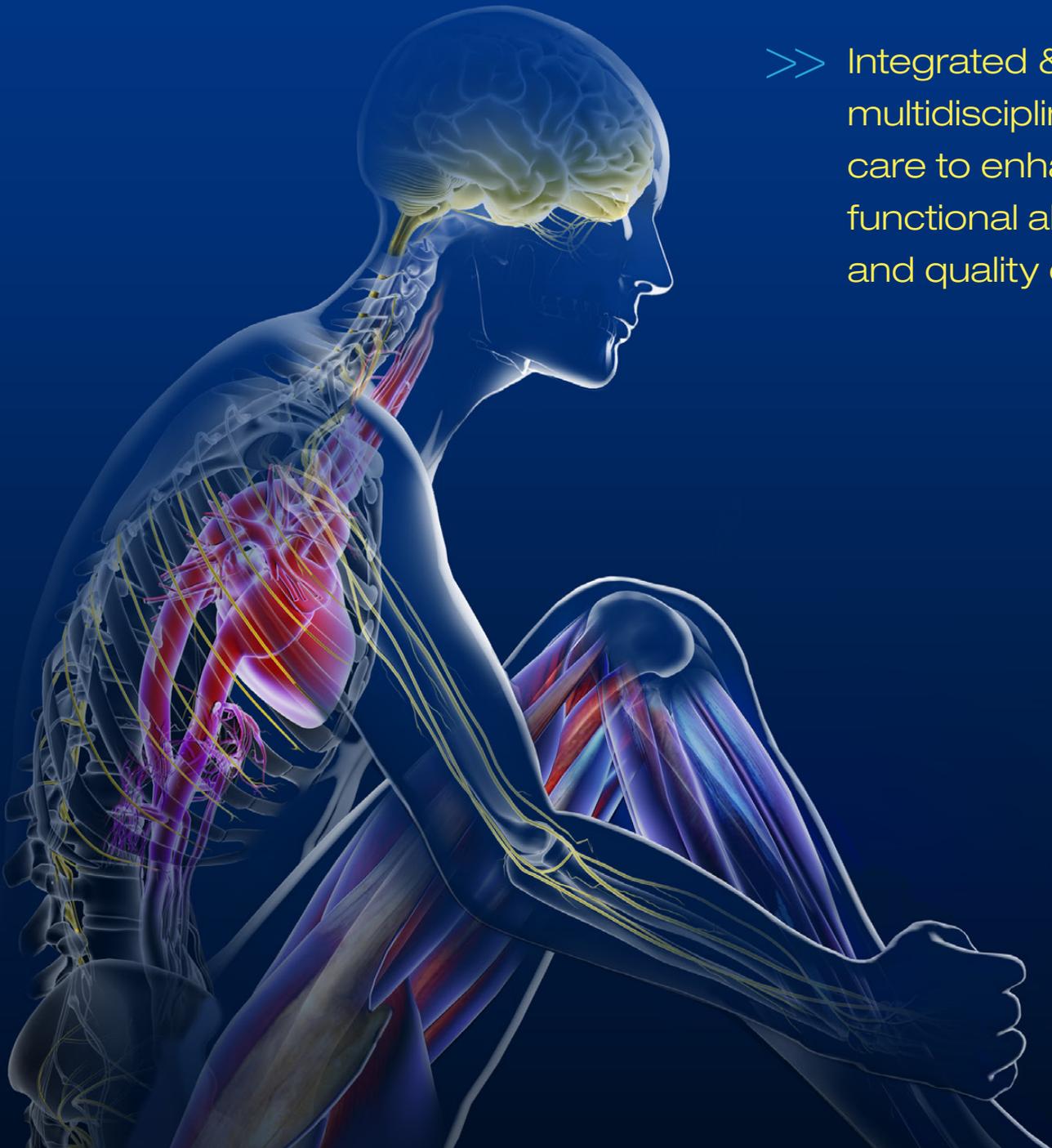




PHYSICAL MEDICINE & REHABILITATION



>> Integrated &
multidisciplinary
care to enhance
functional ability
and quality of life

PM&R IS EVERYWHERE AT MAYO CLINIC

The Physical Medicine and Rehabilitation (PM&R) practice at Mayo Clinic is comprehensive, multidisciplinary and integral to all types of patient care, from assistive technology for amputees, to rehabilitation support for transplant patients, to skills enhancement for elite athletes — and everything in-between.

We're researching new tools, technologies and treatments, including new approaches to regenerative medicine, and translating them to patient care — quickly. In the lab, researchers are making amazing discoveries that may change how we think about aging. We're educating the therapists and PM&R specialists who will care for tomorrow's patients.

Please take a few minutes to peruse this brochure and see the many ways Mayo Clinic is advancing physical medicine and rehabilitation care. Feel free to contact us or any of our colleagues to learn more.



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**HIGHLIGHTS
OF WAYS
WE ARE
ADVANCING
THE PM&R
PRACTICE**

BRAIN INJURY REHABILITATION

Long-term outcomes are among the best in the country.

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ULTRASOUND AND REGENERATIVE MEDICINE

Physiatrists deliver patients' own cells and growth factors into injured joints, promoting healing.

PAGE 28

SPORTS MEDICINE

Two new clinics open to treat injuries, prevent injuries and enhance sports performance.

PAGE 36

PAIN MANAGEMENT

Eighty-nine percent of participants in this pain management program experience a decrease in pain.

PAGE 39

ASSISTIVE TECHNOLOGY

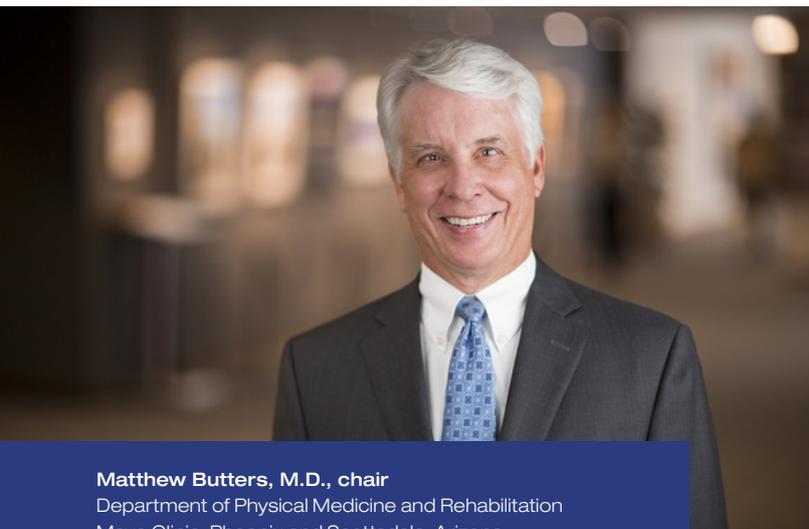
New robotic hand provides coordinated motion.

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RESEARCH

New research center focuses on improving quality of life for all people with disabilities.

PAGE 52



Matthew Butters, M.D., chair
Department of Physical Medicine and Rehabilitation
Mayo Clinic, Phoenix and Scottsdale, Arizona

Eighty years ago,
Mayo Clinic was among the first to integrate PM&R care into patient care. Innovation continues today.

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Mayo Clinic is the first and largest integrated, not-for-profit medical group practice in the world. Doctors from every medical specialty work together to care for patients, joined by common systems and a philosophy that **the needs of the patients come first.**

PATIENTS

128,000

Hospital admissions

1.3+ million

Patients treated annually from all 50 states and 143 countries

612,000

Hospital days of patient care

PEOPLE

4,200+

Physicians and scientists

52,900

Allied health staff

RESEARCH

619

Research-based physicians and medical scientists

2,189

Research-based allied health personnel

2,672

New human research studies approved by the Institutional Review Board

9,832

Active human research studies

6,392

Research publications and review articles in peer-reviewed journals

- Statistics from 2014

EDUCATION

5

Schools operate under the Mayo Clinic College of Medicine, training new physicians, new allied health staff as well as providing advanced degrees and continuing medical education for thousands of learners.

LOCATIONS

Rochester, Minnesota



Jacksonville, Florida



Phoenix & Scottsdale, Arizona



Mayo Clinic Health System*



*Hospitals and clinics in more than 70 communities in Iowa, Wisconsin and Minnesota

PM&R BY THE NUMBERS

PATIENTS*

25,328

Outpatient visits
annually

506,935

Inpatient, outpatient
therapy annually

16,795

Inpatient consults

*Mayo Clinic in Rochester, Minnesota, only

PEOPLE*

44

Physiatrists

27

Technicians

8

Clinical psychologists,
neuropsychologists

76

Occupational therapists,
occupational therapy assistants

124

Physical therapists/
physical therapy assistants

2

Clinical nurse specialists

3

Recreational therapists

100

Registered nurses/
patient care assistants

6

Speech language pathologists

4

Licensed social workers

COORDINATED CARE ACROSS THE SPECTRUM OF PATIENT NEEDS

- > Care seamlessly transitions through acute care, inpatient rehabilitation, outpatient rehabilitation and lifelong care, all on the same campus
- > Specialists and subspecialist consultation available 24/7
- > Team-based care, with highly skilled physical and occupation therapists, many with doctorate degrees

CARF accreditations

- > Inpatient rehabilitation program — Hospital (Adults and pediatric specialty programs)
- > Inpatient rehabilitation program — Hospital: Brain injury program (Adults)
- > Inpatient rehabilitation program — Hospital: Spinal cord system of care (Adults)
- > Inpatient rehabilitation program — Hospital: Stroke specialty program (Adults)
- > Inpatient rehabilitation program — Hospital: Amputation specialty program (Adults)
- > Interdisciplinary outpatient medical rehabilitation programs: Brain injury program (Adults and pediatric specialty programs)
- > Interdisciplinary outpatient medical rehabilitation programs: Spinal cord system of care (Adults)
- > Vocational services: Brain injury program (Adults)



The Inpatient Rehabilitation care team includes **Kurtis Hoppe, M.D.**, medical director, **Heath Elenbaas, nurse manager**, and **Trevor Carlson, therapy manager**.

INPATIENT >> REHABILITATION

Effective rehabilitation for the most complex needs

The Inpatient Rehabilitation Unit at Mayo Clinic Hospital — Rochester, Saint Marys Campus:

- > 38 beds
- > Pediatric and adult care
- > Conditions treated include stroke, traumatic brain injury, spinal cord injury, amputation, cancer, and complex medical needs, including posttransplant.
- > Located in the midst of acute care and surgical suites.

About 70 percent of adults and 95 percent of children are discharged to home.

PM&R specialists are routinely consulted on rehabilitation planning and treatment before and after all types of surgery. And, Mayo Clinic is one of the few places in the world that offers patients complex surgery, such as hemipelvectomy and ventricular assist device placement with follow-up rehabilitation.

Rehabilitation is offered for the most complex needs. Treatment and technologies include:

- > Locomotor training
- > Virtual environment therapeutic interventions
- > Functional electrical stimulation
- > Robotics



PM&R staff are part of the multidisciplinary team that cares for patients with ventricular assist devices.

