

## INSIDE THIS ISSUE

3 Treating and Managing Obesity: An Emerging Role for Physiatry

4 New Musculoskeletal Center Integrates Orthopedics, Physical Medicine and Rehabilitation, and Sports Medicine

7 Research Highlights

## Diagnosing and Treating Sports-Related Concussion

The Centers for Disease Control and Prevention estimate that approximately 1.6 million to 3.8 million sports-related concussions occur annually in the United States, although the true incidence is probably much higher. Under-reporting may be due to the fact that athletes, coaches, trainers, family, and even some health care professionals are unaware of the symptoms and treatment options for concussion. And athletes who experience concussion sometimes fail to report their symptoms to avoid losing playing time.

"Concussions that are unrecognized or are mismanaged put athletes at considerable risk for

potentially catastrophic sequelae from reinjury," says Jonathan T. Finnoff, DO, cochair of the Mayo Clinic Sports Medicine Center Concussion Management Program and consultant in the Department of Physical Medicine and Rehabilitation at Mayo Clinic in Rochester, Minnesota.

Repetitive head trauma from participation in contact sports such as boxing, football, and ice hockey can lead to a permanent decrease in brain function, including memory loss, early Alzheimer disease, movement disorders (eg, parkinsonism), and emotional disturbances. The most notable complication of concussion is second impact syndrome. In this syndrome, an athlete who is recovering from an initial concussion sustains a subsequent concussive injury, resulting in diffuse brain swelling and severe, permanent neurologic dysfunction or death.

Standard neuroimaging studies are typically

Mayo Concussion Test (MCT)		Concentration (pts)	
Orientation	0 1	1-2	0 1
Name	0 1	3-5	0 1
Year	0 1	6-7-5-4	0 1
Day of week	0 1	8-1-1-2-3-7	0 1
Month (write 1 back)	0 1	SCORE	0 1 2 3 4
Place	0 1		
SCORE	0 1 2 3 4 5		

Symptom	Post-Concussion Symptoms Scale (PCSS)			
	None	Mild	Moderate	Severe
Headache	0 1	2 3 4	5 6	
Nausea	0 1	2 3 4	5 6	
Vomiting	0 1	2 3 4	5 6	
Balance Problems	0 1	2 3 4	5 6	
Dizziness	0 1	2 3 4	5 6	
Fatigue	0 1	2 3 4	5 6	
Inability falling asleep	0 1	2 3 4	5 6	
Sleeping more than usual	0 1	2 3 4	5 6	
Sleeping less than usual	0 1	2 3 4	5 6	
Disorientation	0 1	2 3 4	5 6	
Sensitivity to light	0 1	2 3 4	5 6	
Sensitivity to noise	0 1	2 3 4	5 6	
Irritability	0 1	2 3 4	5 6	
Sadness	0 1	2 3 4	5 6	
Nervousness	0 1	2 3 4	5 6	
Feeling more emotional	0 1	2 3 4	5 6	
Numbness or tingling	0 1	2 3 4	5 6	
Feeling drowsy or slow	0 1	2 3 4	5 6	
Feeling mentally foggy	0 1	2 3 4	5 6	
Difficulty concentrating	0 1	2 3 4	5 6	
Difficulty remembering	0 1	2 3 4	5 6	
Visual problems	0 1	2 3 4	5 6	

**Figure.** The Mayo Concussion Test (MCT). When an athlete is suspected of having sustained a concussion, he or she is removed from play (see Table on page 2 for this protocol), and the clinician or athletic trainer on the sidelines performs a brief history and physical examination and administers the MCT and Post-Concussion Symptoms Scale (PCSS). The results of the MCT and PCSS are compared to baseline results of the same tests. The MCT evaluates orientation, immediate memory, concentration, and delayed recall. Correct answers are given a score of 1, whereas incorrect scores are given a score of 0. The PCSS evaluates for symptoms associated with concussion. Each symptom is given a score between 0 (no symptoms) and 6 (severe symptoms). Ultimately, the diagnosis of concussion is confirmed if the athlete's sideline PCSS reveals new or more severe postconcussive-type symptoms or if the athlete's sideline MCT score is lower than the baseline score. The athlete is removed from play and followed up, as indicated in the protocol.



Jonathan T. Finnoff, DO

normal; therefore, concussion is a clinical diagnosis. The most common symptom is headache. Other symptoms include dizziness, nausea, vomiting, balance problems, fatigue, sleep disturbance, sensitivity to light and noise, mood changes, and difficulty with concentration and memory.

