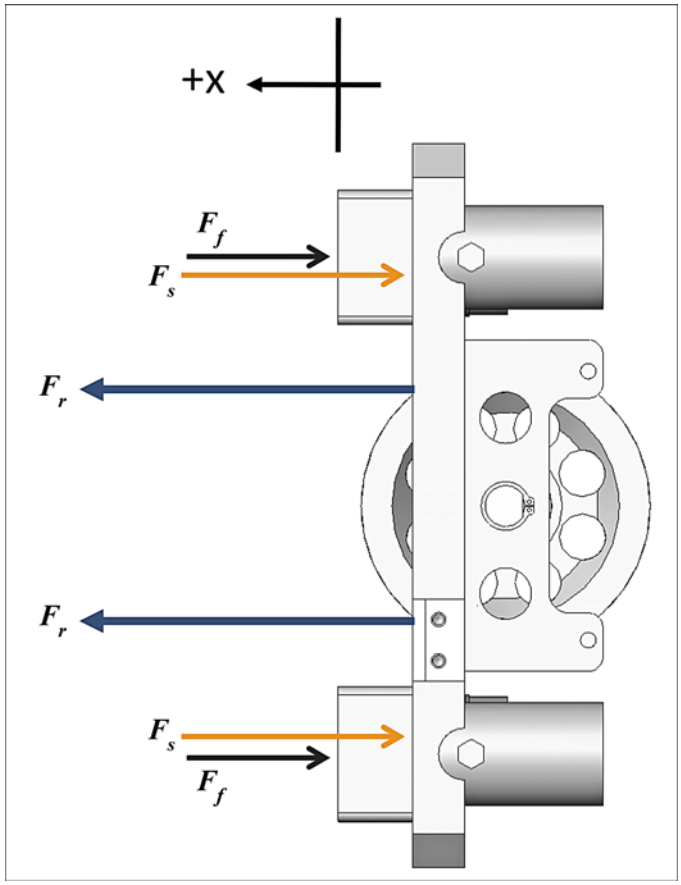
JRRD at a Glance

ZeroG: Overground gait and balance training system

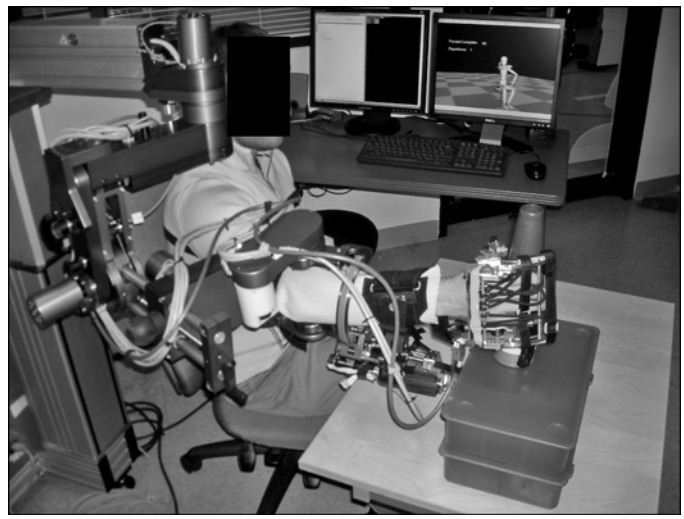
Joseph Hidler, PhD, et al.



We present a new overground body-weight support (BWS) system called ZeroG that allows patients to practice gait, balance, and postural activities in a safe, controlled manner. The system can provide static or dynamic BWS, and because it is mounted overhead on a custom track, patients can practice walking on flat surfaces, rough terrain, and stairs. In addition, ZeroG uses an active trolley system that automatically follows patients as they walk. As a result, patients only feel the vertical unloading forces and very little horizontal forces. We believe training with ZeroG will allow patients the ability to practice activities that are critical to achieving functional independence at home and in the community.