EXPERT REHABILITATION CARE FOR PATIENTS WITH VENTRICULAR ASSIST DEVICES

- > PM&R staff work with cardiac surgeons, cardiologists and pulmonologists to develop integrated treatment plans.
- > Presurgical consultation is performed to identify physical or cognitive impairments proactively that may impact postoperative recovery and function.
- > Postsurgical care involves detailed education for patients and caregivers, and outpatient management.
- > Select patients transition to the Inpatient Rehabilitation Unit for comprehensive rehabilitation.

PATIENT MIX (2014)

25%

Stroke

15%

Spinal cord injury dysfunction

20%

Brain injury or disorder

3%

Amputation

6%

Cardiac

23%

Other
(Includes complex medical disorders)

8%

Neurological

LEVEL I ADULT AND PEDIATRIC TRAUMA CENTER

Mayo Clinic Hospital — Rochester, Saint Marys Campus, is a Level I Trauma Center. The trauma and complex medical rehabilitation consult team:

- > Provides acute rehabilitation expertise to the bedside to optimize functional outcomes
- > Collaborates with medical and surgical specialties to develop care plans
- > Is part of daily multidisciplinary rounds for patients in intensive care units

INPATIENT CARE REHABILITATION PROGRAMS

- > Amputation
- > Brain injury
- > Cancer
- > Cardiovascular
- > Complex medical care
- > Major multiple trauma
- > Neurological disorders
- > Orthopedics
- > Pediatric
- > Postoperative
- > Pulmonary
- > Spinal cord injury
- > Stroke
- > Transplant

BRAIN

>> REHABILITATION

Traumatic Brain Injury Model System

Mayo Clinic is one of a handful of centers offering longitudinal care to support patients and their families through all phases of brain rehabilitation: acute, inpatient and outpatient care.

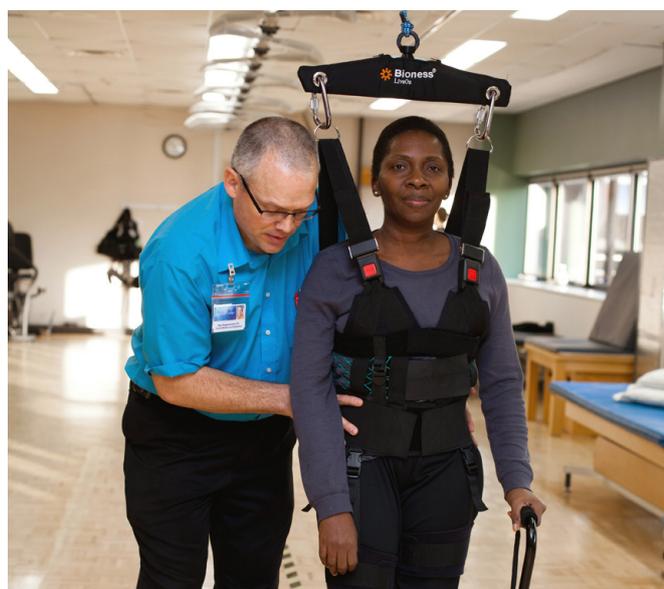
- > One of 16 Traumatic Brain Injury Model System centers.
- > One of only six centers continuously funded since 1998 by the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR).
- > Comprehensive treatment for all acquired brain injuries including stroke, TBI, encephalopathy and tumor.

OUTCOMES

- > The average length of stay for stroke rehabilitation is 12 days. The national average is 14.8 days.*
- > The average length of stay for traumatic brain injury is 11.4 days. The national average is 14 days.*
- > 87.5 percent of patients with traumatic brain injury are discharged to the community, compared to the national average of 77.8 percent.*
- > 100 percent of patients with stroke or brain injury were satisfied with their rehabilitation experience.**

* *Uniform Data Systems for Medical Rehabilitation, Oct. 1, 2014–Sept. 30, 2015*

** *Patients responding to the Mayo Clinic Patient Satisfaction Survey*



Physical therapists can tailor this dynamic body weight-supported system to each patient, adjusting body weight support, momentum and speed.

BREADTH, DEPTH, EXPERIENCE

Acute care rehabilitation consultation teams, led by physiatrists, are integrated into subspecialist cerebrovascular, neurosurgery, and trauma teams. Mayo Clinic is a:

- > Comprehensive Stroke Center, certified by The Joint Commission
- > National Cancer Institute-designated Comprehensive Cancer Center
- > CARF-accredited institution in stroke and brain injury (Inpatient Rehabilitation Unit)

BRAIN REHABILITATION OUTPATIENT SERVICES

- > Cognitive rehabilitation
- > Comprehensive concussion management
- > Driving assessment
- > Neuromuscular rehabilitation program
- > Neuropsychological assessment and care
- > Rehabilitation for aphasic and non-aphasic communication disorders
- > Remote coordination of brain rehabilitation care
- > Spasticity management
- > Specialized rehabilitation nursing services
- > Telemedicine care
- > Vestibular rehabilitation
- > Vision rehabilitation
- > Vocational rehabilitation services

BRAIN INJURY COPING SKILLS

This 12-week program helps survivors with brain injuries and their family members or caregivers. Outcomes include significant decrease in problematic behavior in brain injury survivors and high levels of satisfaction for survivors and caregivers.

DYSPHAGIA REHABILITATION

Mayo Clinic treats more than 1,000 patients with dysphagia every year, from premature infants to patients at the end of life.

Coordinated care: Videofluoroscopy images and clinical reports are part of the patient's electronic health record, making it easier to coordinate care and follow-up.

Technology: Seven therapists are certified in adult and pediatric neuromuscular electrical stimulation therapy used to improve the function of the swallowing mechanism.

Expertise: A Mayo Clinic acute therapy supervisor is one of only 13 occupational therapists in the country certified in dysphagia evaluation and treatment by the American Occupational Therapy Association.

Allen Brown, M.D., has led numerous studies looking at ways to improve brain rehabilitation care and quality of life for patients with traumatic brain injury.



RESEARCH HIGHLIGHTS

Predicting outcome after stroke: This analysis showed that a measure of functional independence in motor performance and age upon rehabilitation hospital admission for stroke are predominant predictors of outcome at discharge.

Brown AW, et al. Measure of functional independence dominates discharge outcome prediction after inpatient rehabilitation for stroke. *Stroke*. 2015;46:1038.

Headache after TBI: This survey showed that management strategies for treating headache after TBI vary widely among general and specialty clinical practices, suggesting additional work is needed to lead to standardized management approaches for patients after TBI.

Brown AW, et al. Headache after traumatic brain injury: A national survey of clinical practices and treatment approaches. *PM&R*. 2015;7:3.

Predicting institutionalization after TBI rehabilitation: This analysis showed that higher levels of independence in bladder management, bed-chair-wheelchair transfers and comprehension at admission were associated with lower risks of institutionalization on discharge.

Eum RS, et al. Predicting institutionalization after traumatic brain injury inpatient rehabilitation. *Journal of Neurotrauma*. 2015;32:280.

Wireless sensors to measure walking post stroke: Wireless sensing allowed clinicians to audit skills practice and provided ground truth regarding changes in clinically important, mobility-related activities.

Dorsch AK, et al. SIRRACT: An international randomized clinical trial of activity feedback during inpatient stroke rehabilitation enabled by wireless sensing. *Neurorehabilitation and Neural Repair*. 2015;29:407.

Long-term survival after TBI: In this analysis, using the Rochester Epidemiology TBI cohort, TBI did not have a significant impact on long-term mortality, compared with matched population-based controls.

Brown AW, et al. Long-term survival after traumatic brain injury: A population-based analysis controlled for nonhead trauma. *Journal of Head Trauma Rehabilitation*. 2014;29:E1.

>> SPINAL CORD INJURY REHABILITATION

CARF accredited for more than 25 years

- > Mayo Clinic's patients include those with traumatic and nontraumatic spinal cord injury. The patient base of nontraumatic spinal cord injury — 80 to 120 patients a year — is among the largest in the world.
- > Full continuum of care for children and adults: acute care, inpatient rehabilitation, outpatient rehabilitation and lifelong follow-up.
- > Doctors, rehabilitation nurses and therapists have spinal cord injury subspecialty training.

Innovation — Diaphragmatic Pacing System

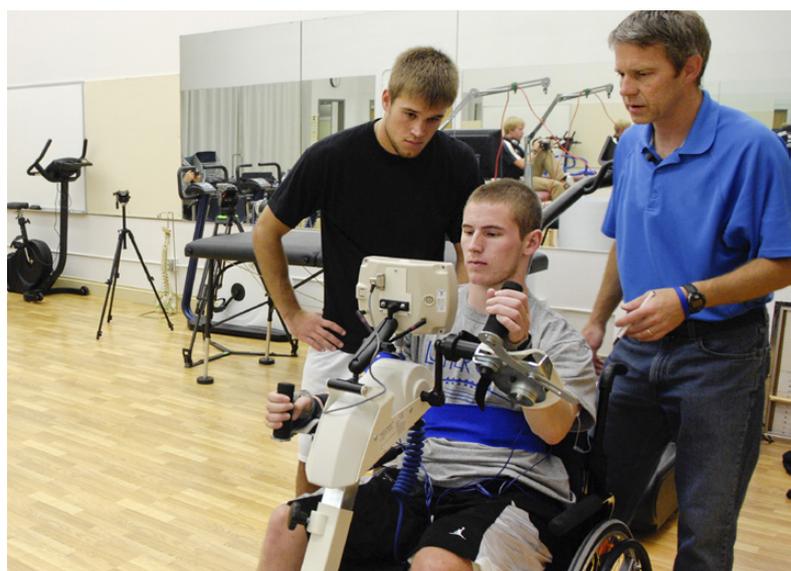
Mayo Clinic is one of several centers nationwide to offer the implantable diaphragmatic pacer to patients with high cervical spinal cord injury and neurological conditions that require a ventilator, such as congenital central hypoventilation syndrome (Ondine's curse).

Outcomes

- > 79 percent of Mayo Clinic patients with spinal cord dysfunction discharge to home, compared to the national average of 72 percent.*
- > Length of stay is 20 days, compared to the national average of 22 days.*
- > 92 percent of patients were satisfied with the spinal cord injury program and services.**

* *Uniform Data Systems for Medical Rehabilitation, Oct. 1, 2014–Sept. 30, 2015*

** *Patients responding to the Mayo Clinic Patient Satisfaction Survey*



THERAPIES & SERVICES

- > Robot-assisted and body weight-supported gait training
- > Biofeedback
- > Functional electrical stimulation
- > Upper extremity tendon transfers for tetraplegia
- > Assistive technology program
- > Clinical psychology and neuropsychology rehabilitation
- > Intrathecal baclofen pump program
- > Botox injection programs
- > Neuropathic pain management
- > Wheelchair Seating Clinic
- > Orthotic assessment and fabrication

RESEARCH HIGHLIGHTS

Mayo Clinic has a strong record of participation in research studies. Examples include:

- > Research in collaboration with the Department of Neurology that includes basic science and development of biotechnology to support nerve regeneration in the spinal cord system
- > Studies on epidural spinal stimulation to encourage improved rehabilitation outcomes
- > Assessment of outcomes for individuals with concurrent spinal cord injury and traumatic brain injury
- > Pilot study for participation in virtual exercise sessions with peers
- > Motion measurements and computer modeling of wheelchair seating, and spine and shoulder motion, during activities of daily living
- > Clinical trial of lower limb exoskeleton use, with and without functional electrical stimulation
- > Development of novel interventions for preventing and treating overuse injuries of the upper extremities

BLADDER AND BOWEL REHABILITATION

Effective bladder and bowel management can significantly improve overall quality of life for patients with neurogenic bladder or bowel. For some, this can be more important than the ability to ambulate.