A common misconception about concussion is that the athlete needs to lose consciousness in order to be diagnosed with a concussion. “Each concussion presents in a unique manner, and it is well established that a concussion does not require a loss of consciousness. Furthermore, a brief loss of consciousness does not provide any information regarding concussion severity. What clinicians need to remember is that if an athlete sustains a blow to the body or head and subsequently develops postconcussive symptoms, by definition, that athlete has sustained a concussion,” says Dr Finnoff.

### Understanding Who Is at Risk

Athletes who engage in contact sports and female athletes are at increased risk for concussion. Young athletes may be more susceptible than adults to concussions due to a larger head-to-body size ratio, weaker neck muscles, or increased vulnerability of the young brain to concussion.

### Timely Diagnosis and Treatment

According to Dr Finnoff, timely diagnosis and prompt treatment can help prevent more serious concussion complications. Obtaining preinjury baseline data on athletes who engage in contact sports can make the sideline assessment more accurate. Mayo Clinic’s Sports Medicine Center performs baseline testing on high school athletes involved in high-risk sports as part of their preseason physicals.

Baseline assessments include a brief cognitive test (the Mayo Concussion Test), a computer-based neuropsychological test, and the Post-Concussion Symptoms Scale (Figure, on page 1). These data are available during games and in the clinic and provide medical personnel with a preinjury reference point from which to judge an athlete’s status following a concussion.

“Baseline data are objective measures that can also help us deal with athletes who deny having a concussion,” says Dr Finnoff. “If they are struggling with the objective tests relative to their baseline scores, the clinician on the sidelines can pull them out of a competition despite their denial, even in the heat of the moment, and still be confident in this decision.”

If a concussion is suspected, Mayo Clinic sports medicine specialists follow a protocol for evaluating and treating athletes of all ages (Table).

### Resuming Athletic Activity

“Once the athlete is asymptomatic and has normal neuropsychological measures, then we can begin a functional return-to-play process,” explains Dr Finnoff. “Over 5 days, we gradually increase cognitive and physical challenges in a systematic, stepwise fashion. If the athlete has symptoms at any time, he or she rests again, until the symptoms stop. Then we resume the protocol on the level at which the athlete was symptom-free.”

Mayo sports medicine specialists monitor symptomatic athletes for up to 2 weeks, at which time, symptomatic athletes are referred to the Mayo Clinic Complex Concussion Team, comprising a brain rehabilitation specialist, occupational and speech therapists, a rehabilitation nurse, a neuropsychologist, and other health care professionals as indicated. They manage the athlete’s postconcussion symptoms and assist with modifications in work and school that are required for recovery. When the athlete’s symptoms resolve and all baseline measures return to normal, he or she will resume the return-to-play protocol under the supervision of Mayo Clinic’s Sports Medicine Center staff.

“Our team approach to providing medical care is ideal for these patients as we have ready

**Table. Protocol for Evaluating and Treating Suspected Concussion**

- Remove athlete from competition immediately and do not allow him or her to resume play for the remainder of the game.
- Perform the Mayo Concussion Test and the Post-Concussion Symptoms Scale (as shown in the Figure on page 1) on-site and compare the results with the athlete’s baseline data.
- Monitor for worsening of symptoms and/or focal neurologic deficits, including weakness and sensory change, every 15 to 30 minutes during the first several hours after injury.
- If symptoms worsen, the athlete should be transported to an emergency department for further evaluation, as changes may suggest an injury more serious than a concussion, such as intracranial hemorrhage.
- If symptoms remain stable or improve, the athlete can be sent home if an adult caregiver is present. The caregiver is given a list of symptoms to be aware of that would warrant a trip to an emergency department, and the athlete is not allowed to drive.
- Place the athlete on physical (no sports, running, jumping, weight lifting, etc) and cognitive (no school, studying, video games, etc) rest to minimize stress on the brain.
- Have the athlete follow up with his or her physician within 24 to 48 hours for a physical examination and symptom evaluation, as well as additional cognitive testing.

access to specialists, subspecialists, and therapists who work in coordination to help these athletes return to play at the appropriate time," explains Dr Finnoff.

### Ongoing Research

Mayo Clinic sports medicine and physical medicine and rehabilitation researchers are also involved in several clinical research projects related to concussion:

- Identifying biomarkers that may help

indicate concussion severity and predict risk of concussion.

- Evaluating biomechanical forces that cause concussion, including work with accelerometers in helmets to detect g-forces in athletes when they sustain concussion.
- Evaluating new neuroimaging technology that may increase the ability to detect concussions.
- Gauging the safety of athletes who have undergone previous neurosurgical procedures to resume participation in sports.