Retraining of interjoint arm coordination after stroke using robot-assisted time-independent functional training

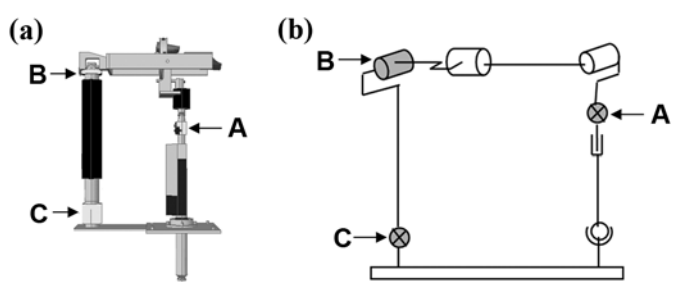
Elizabeth B. Brokaw, MS, et al.



In the aging veteran population, stroke is prevalent. Reduction of stroke-related disability is a high priority for both the Department of Veterans Affairs and national healthcare. Robotic approaches to treat motor impairments after stroke can potentially improve functional independence and quality of life in this large population of veterans.

Variable structure pantograph mechanism with spring suspension system for comprehensive upper-limb haptic movement training

Joel C. Perry, PhD, et al.

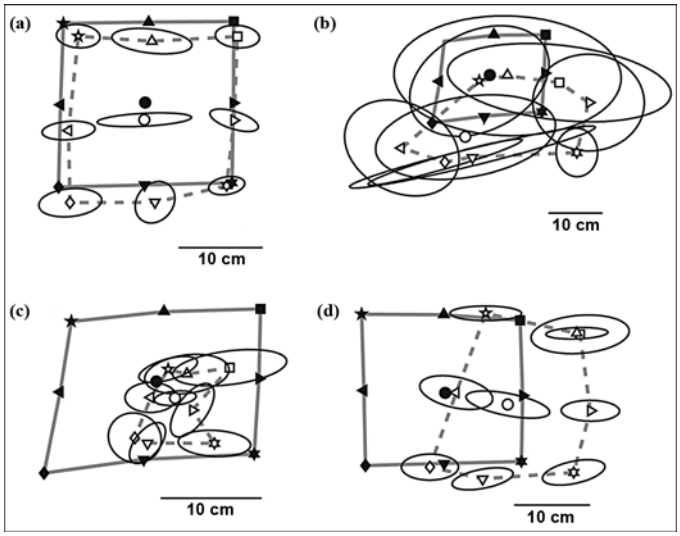


Various types of robotic rehabilitation systems have been proposed to treat veterans with upper-limb impairments, such as stroke, traumatic brain injury, or direct

trauma to the arm. Furthermore, the effectiveness of robotic rehabilitation has been validated by many clinical studies; however, the high cost of currently available systems makes them unaffordable for many hospitals and rehabilitation centers. In this article, we describe and test a multifunction device developed for training shoulder, elbow, and wrist impairments. We found that this multifunction device could significantly reduce the cost of robotic rehabilitation hardware, while providing comparable performance to other single-function devices.

Potential of robots as next-generation technology for clinical assessment of neurological disorders and upper-limb therapy