Management techniques include:

- > Intermittent catheterization
- > Indwelling catheters
- > Voiding techniques, as able
- > Other surgical options, including bladder augmentation
 - Individualized bowel program
 - Anal irrigation system

Physiatrists, advanced-practice nurses and PM&R therapists:

- > Have subspecialty spinal cord injury training
- > Work closely with neuro-urologists, colorectal surgeons and rehabilitation nurses to create an effective treatment and management plan
- > Meet regularly with neuro-urologists to review urologic assessment and management options



Physiatrist Mark Christopherson, M.D., Spinal Cord Injury Program, and surgeon Douglas Husmann, M.D., Urology



Above, Mayo Clinic Children's Center includes providers from over 40 medical and surgical specialties, all focused on children's health care needs. Right, a young patient benefits from neuromuscular re-education using the Armeo to access video games.

>> PEDIATRIC CARE

INPATIENT

Care provided for all rehabilitation needs, including:

- > Acute neuromuscular illness or disease
- > Brain and spinal cord injury
- > Cerebral palsy
- > Complex medical conditions
- > Multiple trauma
- > Post brain or spinal cord tumor resection
- > Post complex orthopedic surgery
- > Postsurgical partial hemispherectomy for intractable seizures
- > Postsurgical solid organ transplant
- > Selective dorsal rhizotomy
- > Traumatic brain injury and concussion

CARF accreditations: Pediatric specialty program and pediatric brain injury program

Expert care: Three physicians are board certified in pediatric rehabilitation medicine.

OUTPATIENT

Physiatrists collaborate with physicians from virtually every pediatric specialty in these multidisciplinary clinics:

Aerodigestive Clinic: Patients with feeding and swallowing difficulties see specialists from multiple disciplines — otolaryngology, dietetics, gastroenterology, pulmonology, pediatrics, sleep medicine, speech pathology and occupational therapy and others — in just one week to develop a coordinated care plan.

Newborn Intensive Care Follow-up Clinic: Neurologists, neonatologists, therapists, dietitians and social services staff work together to care for high-risk infants.

Pediatric brain injury and concussion follow-up: Physiatrists, neuropsychologists and brain injury nurses provide individualized evaluation, testing and treatment recommendations using the full breadth of resources available at Mayo Clinic.

Cerebral Palsy Clinic: Physiatrists, orthopedists, neurologists, neurosurgeons, urologists, therapists, dietitians and social workers collaborate to evaluate and treat children with cerebral palsy with the goal of maximizing function and participation.

Spina Bifida Clinic: Physiatrists, orthopedists, urologists, neurologists, neurosurgeons, therapists, social workers and dietitians work together to evaluate and treat children with spinal dysraphism to maximize function and participation.

Length of stay for children on the rehabilitation unit is 6.3 days shorter than the national average.

REHABILITATION OUTCOMES

- > Functional gains per rehabilitation day (length of stay efficiency) is 3.25, compared to the national average of 1.54.*
- > Ultimate functional outcome (WeeFIM rating total gain) is 25.4, compared to the national average of 22.1.*
- > Average length of stay on the rehabilitation unit for children is 18.6 days, compared to the national average of 24.9 days.*
- > All of our patients are discharged to home, compared to the national average of 90.2 percent.*
- > 100 percent of pediatric families would recommend Mayo Clinic's Inpatient Rehabilitation Unit to family or friends if their child were to need similar care.**

* Uniform Data Systems for Medical Rehabilitation, Oct. 1, 2014–Sept. 30, 2015

** Patients responding to the Mayo Clinic Patient Satisfaction Survey



This pediatric body-weight supported treadmill, combined with a robotic-driven gait orthosis, is one of the few pediatric devices available in the U.S. It is used in gait training for children with cerebral palsy, brain injury, spinal cord injury, and after selective dorsal rhizotomy and complex orthopedic surgeries.

INNOVATIVE CARE FOR YOUNG PATIENTS

Functional gait disorders: Children participate in a one-to-two week intensive gait re-education program.

Plagiocephaly: Infants are evaluated by physicians for complicating conditions. Physical therapists treat torticollis, as needed. Occupational therapists use a 3-D laser scan to quantify and follow head shape asymmetry and fit for cranial orthoses.

Pain: Two areas assist with pain, one focused on pharmacological strategies and the other focused on behavioral strategies.

- > **Pain Clinic:** Treatment may include medications, physical therapy, injections and biobehavioral techniques.
- > **Pediatric Pain Rehabilitation Program:** This three-week outpatient program serves patients with persistent pain. Most patients:
 - Taper off narcotic pain medications
 - Demonstrate increased physical stamina and aerobic capacity
 - Show improvements in psychological measures

Voiding dysfunction: A team that includes urologists, physical therapists and nurses addresses voiding dysfunction.

RESEARCH HIGHLIGHTS

Shear wave ultrasound elastography:

Researchers use this new technology to:

- > Measure muscle stiffness in children with spastic cerebral palsy who have been treated with botulinum toxin and those who have undergone a selective dorsal rhizotomy. The research is funded by an NIH KL2 competitive research grant.
- > Investigate muscle properties in children with idiopathic toe walking (ITW). This is part of a pilot study investigating use of Kinesio tape for normalizing walking. This work is funded by the Gabriella E. Molnar-Swofford Pediatric PM&R Research Award through the Foundation for Physical Medicine and Rehabilitation.

Obesity: Researchers are investigating health attitudes and physical activity in parents of children with and without disabilities.

Pain management: In collaboration with Mayo's Anesthesiology and Psychiatry and Psychology departments, a new smartphone app, iBeatPain, was developed at Mayo Clinic to help teens manage their chronic pain symptoms. This app is being studied.

Spasticity in cerebral palsy: An emerging area of research involves a new paradigm regarding the etiology of movement difficulties and spasticity in individuals with cerebral palsy due to birth prematurity.

New research underway:

- > Clinical efficacy of epicatechin in patients with Friedreich's ataxia: Open label phase II clinical trial
- > Effect of treatment on activity and muscle function in pediatric patients with scoliosis
- > Kicking behavior in infants with spina bifida following in utero and postnatal surgery: A novel approach for assessment of surgical efficacy and design of evidence-based intervention strategies

U.S. News & World Report

- > Ranked Mayo Clinic Children's Center in all 10 specialties for 2014–2015.

Shriners Hospitals for Children

- > This health care system of 22 hospitals recently joined the Mayo Clinic Care Network to offer its providers and patients convenient access to additional expertise from Mayo Clinic.

Proton Beam Therapy

- > Beginning in June 2015, Pediatric PM&R cares for children undergoing proton beam therapy for childhood cancer.

Hypoplastic left heart syndrome

- > PM&R specialists are part of the team that provides stem cell treatments for this rare heart disorder.

Level 1 Pediatric Trauma Center

- > This designation is based in part on the excellence of rehabilitation care.

Mayo Clinic Children's Center

- > Offers children's hospital and outpatient care:
 - > 144 hospital beds
 - > More than 200 pediatric specialists
 - > More than 55,000 unique pediatric patients and 220,000 patient visits annually

>> CANCER REHABILITATION

Longest-functioning cancer rehabilitation service

In 1980, PM&R developed the Cancer Adaptation Team that has become the longest continually functioning inpatient consultation team in the U.S. devoted to the preservation of function among hospitalized patients with cancer. Rehabilitation services have been integrated within the Mayo Clinic Cancer Center since its inception.



OUTPATIENT CANCER REHABILITATION CLINIC

Physiatrists collaborate with cancer specialists, psychiatrists, social workers, and palliative and pain management specialists to optimize patients' comfort and quality of life. This clinic:

- > Delivers evidence-based exercise programs for cancer survivors
- > Addresses sequelae of cancer and its treatment
- > Screens for treatable functional deficits

CANCER ADAPTATION TEAM (CAT)

- > Has become a model for other centers. A study published in *Mayo Clinic Proceedings* showed significant functional improvement on the Karnofsky Performance Status and Barthel Mobility Index among patients followed by the CAT. This was one of the first studies to demonstrate the effectiveness of cancer rehabilitation.
- > Coordinates seamless rehabilitation across acute hospitalization, post-acute inpatient rehabilitation and outpatient clinics.

Andrea Cheville, M.D.,

Mayo Clinic PM&R research chair,
has done extensive research in
cancer survivorship, lymphedema,
cancer pain, and functional
assessment and modeling.



LYMPHEDEMA CLINIC

- > Provides diagnostic and treatment services for lymphedema of diverse etiologies, including cancer-related, primary and systemic-related, as well as other types of edema (chronic venous stasis, Klippel-Trenaunay syndrome and others)
- > Is integral in the management of patients with breast and other cancers to detect and address lymphedema in its early and remediable stages
- > Offers specialized diagnostic and assessment tests: lymphoscintigraphy, vascular studies, bioimpedance and optoelectronic volumetry
- > Offers diverse management approaches: wound care, myofascial release techniques and other musculoskeletal treatments

RESEARCH HIGHLIGHTS

- > Yost KJ, et al. Lymphedema after surgery for endometrial cancer: Prevalence, risk factors and quality of life. *Obstetrics & Gynecology*. 2014;124(2 Pt 1):307.
- > Cheville AL, et al. Adapting lymphedema treatment to the palliative setting. *American Journal of Hospice and Palliative Medicine*. 2014;31(1):38.
- > Cheville AL, et al. Improving adherence to cancer treatment by addressing quality of life in patients with advanced gastrointestinal cancers. *Journal of Pain and Symptom Management*. 2015;50(3):321.



>> AMPUTEE REHABILITATION

Successful rehabilitation for rarest surgeries

HEMIPELVECTOMY

Mayo Clinic treats as many as 20 patients a year who undergo hemipelvectomy because of cancer or traumatic injury. Mayo Clinic researchers have found that patients who had a hemipelvectomy or hip disarticulation not only thrived with prostheses, but also lived longer. The findings showed that high body mass index, advanced age and depression do not preclude prosthetic rehabilitation. Further, prostheses can be effective even when patients have arthritis, coronary artery disease, cerebrovascular disease, diabetes, depression and dementia.



Rotationplasty has allowed me to do anything that I would like to do.”

Female patient 15 years after surgery

ROTATIONPLASTY

Mayo Clinic has treated several patients with osteosarcomas with rotationplasty, a surgery performed to replace the knee with the patient’s own rotated ankle joint. The surgery positions the rotated foot to extend downward into a prosthetic lower leg. The operation gives children mobility to play sports and the benefit of a “knee.” Following surgery, PM&R specialists work with patients to stretch the ankle safely, enabling flexibility of the rotated joint, and prescribe prostheses when indicated.



RESEARCH HIGHLIGHTS

- > Kralovec ME, et al. Prosthetic rehabilitation after hip disarticulation or hemipelvectomy. *American Journal of Physical Medicine & Rehabilitation*. 2015;94:1035.
- > Houdek MT, et al. Functional outcome measures of patients following hemipelvectomy. *Prosthetics and Orthotics International*. In press.

Karen Andrews, M.D., has led studies on translation of robotic principles to upper limb myoelectric prostheses and prosthetic rehabilitation following hip disarticulation and hemipelvectomy level amputations.



>> VASCULAR ULCER & WOUND HEALING CENTER

PM&R brings critical expertise that saves limbs

The Vascular Ulcer and Wound Healing Center is a collaboration that includes specialists in PM&R, vascular medicine, vascular surgery, orthopedic surgery, internal medicine and vascular radiology, as well as nurses, therapists, orthotists and pedorthists.



REGENERATIVE MEDICINE TO ENHANCE WOUND HEALING

Animal studies conducted at Mayo Clinic have shown the effectiveness of cell-based therapy in the treatments of chronic wounds. A cytokine scaffold capable of supporting the growth and differentiation of stem cells has been developed. Using this product on rats, the team noted a significant reduction in wound size over time, decreased time to wound healing and the ability to grow dermal structures (sweat glands and hair) in the wound. Researchers are now working to use this product in larger animals and then advance to a phase I trial in humans.



A cytokine scaffold capable of supporting the growth and differentiation of stem cells has been developed.

RESEARCH HIGHLIGHTS

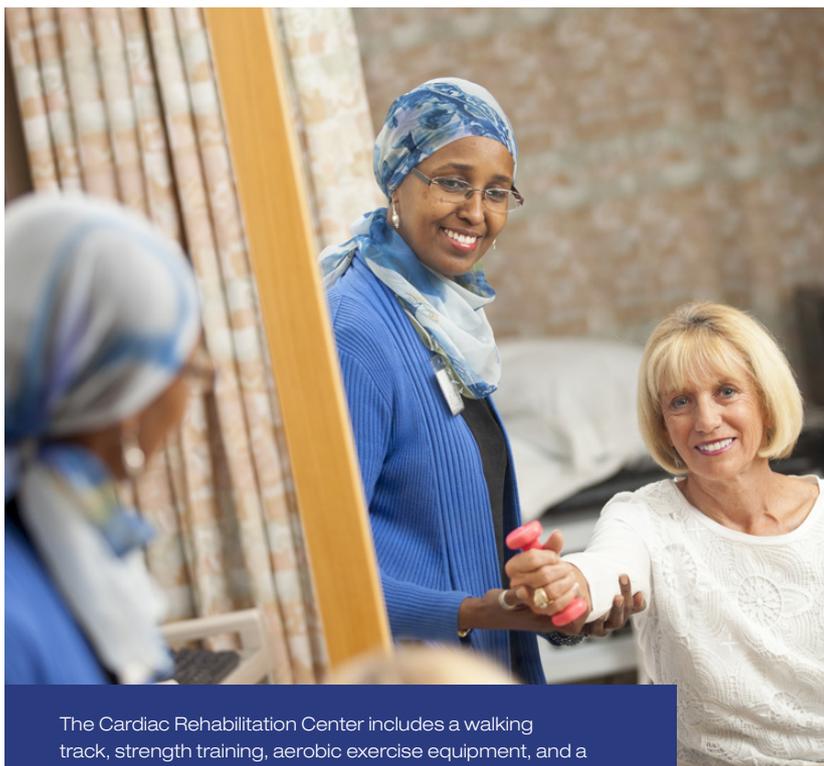
- > Andrews KL, et al. Wound management of chronic diabetic foot ulcers: From the basics to regenerative medicine. *Prosthetics and Orthotics International*. 2015;39:29.
- > Andrews KL. Guest editorial for special issue: Prevention and management of foot complications in patients with diabetes – An interdisciplinary care perspective. *Prosthetics and Orthotics International*. 2015;39:6.

CARE IS PROVIDED FOR WOUNDS RELATED TO:

- > Arterial disease
- > Diabetes
- > Vasculitis
- > Venous disease

PM&R EXPERTISE INCLUDES:

- > Amputee rehabilitation
- > Footwear and orthotics
- > Noncontact low-frequency ultrasound
- > Optimizing compression and other measures to decrease edema for patients with chronic venous insufficiency and wounds
- > Prevention of complications and impairment from secondary conditions
- > Use of impulse pumps to increase perfusion for patients with arterial occlusive disease and ischemia
- > Wound offloading strategies



The Cardiac Rehabilitation Center includes a walking track, strength training, aerobic exercise equipment, and a demonstration kitchen.

>> CARDIOVASCULAR HEALTH & REHABILITATION

Outcomes among best in the nation

Inpatient and outpatient care is offered by a team that includes physiatrists, preventive cardiologists, exercise physiologists, physical therapists, occupational therapists, dietitians, pharmacists and nurses. They treat patients with documented cardiovascular disease or those at high risk for its development. Outpatient cardiovascular rehabilitation may last up to 36 sessions.

OUTCOMES

High participation: 65 percent of all eligible Mayo Clinic patients participate in the cardiovascular rehabilitation, compared to national averages reported from 10 to 23 percent.

Effectiveness: Cardiac rehabilitation participation is associated with a markedly reduced risk of readmission and death after incident myocardial infarction. At Mayo Clinic, results for mortality and recurrent cardiac events are among the best in the nation, with lower readmissions for any reason and for cardiac care compared to patients who didn't participate in cardiac rehabilitation.

RESEARCH HIGHLIGHTS

- > Thomas RJ, et al. The role of cardiac rehabilitation following acute coronary syndromes. *Current Cardiology Reports*. 2014;16:534.
- > Silber TC, et al. Cardiac rehabilitation after spontaneous coronary artery dissection. *Journal of Cardiopulmonary Rehabilitation and Prevention*. 2015;35:328.
- > Thomas RJ. The gap in cardiac rehabilitation referral: A system-based problem with system-based solutions. *Journal of the American College of Cardiology*. 2015;65:2089.
- > Alsara O, et al. Inpatient rehabilitation outcomes for patients receiving left ventricular assist device. *American Journal of Physical Medicine and Rehabilitation*. 2014;93:860.

OUTPATIENT CARDIAC REHABILITATION INCLUDES:

- > Supervised exercise, including aerobic, strengthening, flexibility, and balance exercises
- > Risk factor management with evaluations by prevention specialists
- > Smoking cessation counseling
- > Nutrition counseling
- > Pharmacy counseling
- > Psychological evaluation
- > Cooking demonstrations by an executive chef
- > Interactive support group
- > Resiliency class



>> MUSCULOSKELETAL REHABILITATION

Musculoskeletal Rehabilitation Clinic integrates
PM&R, orthopedics and sports medicine



In this ultrasound-guided knee joint injection, the needle is placed into the joint from a lateral to medial approach.

CONVENIENT FOR PATIENTS

In most situations, a patient sees a physiatrist and completes any needed diagnostic tests, imaging, and specialist or surgeon consultations within a few days. Patients can quickly move through clinical consultations, imaging or testing and treatment. In addition, the center provides in-depth patient education on conditions, treatment and recovery via electronic kiosks and anatomical models.



PM&R physicians use image guidance to deliver patients' own cells and growth factors into injured or irritated joints, or tendons, to promote pain relief and healing.

TREATMENT

Patients benefit from accurate and highly efficient evaluations, testing, subspecialty consultations and diagnosis for musculoskeletal disorders and pain. Many patients are treated with physical therapy and injections. Mayo Clinic uses ultrasound imaging to diagnose and maximize the benefits of injection therapies. Patients are assured of comprehensive nonsurgical treatment before progressing to surgery, if needed.

REGENERATIVE MEDICINE

PM&R physicians are using image guidance to deliver the body's own cells and growth factors into injured or irritated joints, or tendons, to promote pain relief and healing. Platelet-rich plasma (PRP) and bone marrow concentrate (BMC) are used to treat symptoms associated with arthritis, tendinopathies and avascular necrosis of the hip.

ARTHROPLASTIES

Thousands of patients benefit from arthroplasties at Mayo Clinic every year. Rehabilitation care is provided in the acute care setting. Patients generally do very well and few require acute inpatient hospitalization or extensive outpatient rehabilitation care.

MUSCULOSKELETAL REHABILITATION CLINIC

- > Provides treatment and rehabilitation for virtually all musculoskeletal conditions.
- > Offers access to consultants from PM&R, neurology, neurosurgery, orthopedics, rheumatology, bone endocrinology, radiology, anesthesia and sports medicine.
- > Provides in-depth patient education on conditions, treatment and recovery via electronic kiosks and anatomical models.

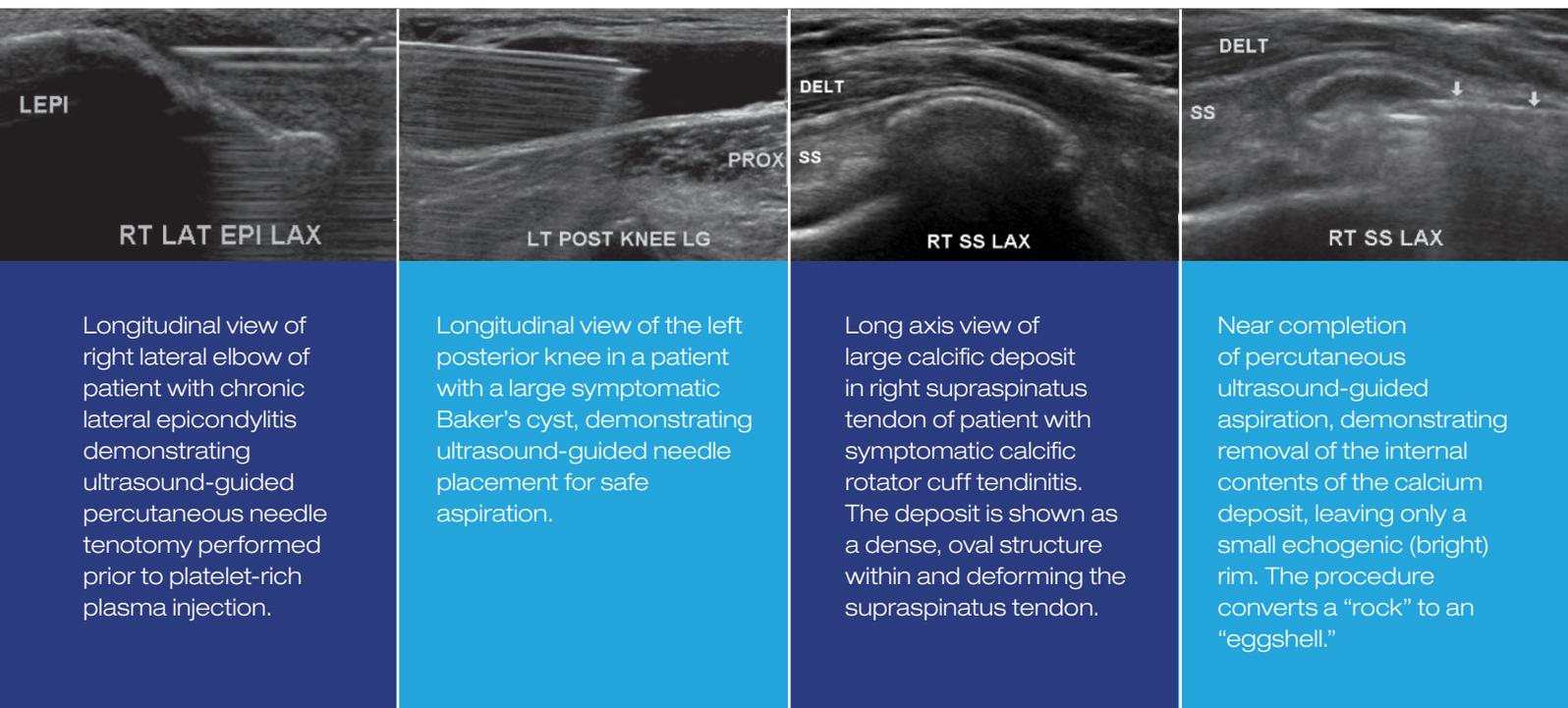
>> ULTRASOUND

Innovative diagnostic & interventional techniques

With the latest ultrasound imaging, PM&R clinicians are offering new diagnostic and interventional approaches to address musculoskeletal disorders.