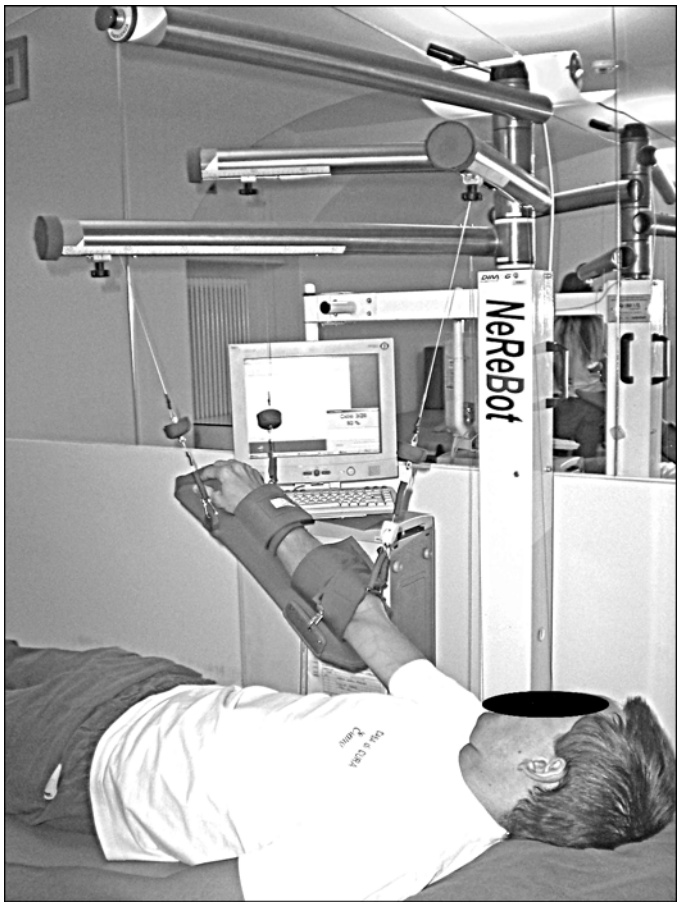
Stephen H. Scott, PhD; Sean Dukelow, MD, PhD



Stroke and traumatic brain injury affect many people every year. Afterward, people can have problems moving, sensing, seeing, or thinking. Measuring these problems is important because we use this information to plan treatment. The measurement tools we have do not always obtain a full and accurate picture of someone's neurologic function. This article reviews a new way of measuring problems related to brain damage using robotic technology. It also discusses the use of robots to help deliver treatment for these problems.

Upper-limb robot-assisted therapy in rehabilitation of acute stroke patients: Focused review and results of new randomized controlled trial

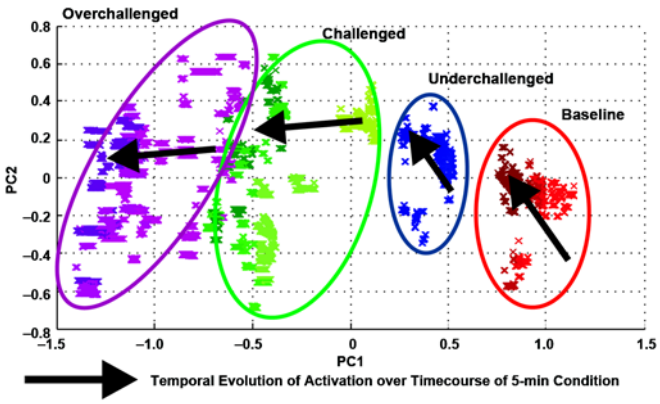
Stefano Masiero, MD, et al.



Rehabilitation is fundamental in reducing residual motor problems of patients with stroke, both during hospitalization (known as the "acute/subacute phase") and after discharge (known as the "chronic phase"). In the last 2 decades, the use of robotics in poststroke rehabilitation has been investigated intensely and some positive clinical results have been found. We present the most recent results of a study using robotic therapy in the acute phase poststroke, when patients are likely to improve in the most relevant motor abilities.

Psychological state estimation from physiological recordings during robot-assisted gait rehabilitation

Alexander Koenig, MSc, et al.



We describe a method to objectively determine if robot-assisted gait training optimally challenges a patient. This information is important because patients benefit most from rehabilitation training that positively challenges and motivates them while not being too stressful or boring. We used physiological recordings to automatically classify whether the patient is mentally engaged. While nondisabled subjects could report this information verbally, cerebral lesions caused by traumatic brain injury or stroke might limit other patients' communication or self-assessment capabilities. Our method is the first approach toward a gait-training environment that detects the mental state of a patient and automatically adapts the training to the patient's needs and demands.

Efficacy of rehabilitation robotics for walking training in neurological disorders: A review

Candace Tefertiller, PT, DPT, ATP, NCS, et al.