CURRENT USES

- > Needle placement into joints for aspiration or injection: Ultrasound guidance is particularly helpful for patients with challenging anatomy, those on blood thinners or those for whom a non-guided injection has failed.
- > Aspiration and injection of ganglion cysts.
- > Diagnostic or therapeutic injections into tendon sheaths and bursae.
- > Diagnostic or therapeutic nerve blocks.
- > Percutaneous treatment of calcific tendinitis through aspiration or fragmentation of calcium deposits.
- > Needle tenotomy or fasciotomy: High-resolution ultrasound guides a needle to break up scar and degenerative tissue in chronic tendinopathy or fasciopathy, prompting the body's own cells to begin the regeneration process.
- > Percutaneous ultrasonic tenotomy and debridement: High-resolution ultrasound is combined with a minimally invasive device developed at Mayo Clinic that fragments, emulsifies and removes scar and degenerative tissue in chronic tendinopathy and fasciopathy.
- > Percutaneous trigger finger release: Musculoskeletal ultrasound helps guide a small blade or needle under the skin to the problematic tendon to sever the constricting tissue.
- > Regenerative medicine: High-resolution ultrasound is used as a guide to deliver the body's own cells and growth factors into joints and tendons in the form of platelet-rich plasma (PRP) and bone marrow concentrate.



Longitudinal view of right lateral elbow of patient with chronic lateral epicondylitis demonstrating ultrasound-guided percutaneous needle tenotomy performed prior to platelet-rich plasma injection.

Longitudinal view of the left posterior knee in a patient with a large symptomatic Baker's cyst, demonstrating ultrasound-guided needle placement for safe aspiration.

Long axis view of large calcific deposit in right supraspinatus tendon of patient with symptomatic calcific rotator cuff tendinitis. The deposit is shown as a dense, oval structure within and deforming the supraspinatus tendon.

Near completion of percutaneous ultrasound-guided aspiration, demonstrating removal of the internal contents of the calcium deposit, leaving only a small echogenic (bright) rim. The procedure converts a "rock" to an "eggshell."

REHABILITATIVE ULTRASOUND IMAGING (RUSI) IN PHYSICAL THERAPY

- > Helps patients gain strength following abdominal surgery. The use of RUSI for postsurgical rehabilitation after a Whipple procedure for pancreatic cancer was presented at the American Physical Therapy Association Combined Sections Meeting, Chicago, February 2012.
- > Helps patients improve lower back pain by facilitating core muscle activation and improving core strength.

RESEARCH HIGHLIGHTS

- > Smith J, et al. Sonographically guided anterior cruciate ligament injection: *Technique and validation. PM&R. 2015;7:736.*
- > Barnes DE, et al. Percutaneous ultrasonic tenotomy for chronic elbow tendinosis: a prospective study. *Journal of Shoulder and Elbow Surgery. 2015;24:67.*
- > Smith J, et al. Sonographically guided posterior subtalar joint injections via the sinus tarsi approach. *Journal of Ultrasound in Medicine. 2015;34:83.*

>> ARTHRITIS MANAGEMENT & REHABILITATION

Mayo Clinic offers expert care to patients dealing with all types of arthritis: rheumatoid arthritis and inflammatory arthritis, connective tissue diseases, inflammatory myopathies, osteoarthritis, hypermobility syndromes and seronegative spondyloarthropathies.



Physiatrists Margaret Moutvic, M.D., Mary Jurisson, M.D., and Terry Oh, M.D., provide care for patients with more than 100 types of arthritis.

TREATMENT

The PM&R team includes physicians, physical therapists, certified hand therapists and occupational therapists. Specialists represent rheumatology, orthopedics (hand, spine and large joint), bone endocrinology, orthopedic-certified therapy and genetics.

The team offers patients:

- > Evaluation of barriers to functioning
- > Physical modalities: heat, cold, electrical stimulation and laser therapy
- > Education to improve exercise, joint protection, diet, sleep and pain
- > Alternative therapies, including tai chi, Feldenkrais method and acupuncture
- > Inpatient postoperative rehabilitation
- > Orthotics
- > Injections

MELORHEOSTOSIS RESEARCH

The Melorheostosis Research Group, in collaboration with colleagues in musculoskeletal radiology, presented new data on radiographic findings at the 2014 Musculoskeletal Radiology and Melorheostosis Society meetings suggesting that, in some patients, there may be progression in the distribution of the disease.

ELECTROMYOGRAPHY >> LABORATORY

Researching, using adjunctive ultrasound
to improve accuracy of diagnoses

PM&R PHYSICIANS ARE USING:

- > Electromyography for intraoperative monitoring for cranial, spine, brachial plexus and other peripheral nerve surgery.
- > Ultrasound to isolate small or deep muscles in the diaphragm, head, neck or limb, and identify the course of a nerve for effective stimulation.
- > Specialized tests are used for congenital myasthenia, cramp-fasciculation syndrome, periodic paralysis, cranial nerve evaluation, hemifacial spasm, diaphragm evaluation and diaphragm pacing assessment.

RESEARCH HIGHLIGHTS

- > Boon AJ, et al. Sensitivity and specificity of diagnostic ultrasound in the diagnosis of phrenic neuropathy. *Neurology*. 2014;83:1264.
- > Gertken JT, et al. Electromyography and anticoagulation. *PM&R*. 2013;5:S3.
- > Boon AJ, et al. Utility of ultrasound-guided surface electrode placement in lateral femoral cutaneous nerve conduction studies. *Muscle & Nerve*. 2011;44:525.
- > Goodman BP, et al. Prolonged compound muscle action potential duration in critical illness myopathy. *Muscle & Nerve*. 2009;40:1040.



>> HAND REHABILITATION

Resolving pain, regaining dexterity

Rehabilitation specialists are involved from the earliest stages of diagnosis, through treatment and long-term management of complex diseases and injuries of the upper extremities. Physiatrists work closely with hand surgeons and hand therapists to help patients resolve pain, regain dexterity and function.

MAYO CLINIC OFFERS:

- > Diagnoses and rehabilitative care for complex upper extremity diseases and injuries
- > Close collaboration with hand and neurologic surgeons
- > Certified hand therapists
- > Extensive experience with hand injuries and replantations
- > First clinical hand transplant program in the U.S.

EXPERT REHABILITATION CARE

- > Hand arthritis, rheumatic diseases
- > Following tendon transfer
- > Following arthroplasties
- > Neoplasms in the hand and upper extremities
- > Complex regional pain syndrome
- > Upper extremity neuropathies
- > After replantation of hands and fingers
- > Before and following hand transplantation
- > Ultrasound-guided treatments for Dupuytren's contracture and trigger finger

Mayo Clinic performs more brachial plexus surgical repairs than any other medical center in the Western Hemisphere — about **150 a year**.

BRACHIAL PLEXUS

- > A trio of experienced surgeons work together to perform the complex microsurgical repairs.
- > Postsurgery, physiatrists and certified hand therapists help patients improve function and manage pain during recovery that may progress up to three years.
- > Once reinnervation occurs, therapists educate patients to activate the muscles that reanimate following surgery.

Mayo Clinic researchers have found that even small improvements in strength — regaining just 4 percent of normal bicep strength — allows patients to bring a fork to the mouth and resume other important movements.





>> SPINE CENTER

Providing a spectrum of nonsurgical treatments

The Spine Center offers a broad scope of medical and interventional treatments, including:

- > Therapeutic exercise prescriptions
- > Counseling for self-care and spine health
- > Complementary medicine options
- > Manual medicine techniques
- > Medication review and recommendations
- > Myofascial techniques
- > Nursing education to improve pain control
- > Physical therapy modalities
- > Psychological screening
- > Trigger point injections
- > Fluoroscopy-guided epidural and facet joint injections
- > Platelet-rich plasma injections for sacroiliac joint pain
- > New or experimental pain treatments

Care providers: Physiatrists usually conduct the initial evaluation. Other team members may include physicians, nurses, therapists and midlevel providers from neurology, anesthesia, neurosurgery, radiology, rheumatology, orthopedics, work rehabilitation, pain rehabilitation, orthotics, psychiatry and psychology and dietetics.

Patients: About 20,000 patients are seen annually.

“Experienced spine physiatrists offer effective alternatives to surgery, focusing on improving function and quality of life.”

Randy Shelerud, M.D.

RESEARCH HIGHLIGHTS

PM&R researchers are:

- > Studying minimally invasive lumbar decompression for spinal stenosis
- > Investigating stem cell technologies to restore disk tissue in human lumbar spines
- > Studying high-frequency implantable spinal cord stimulation in patients with disabling chronic low back pain

Efficacy studies are focused on:

- > Transforaminal epidural steroid injections
- > Injections with novel medications, such as clonidine, as substitutes for steroids
- > Repeated injections



MAYO CLINIC SPORTS MEDICINE >> CENTER

Two new locations open

Mayo Clinic Sports Medicine Center, a one-stop shop for the evaluation and treatment of sports and activity-related injuries, injury prevention and sports performance enhancement, opened two Sports Medicine Center locations in 2014. One is on Mayo Clinic's campus in Rochester, Minnesota; the second is at Mayo Clinic Square in downtown Minneapolis.

Performance enhancement: Mayo Clinic Sports Medicine has partnered with EXOS, a leader in sports performance, to develop sports performance and injury prevention programs for a variety of sports and activities, including hockey, golf, running and throwing. Video analysis is used to improve an athlete's gait, swing and overhead throw and to identify movement flaws that increase injury risk.

Musculoskeletal ultrasound: Mayo Clinic is at the forefront in applying this technology to sports medicine, including ultrasound-guided injections and real-time evaluation of soft tissue injuries.

Concussion treatment: The Sports Medicine Center evaluates more than 800 individuals a year who sustain concussions related to sports or fitness activities. PM&R experts in brain injury rehabilitation are consulted to aid in the treatment of patients with persistent post-concussion symptoms.

Exertional leg pain: Sports Medicine Center physicians evaluate and treat athletes with exertional leg pain caused by conditions such as chronic exertional compartment syndrome or popliteal artery entrapment syndrome.

Team approach: Care providers include physiatrists, orthopedic surgeons, pediatricians, emergency medicine physicians, physical therapists, athletic trainers, sports nutritionists, strength and conditioning specialists and sports psychologists.

Patients: More than 28,000 every year.

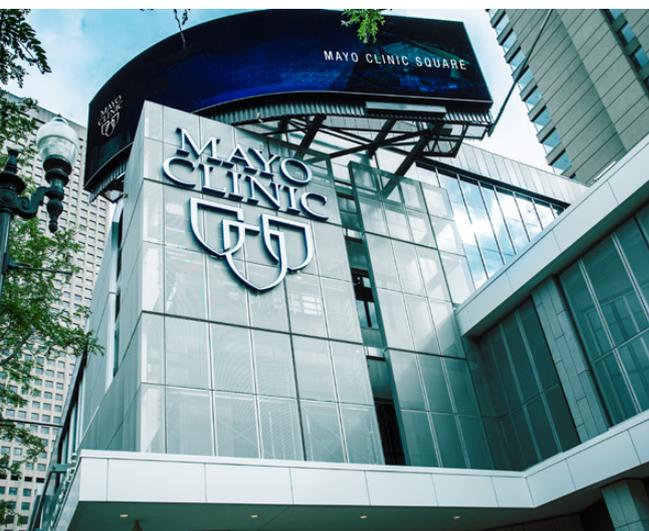
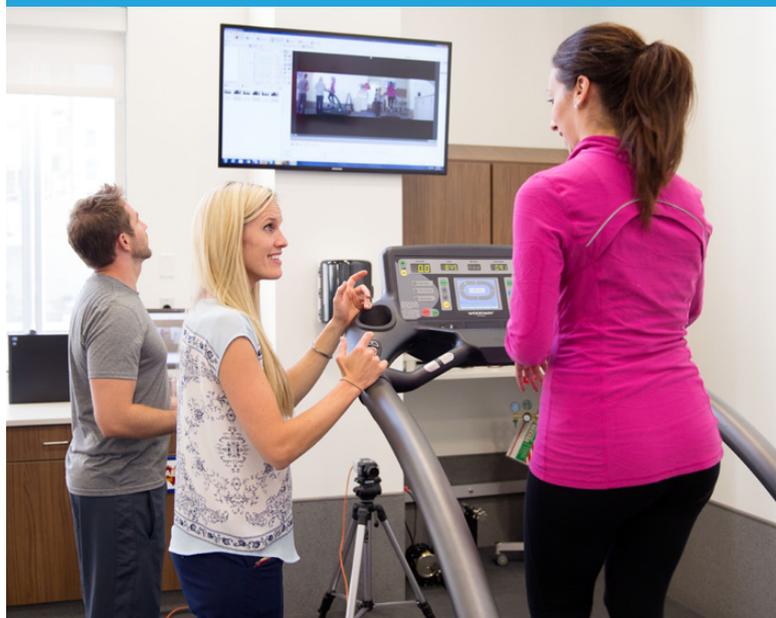
REGENERATIVE MEDICINE IMPROVES TENDON AND JOINT INJURIES

Mayo Clinic researchers are investigating the use of regenerative medicine to treat common conditions such as tendinopathy, muscle strains and osteoarthritis. In a study published in *PM&R*, Mayo Clinic researchers found that ultrasound-guided percutaneous needle tenotomy followed by platelet-rich plasma (PRP) injection is a safe and effective treatment for chronic, recalcitrant tendinopathy. This is the first clinical study to investigate the use of both tenotomy and PRP injections. Researchers found:

- > Maximum benefits tended to occur four months after the procedure.
- > More than 70 percent of patients had better use of their joints.
- > 76 percent reported improvement in pain.
- > Treatment resulted in structural improvements in injured tendons, which were detected via ultrasound.

TREATMENT TAILORED TO WOMEN'S NEEDS

Evaluations are offered to enhance sports performance for recreational and professional female athletes, addressing biomechanical and movement abnormalities specific to women. Sports Medicine physicians are experts in rehabilitation for concerns more common in women, such as stress fractures, patellofemoral pain and anterior cruciate ligament injuries.



MAYO KEEPS PROFESSIONAL BASKETBALL PLAYERS IN THE GAME

In 2014, Mayo Clinic became the preferred medical provider for the Minnesota Timberwolves and Lynx professional basketball teams. Mayo Clinic is proud to provide injury prevention programs to help keep athletes at the top of their game. Part of this collaboration included the opening of Mayo Clinic Square, where the Minnesota Timberwolves and Lynx train and have direct access to Mayo Clinic Sports Medicine Center expertise.

>> WORK REHABILITATION CENTER

Functional approach includes
return to work and stay at work as goals



SERVICES PROVIDED

- > Treatment for acute musculoskeletal injuries
- > Subacute and restorative therapy for workers at risk of delayed recovery
- > Work conditioning for patients with chronic or catastrophic injuries

One convenient location

Physiatrists and therapists work in one convenient location to facilitate integrated patient care. Physiatrists provide evaluation and medical treatment for individuals with work-related injuries. Physical and occupational therapists are specially trained in work rehabilitation, functional job analysis and functional capacity evaluation.

Holistic care

All care providers address the physical and psychosocial aspects of the injury, as well as its impact on overall fitness and health.

Resource for employers

Therapists include work as a part of patient treatment plans and may visit work sites to facilitate return to work. The staff communicates and works with employers on fitness for duty, return-to-work issues and injury prevention.

Outcomes

- > 93 percent of Mayo Clinic employees with low back pain treated at the Work Rehabilitation Center returned to their previous positions.
- > While 20 percent had permanent restrictions, all returning workers remained on the job 12 months after program completion.



TREATING & MANAGING >> PAIN

Assessment and intervention for acute and chronic pain

PAIN CLINIC SERVICES

- > Medication management
- > Fluoroscopy-guided spine injections
- > Diagnostic and neurolytic nerve blocks
- > Radiofrequency denervation of facet and sacroiliac joints
- > Implantation of intrathecal drug delivery system
- > Spinal cord stimulation system implantation
- > Stem cell and platelet-rich plasma therapy

CONCERNS ADDRESSED

- > Disk disease, spinal stenosis and radiculopathy
- > Facet and sacroiliac joint pain syndrome
- > Myofascial pain and fibromyalgia
- > Cancer pain
- > Postherpetic neuralgia
- > Complex regional pain syndrome
- > Refractory chest pain
- > Spasticity secondary to spinal cord injury, multiple sclerosis, others



PAIN REHABILITATION CENTER

- > Is one of the largest pain rehabilitation programs in the U.S., helping more than 450 patients with chronic pain each year
- > Focuses on improving pain self-management skills and resuming normal life activities
- > Offers two-day and three-week outpatient programs, including:
 - Medication management to eliminate opioid pain medication
 - Physical and occupational therapy
 - Sleep hygiene
 - Stress management and relaxation techniques
 - Biofeedback
 - Lifestyle management

SURVEY RESULTS

Patients who complete pain rehabilitation report significant improvements.

88%

Of patients who were using narcotic pain medication on admission and completed the program were not using narcotic pain medication six months after the program.*

87%

Increase in energy or vitality**

82%

Improved perception of overall health**

89%

Decreased pain severity**

81%

Improved social functioning**

88%

Less pain interference in daily life**

*Based on results from 280 patients who completed the program and filled out the six-month follow-up survey.

**Measurements are from the Multidimensional Pain Inventory and SF-36 Health Survey. Results listed are based on surveys that were completed at discharge by 659 patients, 2013-2014 Mayo Clinic pain rehabilitation database.

FIBROMYALGIA & CHRONIC FATIGUE >> CLINIC

In just two days, physiatrists and internal medicine specialists are able to diagnose or confirm fibromyalgia and develop a treatment plan. Nurses, wellness and endurance coaches, and physical and occupational therapists provide education, self-management strategies and resources to help patients control and manage chronic symptoms.

Benefits of Mayo Clinic's approach:

- > Multidisciplinary approach helps assure a correct diagnosis
- > Individual treatment plans

RESEARCH HIGHLIGHTS

Since 2012, Terry Oh, M.D., has led more than a dozen research studies on fibromyalgia and its risk factors.

- > Jiao J, et al. Association of abuse history with symptom severity and quality of life in patients with fibromyalgia. *Rheumatology International*. 2015;35:547.
- > Jiao J, et al. Physical trauma and infection as precipitating factors in patients with fibromyalgia. *American Journal of Physical Medicine & Rehabilitation*. 2015;94:1075.
- > Kim CH, et al. Association between alcohol consumption and symptom severity and quality of life in patients with fibromyalgia. *Arthritis Research & Therapy*. 2013;15:R42
- > Craft JM, et al. Unique barriers and needs in weight management for obese women with fibromyalgia. *Explore (NY)*. 2015;11(1):51.



In two days, specialists diagnose or confirm fibromyalgia and develop a treatment plan.

>> OSTEOPOROSIS



Mehrsheed Sinaki, M.D., developed both the ROPE and SPEED programs and has published more than 50 papers on osteoporosis, prevention of osteoporosis-related complications and the role of exercise.

Mayo Clinic physiatrists have developed what are now widely used treatment strategies to minimize complications from osteoporosis:

Rehabilitation of Osteoporosis Program-Exercise (ROPE): This spinal extension exercise program for patients with nontraumatic vertebral compression fractures significantly reduces the risk of additional fractures. The program is widely used around the world.

Spinal Proprioceptive Extension Exercise Dynamic (SPEED) program: This program uses spinal-weighted kypho-orthosis (WKO) and a spinal proprioceptive extension exercise dynamic program to significantly reduce the risks of falls in ambulatory kyphotic patients with and without osteoporosis.

Kyphosis reduction without spinal bracing: This posture training program uses mechanical reduction of kyphosis and recruitment of spinal proprioception.

RESEARCH HIGHLIGHTS

- > Sinaki M, Pfeifer M. Treatment of vertebral fractures due to osteoporosis: Role of posture training support and spinal proprioceptive. *Osteologie*. 2015;24:7.
- > Huntoon EA, et al. Significantly fewer refractures after vertebroplasty in patients who engage in back extensor strengthening exercises. *Mayo Clinic Proceedings*. 2008;83:54.
- > Sinaki M, et al. Significant reduction in risk of falls and back pain in osteoporotic-kyphotic women through a Spinal Proprioceptive Extension Exercise Dynamic (SPEED) program. *Mayo Clinic Proceedings*. 2005;80:849.

WOMEN-FOCUSED SPECIALTY AREAS

- > Breast Clinic
- > Gynecology
- > Obstetrics
- > Reproductive endocrinology and infertility
- > Urogynecology
- > Urology (urinary tract conditions, including urinary incontinence and pelvic organ prolapse)
- > Women's Cancer Program
- > Women's Health Clinic (menopause and sexual health concerns)
- > Women's Heart Clinic

PELVIC FLOOR DYSFUNCTION

PM&R experts offer pelvic floor muscle assessment and treatment for pelvic pain, chronic constipation and urinary incontinence for women and men. This highly collaborative area incorporates PM&R, gynecology, urogynecology, urology, women's health and gastroenterology.