Many people who have neurological injuries and diseases have difficulty walking. Physical therapists often manually assist people in improving their walking ability. Many different approaches are used to retrain walking after spinal cord injuries (SCIs), traumatic brain injuries (TBIs), and stroke, and the use of robotic technologies is growing. This article reviews studies that have examined the effects of robotic technologies on the recovery of walking. Overall, the results support that locomotor training with robotic assistance can improve walking following stroke or SCI. Evidence on robotic assistance in multiple sclerosis is limited; however, the potential effect of robotics on gait seems to be at least equal to that of other techniques. The evidence on TBI and Parkinson disease is insufficient to suggest that use of locomotor training with robotic assistance benefits these populations.

Short-term ankle motor performance with ankle robotics training in chronic hemiparetic stroke

Anindo Roy, PhD, et al.

People who have had a stroke can improve their limb function years later through practicing a task with their weaker limb. In this article, we provide findings on the effects of a single training session with a new ankle robot in people with stroke. Seven subjects with weakness from a stroke and seven nondisabled subjects participated in this study. Subjects played a video game for 1 hour by moving their ankles first without and then with the help of the robot. Subjects finished the session by repeating the task without the help of the robot. We found that training increased accuracy, speed, and smoothness of ankle movements in those with stroke but not nondisabled subjects. Moreover, these benefits were retained at 48 hours. These results suggest the ankle robot can help the weak ankle move more efficiently. It can also be used to examine the ability of the weak leg to relearn new tasks. Finally, our approach can be tailored to patients' needs in other settings.

JRRD, Volume 48, Number 4, 2011

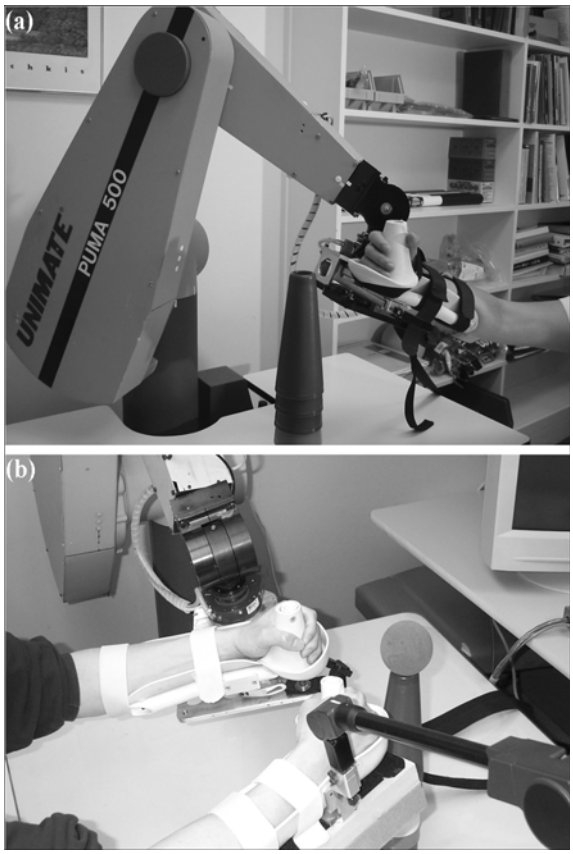
Pilot study to test effectiveness of a video game on reaching performance in stroke

Ana Maria Acosta, PhD, et al.

This study is a first step toward developing rehabilitation therapies to improve arm function in people with stroke. We examined the effect of playing a fun and engaging air hockey video game compared with reaching tasks with arm display feedback during various arm weight-support conditions in a group of people with stroke. The results showed that the reaching distances achieved with the reaching task were greater than those covered with the video game. These findings highlight the importance of designing games that target specific areas of difficulty in movement to be useful for rehabilitation.

Robot-assisted upper-limb therapy in acute rehabilitation setting following stroke: Department of Veterans Affairs multisite clinical trial

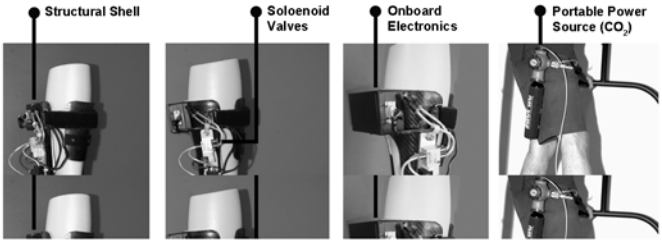
Charles G. Burgar, MD, et al.