Conditions treated include:

- > Pelvic floor tension myalgia
- > Pelvic floor muscle weakness and incontinence
- > Dyspareunia
- > Pelvic organ prolapse
- > Abdominal wall pain
- > Pelvic floor muscle dysfunction after gynecological/urological surgeries or pelvic radiation
- > Prenatal and postnatal rehabilitation, including diastasis recti, back pain, sacroiliac dysfunction and perineal trauma during delivery

Treatment options include:

- > Bowel and bladder training
- > Manual therapy — internal (vaginal and rectal) and external
- > Prescriptive exercises for pelvic muscles
- > Neuromuscular re-education of transverse abdominis and pelvic floor muscles using real-time ultrasound imaging
- > Variety of modalities for pain modulation including shortwave diathermy, electrical stimulation, heat and ice
- > External and internal surface EMG biofeedback to augment training of the pelvic floor muscles
- > Mindfulness, relaxation techniques and breath work
- > Dilator therapy
- > Development and instruction in individualized home exercise program

PELVIC FLOOR TENSION MYALGIA PROGRAM

Patients have the option to come for a one-week rehabilitation program that is customized to their specific needs. Typically, the patient will be seen twice a day for a variety of treatment options.

EVACUATION DISORDERS PROGRAM

Mayo Clinic offers intensive treatment for pelvic floor dysfunction — constipation, incontinence and pelvic floor dyssynergia.

This biofeedback-assisted pelvic floor muscle rehabilitation and behavioral modification program is staffed by specially trained registered nurses who help patients:

- > Establish a more regular bowel emptying pattern using an appropriately coordinated evacuation effort.
- > Wean off laxatives, enemas or other artificial means of evacuation and build confidence in the skills learned to establish a successful home program.

Outcomes

- > 72 percent of patients have shown initial improvement in colorectal, urinary and pelvic floor symptoms after program completion (measured with CRADI-8, UDI-6, and PFIQ-7).

The two-week intensive program includes:

Week 1: On average, three 30–45 minute sessions daily, employing rectal sensors and EMG to monitor pelvic muscle tension.

Week 2: Continued sessions to advance coordination of abdominal and pelvic floor activity using rectal balloon simulation of bowel movements.

>> NEUROLOGIC DISEASE REHABILITATION

Supporting patients as disease progresses

Doctors and therapists address the changing functional limitations that affect patients with wide-ranging neurological conditions, including rare conditions, through a multidisciplinary approach.

Focus: Care providers offer rehabilitation and palliative care, assistive devices, services and resources to help patients maintain quality of life as they adapt to functional or cognitive decline.

Continuum of care: The team serves patients with rapidly or slowly changing rehabilitation needs, especially those who have limited medical treatment options.



UNIQUE MOTOR-PREPROGRAMMING INTERVENTION FOR FUNCTIONAL MOVEMENT DISORDERS

The program is unique in the intensity of the sessions and coordinated efforts between the physicians and therapists. Patients have physical and occupational therapy sessions twice a day for five days. Over the course of the treatment, patients extinguish abnormal movement patterns and enhance and habituate normal body control using proprioception and visual feedback. This intervention:

- > Enables reduction of those movements with enhanced intentional control for patients with excessive movements
- > Improves efficient and effective motor patterns for normal movement for patients with restricted or incomplete movements

TREATING HUNDREDS OF COMMON AND RARE NEUROLOGIC CONDITIONS

Neuromuscular diseases

Muscle disorders: Polymyositis, dermatomyositis, inclusion body myositis, dystrophies, others

Neuromuscular junction disorder: Myasthenia gravis, Lambert-Eaton syndrome

Motor neuron disease: Amyotrophic lateral sclerosis (ALS), bulbar and pseudobulbar palsy, motor neuropathies, multifocal motor neuropathy, post-polio syndrome, primary lateral sclerosis, spinal muscular atrophy

Peripheral nerve disease: Chronic inflammatory demyelinating polyneuropathy, brachial and lumbosacral plexus neuritis, diabetic peripheral neuropathy, hereditary neuropathies, multifocal motor neuropathy, other neuropathies

Movement disorders

Parkinson's disease and parkinsonism: Progressive supranuclear palsy, multiple system atrophy, corticobasal degeneration, hereditary and idiopathic late-onset ataxias, dystonia, functional movement disorders

Demyelinating diseases

Multiple sclerosis, neuromyelitis optica, optic neuritis, transverse myelitis, other central nervous system inflammatory demyelinating diseases

Spasticity management

Consultation, chemodenervation, medical management, bracing, ultrasound guidance and therapy treatments

RESEARCH HIGHLIGHT

- > Czarnecki K, et al. Functional movement disorders: Successful treatment with a physical therapy rehabilitation protocol. *Parkinsonism & Related Disorders*. 2012;18:247.
- > Panos M, et al. Differential expression of multiple kallikreins in a viral model of multiple sclerosis points to unique roles in the innate and adaptive immune response. *Biological Chemistry*. 2014;395:1063.
- > O'Brien T, et al. Translating stem cell research to the clinic: a primer on translational considerations for your first stem cell protocol. *Stem Cell Research & Therapy*. 2015; 22:146.

VESTIBULAR & BALANCE REHABILITATION



Otolaryngologists, neurologists, psychiatrists and PM&R specialists work together to diagnose and treat balance problems, including:

- > Benign paroxysmal positional vertigo
- > Persistent postural-perceptual dizziness
- > Concussion-related dizziness and imbalance
- > Multifactorial imbalance
- > Vestibular hypofunction
- > Mal de Debarquement syndrome
- > Labyrinthitis
- > Vestibular neuritis

Therapists have national certification in vestibular and balance rehabilitation.

>> LOW-VISION REHABILITATION

Occupational therapists with advanced training in low-vision rehabilitation:

- > Provide rehabilitation care to patients with low vision or those who have undergone innovative surgeries at Mayo Clinic, such as implanted miniature telescopes for advanced macular degeneration and implanted retinal prostheses for patients who have lost vision due to progressive diseases including retinitis pigmentosa
- > Teach patients strategies to maintain their independence in a simulated home environment
- > Educate patients on devices recommended or prescribed by ophthalmologists, such as magnifiers and closed-circuit television



>> MENTAL HEALTH CARE

PM&R provides consultation services to the psychology and psychiatry treatment center. Occupational therapists, with training in neurophysiology, psychosocial development and group dynamics, work to empower patients to be successful and satisfied in their daily occupations.

Inpatient services

Occupational and physical therapists work with clients individually and in group settings.

Outpatient services

Individual therapy: Therapists help patients live meaningful lives in their community, while working toward reaching their full potential.

Child and Adolescent Integrated Mood Program: Children and adolescents with depressive or bipolar disorders work in a multidisciplinary group-based psychotherapy program.

Transitions Program: This time-limited, partial hospitalization program assists patients with severe psychiatric illness following psychiatric hospital discharge.

Behavioral Shaping Therapy (BeST): This intense week of therapy for patients with functional movement disorders often leads to complete or near complete resolution of the dysfunctional movement.

Care includes:

- > Supporting patients to develop skills, engage in meaningful activities and work toward recovery goals
- > Teaching strategies to manage illness symptoms in daily life
- > Helping patients implement routines and habits to support a healthy lifestyle
- > Helping patients identify needs and goals to support informed decision-making and healthy living
- > Evaluating patients' cognitive skills and safety awareness to provide recommendations on safe living

MAKING A DIFFERENCE THROUGH PATIENT EDUCATION

There are more than 450 PM&R patient education materials developed by Mayo Clinic, in a database of 10,000 patient education resources. Examples include:

- > "Life After Upper Limb Amputation" — A video profiles people living active lives after an amputation.
- > *Sports Medicine Performance Series* — Covers specific exercises for athletes returning to a sport after an injury.



COMPLEMENTARY & INTEGRATIVE >> MEDICINE

Routinely incorporated into rehabilitation care

RESEARCH HIGHLIGHTS

Peter Dorsher, M.D., has documented the presence of acupuncture meridians and their role in myofascial pain in more than 30 published papers.

Dorsher PT, et al. Convergence of Acupuncture and Myofascial Meridians with Myofascial Pain Syndrome Data: Anatomic and Physiologic Evidence that Acupuncture Meridians Exist. *Journal of Alternative and Complementary Medicine*. In press.

Care includes:

- > Acupuncture
- > Alexander Technique
- > Animal-assisted therapy
- > Feldenkrais Method
- > Herbal medicine
- > Massage
- > Movement therapy, including Pilates, tai chi and qi gong
- > Prolotherapy
- > Stress management strategies including the Stress Management and Resiliency Training program



>> EDUCATION

MAYO SCHOOL OF GRADUATE MEDICAL EDUCATION

PM&R Residency Program

- > Eight physicians per year.
- > First-time pass rate greater than 95 percent for parts 1 and 2 of the American Board of Physical Medicine and Rehabilitation (ABPMR) certification exams.
- > Accredited by the Accreditation Council for Graduate Medical Education.
- > PM&R pioneer and leader Earl Ekins, M.D., was the first PM&R resident and was honored via an ABPMR award given in his name for many years.

Mayo Medical School

- > Every year, 50 students start this M.D. program, which includes PM&R rotations.

PM&R fellowships

- > Pediatrics
- > Sports Medicine

PHYSICAL THERAPY PROGRAM STATISTICS

28

students enroll annually

2,500

students have graduated since 1939

98%

first-time pass rate for the national physical therapy licensure examination



98% first-time pass rate for the national physical therapy licensure examination

MAYO SCHOOL OF HEALTH SCIENCES

The Mayo School of Health Sciences (MSHS) Physical Therapy Program was founded by physiatrist Frank Krusen, M.D., in 1937 and has been continuously accredited since 1939. It became a doctoral program in 2007.

- > Students complete 56 weeks of full-time clinical experiences, among the most of any program in the country.

New physical therapy residencies

A one-year physical therapy orthopedic residency, jointly administered by MSHS and the Department of Physical Medicine and Rehabilitation, was developed in 2013. The residency is accredited by the American Board of Physical Therapy Residency and Fellowship Education and enrolls two physical therapist residents annually. Two additional physical therapy residencies — one in neurologic physical therapy and one in sports physical therapy — will begin enrolling residents in 2016.

MAYO SCHOOL OF CONTINUOUS PROFESSIONAL DEVELOPMENT

- > PM&R offers at least six CME courses a year.
- > Nationally known guest faculty.
- > New courses: annual PM&R Board Review, Mayo Clinic Rehabilitation Medicine Update.
- > Visiting clinicians and professors lecture students and staff.

MAYO REHABILITATION >> MEDICINE RESEARCH CENTER

Discovery, translation and application
of new knowledge to improve quality
of life for people with disabilities



Kristin Zhao, Ph.D., and her team are developing a new prosthetic hand that offers the potential for greater function.

The Mayo Rehabilitation Medicine Research Center focuses on the discovery, translation and application of new knowledge to improve the quality of life for all people with disabilities. Research ranges from fundamental research into the molecular and cell biology of injury and regeneration to new clinical treatments that benefit today's patients.

Research focuses on medical, musculoskeletal and neurological rehabilitation in three areas:

- > Assistive and restorative technology
- > Regenerative medicine and rehabilitation
- > Functional outcomes

ASSISTIVE AND RESTORATIVE TECHNOLOGY

The Assistive and Restorative Technology Laboratory develops, tests, refines and applies new technologies to restore functional independence to patients.

Robotic prosthetic hand offers potential to improved function

Mayo Clinic is working with the School of Biological and Health Systems Engineering, Arizona State University (Tempe, Arizona), Istituto Italiano di Tecnologia Centro E. Piaggio – University of Pisa (Pisa, Italy), and the Istituto Italiano di Tecnologia (Genova, Italy), to develop an adaptive, flexible prosthetic hand for people with upper extremity limb loss.

The SoftHand prosthetic hand coordinates motion at multiple joints of the digits, while grasping objects of varying shapes and sizes. It offers the potential for greater function, lower cost, simpler control and less weight than currently available hands.



Katie Enloe, occupational therapy assistant, models the adapted infant carrier designed and built at Mayo Clinic. Project team members included, left to right: **Tamara Vos-Draper**, occupational therapist; **James Christensen**, project manager, Division of Engineering; and **Glen Malwitz**, mechanical engineer technician.



Randy Fitzgerald, who has the rare condition arthrogryposis multiplex congenita, is a successful competitive gamer. The PM&R team developed a customized mount for his video game console.

BUILDING TOOLS TO IMPROVE QUALITY OF LIFE

Pressure mapping for wheelchair users:

A PM&R team has developed a smartphone app to allow wheelchair users to monitor the risk of pressure ulcers anywhere, anytime. Mayo Clinic is working with Minneapolis VA Health Care System and the University of Minnesota.

Baby carriers: PM&R specialists, along with Mayo engineers, developed an infant car seat brace to mount on a power wheelchair.

Chronic disease management:

Occupational therapists adapted a blood glucose test kit to help a woman with quadriplegia test her own blood sugar levels.

Recreation: Recreational therapists worked with a young man to customize a mount on his wheelchair for his video game controller. Because of severe contractures in his arms and hands, he uses his tongue, lips, nose and chin to run his video game controller. He now travels to participate in video gaming contests.

Self-management of oral secretions:

Occupational therapists teamed with pulmonology specialists and Mount'n Mover, a Minnesota business, to customize a motorized system for a patient with tetraplegia. Now, he can independently switch on a suctioning wand that's mounted in his home office workspace. The customized system allows him to better manage oral secretions, reducing the risk of respiratory illnesses.



“The mission of the center is to develop improved methods to restore function for people who are disabled through disease, injury or aging.”

Christopher Evans, Ph.D.

Director, Mayo Rehabilitation Medicine Research Center

FUNCTIONAL OUTCOMES

Researchers are developing functional outcome models to better measure the health care needs of people with disabilities over time and distance.

RESEARCH HIGHLIGHTS

- > Cheville AL. Functional outcomes. *American Journal of Physical Medicine and Rehabilitation*. 2014;93(10):909.
- > Cheville AL, et al. Age, sex and symptom intensity influence test taking parameters on functional patient-reported outcomes. *American Journal of Physical Medicine and Rehabilitation*. 2014;93(11):931.
- > Cheville AL, et al. Symptom burden and comorbidities impact the consistency of responses on patient-reported functional outcomes. *Archives of Physical Medicine and Rehabilitation*. 2014;95(1):79.

REGENERATIVE MEDICINE AND REHABILITATION

- > In this emerging field, Mayo Clinic researchers seek to regenerate nerve, bone, cartilage, muscle, tendons, ligament and intervertebral disks.
- > Areas of focus: stem cells and gene therapy.
- > High-resolution ultrasound is used to deliver the body's own cells and growth factors into joint and tendons in the form of platelet-rich plasma and bone marrow concentrate.

Degenerative disk disease: A team is participating in a clinical trial using adipose-derived stem cells to regenerate intervertebral disks in patients with degenerative disk disease.

Osteoarthritis: Several different approaches to treating osteoarthritis are being developed. A phase 1 clinical trial is being planned to use gene therapy to treat osteoarthritis. A second trial will explore the use of stem cells for this purpose. Another trial is evaluating the ability of intraarticular steroids to prevent the onset of posttraumatic osteoarthritis.

RESEARCH HIGHLIGHTS

- > Mautner K, et al. A call for a standard classification system for future biologic research: The rationale for new PRP nomenclature. *PM&R*. 2015;7:S53.
- > Pourcho AM, et al. Intra-articular platelet-rich plasma injection in the treatment of knee osteoarthritis: Review and recommendations. *American Journal of Physical Medicine and Rehabilitation*. 2014;93:S108.
- > Wang Z, et al. Efficacy of intervertebral disc regeneration with stem cells — A systematic review and meta-analysis of animal controlled trials. *Gene*. 2015;564:1.

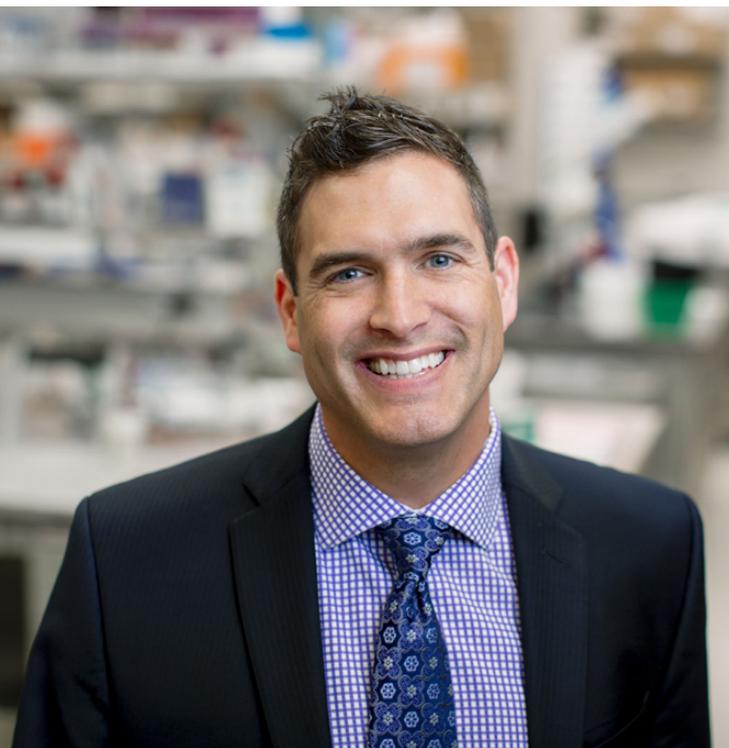
RESEARCH COMPLEMENTS, ADVANCES CARE

The Rehabilitation Medicine Research Center:

> Supports a practice that includes:

- More than 60 physiatrists
- Physical, occupational, recreational and respiratory therapists
- Psychologists
- Nursing specialists
- Speech pathologists
- Social workers

- > Works in collaboration with experts in orthopedics, neurology, neurosurgery, sports medicine, cardiology, psychiatry, aging and regenerative medicine, bringing together scientists and clinicians to perform research studies and clinical trials that transform the care of rehabilitation patients.
- > Is supported, in part, by donations from the Grainger Foundation and the Craig H. Neilsen Foundation and grants from NIH, the U.S. Department of Defense and the state of Minnesota.



Nathan LeBrasseur, Ph.D., leads research on myostatin. Researchers are looking at ways to block myostatin activity to increase muscle mass and, in turn, improve strength, physical function, and whole body metabolism, and reduce frailty due to aging and chronic disease.

AGING AND FRAILITY

PM&R researchers coordinate with other Mayo Clinic research centers, including the Robert and Arlene Kogod Center on Aging. Aging of muscle, which leads to sarcopenia and frailty, is one area of focus. Researchers are studying the use of novel drug and physical therapy approaches to help restore or replenish muscle in aging populations.

RESEARCH HIGHLIGHTS

- > Zhu Y, et al. The Achilles' heel of senescent cells: From transcriptome to senolytic drugs. *Aging Cell*. 2015;14:644.
- > Farr JN, Khosla S. Skeletal changes through the lifespan: From growth to senescence. *Nature Reviews Endocrinology*. 2015;11:513.
- > Jasuj R, et al. Regenerating skeletal muscle in the face of aging and disease. *American Journal of Physical Medicine & Rehabilitation*. 2014;93:S88.

Traumatic brain injury and Alzheimer’s disease: Mayo Clinic has been awarded \$750,000 from the U.S. Department of Defense to study the link between traumatic brain injury (TBI) and Alzheimer’s disease and related conditions (ADRC). Mayo Clinic has been at the forefront of population-based epidemiological research related to both TBI and ADRC. Researchers hypothesize that individuals in the population with a confirmed TBI will not be at increased risk of developing ADRC compared to age- and sex-matched referents without a TBI.

It is further hypothesized that an increased risk of ADRC may be evident in subsets of the cohort with clinical features suspected of increasing risk, such as multiple TBI events or events of increased severity.

“ One of this center’s goals is to help identify better solutions and care models to make sure those affected by disabilities maintain optimal function and quality of life.”

Carmen Terzic, M.D., Ph.D.
Chair, Department of Physical Medicine and Rehabilitation
Rochester, Minnesota

MAYO CLINIC COMPREHENSIVE PM&R CARE

Inpatient care:

- > Amputation
- > Brain injury
- > Cancer
- > Cardiovascular rehabilitation
- > Complex medical care, including patients with ventricular assist devices
- > Major multiple trauma
- > Neurological disorders
- > Orthopedics
- > Pediatrics
- > Postoperative
- > Pulmonary
- > Spinal cord injury
- > Stroke
- > Transplant

Outpatient specialized clinics and services:

- > ALS
- > Amputee care
- > Arthritis management
- > Assistive technologies
- > Bladder and bowel rehabilitation
- > Brachial plexus care
- > Brain injury rehabilitation
- > Cardiovascular rehabilitation
- > Complementary and integrative medicine
- > Dysphagia
- > Electromyography Laboratory
- > Evacuation Disorders Program
- > Fibromyalgia and Chronic Fatigue Clinic
- > Hand Center
- > Low vision
- > Mental health care
- > Musculoskeletal rehabilitation
- > Neurologic rehabilitation
- > Orthopedic rehabilitation
- > Osteoporosis care
- > Pain treatment and management
- > Pediatric care
- > Spasticity care
- > Spinal cord injury rehabilitation
- > Spine Center
- > Sports Medicine Center
- > Stroke care
- > Transplant care
- > Vascular Wound Center
- > Vestibular and balance rehabilitation
- > Women's health
- > Work Rehabilitation Center

SUBSPECIALTY BOARD CERTIFICATION

Mayo Clinic physiatrists have subspecialty board certification in these areas:

- > Electrodiagnostic medicine
- > Hospice and palliative medicine
- > Internal medicine
- > Internal medicine — Rheumatology
- > Pain medicine
- > Pediatric rehabilitation medicine
- > Spinal cord injury medicine
- > Sports medicine
- > Wound care

CONTACT US

Mayo Clinic welcomes inquiries and referrals

Arizona 866-629-6362

Florida 800-634-1417

Minnesota 800-533-1564

RESOURCES

mayoclinic.org/medicalprofs

Clinical trials, CME, Grand Rounds, scientific videos and online referrals.
Sign up for a free PM&R physician e-newsletter.

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