Stroke is a leading cause of serious, long-term disability in the United States, with almost 800,000 strokes occurring every year. As veterans age, they are at increased risk for stroke. Increasing demand for and decreasing length of inpatient rehabilitation motivated us to seek better methods for restoring arm function after stroke. In this multisite clinical trial, we used Mirror Image Movement Enabler, a robotic system developed by Department of Veterans Affairs scientists, to assess its use for acute stroke rehabilitation and test the relationship between training intensity and movement recovery. The results add to the knowledge required to best design and use rehabilitation robots.

A portable powered ankle-foot orthosis for rehabilitation

K. Alex Shorter, PhD, et al.

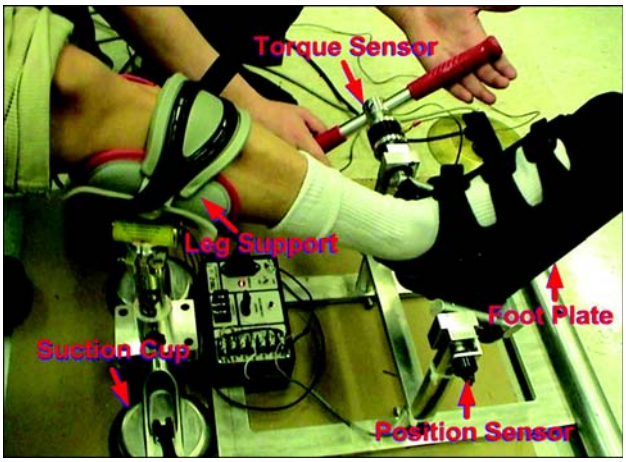


Ankle-foot orthoses (AFOs) are used to ameliorate lower-limb neuromuscular impairments in gait. In this article, we present a novel portable powered AFO (PPAFO) to provide untethered assistance for daily at-home rehabilitation treatment. The PPAFO provides torque assistance with a bidirectional pneumatic rotary actuator. We collected experimental data from one impaired and three nondisabled subjects to demonstrate design functionality. Data from nondisabled walkers demonstrated that the PPAFO provided correctly timed assistance. Additionally, data from the impaired walker demonstrated that the PPAFO provided functional plantar flexor assistance. The PPAFO opens opportunities for new orthotic and clinical treatment strategies.

Quantitative evaluations of ankle spasticity and stiffness in neurological disorders using manual spasticity evaluator

Qiyu Peng, PhD, et al.

People with brain injuries experience physical impairments and are usually examined by experienced clinicians to determine appropriate rehabilitation interventions. Clinicians use clinical scales to judge the severity of the impairments, and the consistency and reliability of those clinical scales are important for accurate rehabilitation and better healthcare services for patients. This article presents a manual spasticity evaluator (MSE) that measures joint range of motion, joint resistance, and stiffness at a controlled speed so that clinicians can use it



conveniently in a clinical setting. The MSE was tested with children with cerebral palsy (CP) to measure joint range of motion, stiffness, and catch angle of spastic ankle joints, but it can be used for adults with neurological disorders including stroke, traumatic brain injury, spinal cord injury, and CP.

Effect of robot-assisted versus conventional body-weight-supported treadmill training on quality of life for people with multiple sclerosis

Lauren M. Wier, MPH, et al.

This study describes how body-weight-supported treadmill training (BWSTT) affects quality of life for multiple sclerosis (MS) patients using either robot-assisted BWSTT or BWSTT alone. The results suggest that task-repetitive gait training on both types of BWSTT may improve quality of life for people with MS-related gait problems. For our study participants, we did not find any quantifiable differences between BWSTT alone and robot-assisted BWSTT. However, the results clearly showed longitudinal improvement in quality of life as a result of BWSTT. Overall, the study suggests that task-repetitive gait training is a noninvasive intervention with the potential to improve quality of life.