## Treating and Managing Obesity

### An Emerging Role for Psychiatry

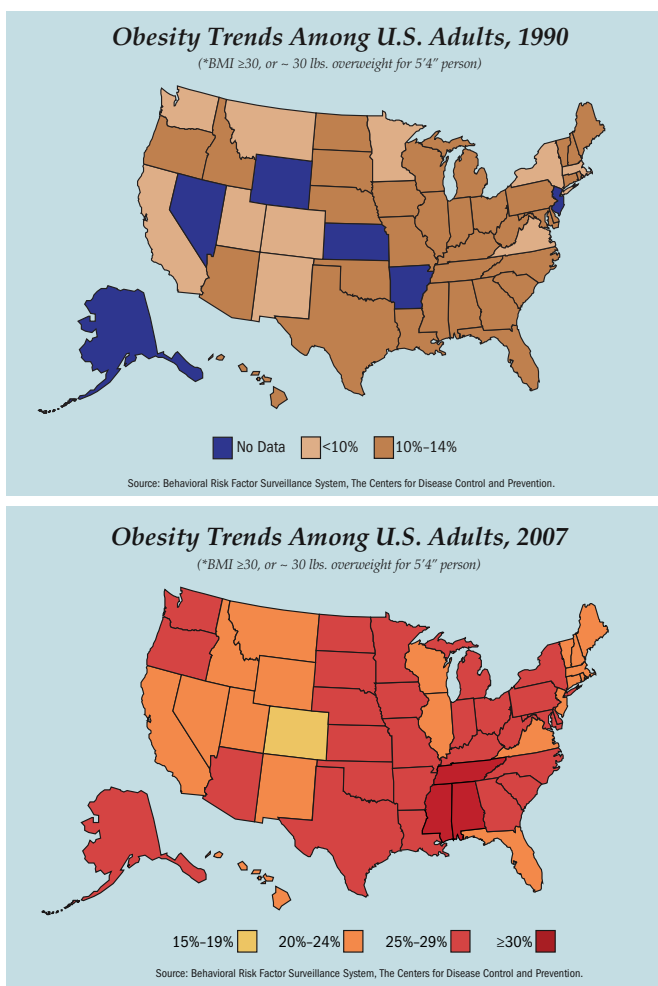
Much has been written in both the lay press and the medical literature about the health consequences of obesity and inactivity. Despite the attention that this public health dilemma has received, almost two-thirds of Americans are overweight (body mass index [BMI], calculated as weight in kilograms divided by height in meters squared, between 25 and 29.9) or obese (BMI  $\geq 30$ ). Between 1986 and 2000, the percentage of people with a BMI of 40 or higher quadrupled.

Looking at the generation ahead offers some alarming statistics as well. Childhood obesity has tripled during the past generation, and almost 20% of youths aged 12 to 19 years are overweight. And more than 70% of Americans do not achieve the recommended amount of physical activity to obtain health benefits.

The consequences of obesity on morbidity, mortality, and quality of life are well documented and noteworthy. Adults with a BMI higher than 30 (Figure) have a 200% to 300% higher mortality rate than normal-weight adults. Hypertension and cardiovascular disease, cancer, type 2 diabetes, and musculoskeletal problems such as osteoarthritis are just a few of the diagnoses associated with obesity and inactivity.

Obesity and inactivity also have far-ranging economic consequences for businesses and for the US economy. The cost to business of obesity-related health care issues totaled \$15.4 billion in 2002, a figure that does not include considerable costs associated with lost productivity and absenteeism. One large study found that employees with an elevated BMI ( $>25$ ) had medical costs

*Continued on page 6*



**Figure.** These maps show that the percentage of obese adults reported in the United States (people with a BMI of 30 or higher, or those who are at least 30 pounds overweight) has increased dramatically over the past 2 decades.



## *New Musculoskeletal Center Integrates Orthopedics, Physical Medicine and Rehabilitation, and Sports Medicine*

Celebrating its 75th anniversary this year, the Mayo Clinic Department of Physical Medicine and Rehabilitation in Rochester, Minnesota, marked a major milestone with the integration of its services into the W. Hall Wendel, Jr. Musculoskeletal Center. The Musculoskeletal

Center unites Mayo Clinic's multidisciplinary orthopedic specialties and services with the technology needed to provide state-of-the-art diagnosis, outpatient treatment, and rehabilitation for all types of musculoskeletal conditions (Figure).

**Figure.** Mayo's new PM&R Center services were fully integrated into the Musculoskeletal Center in winter 2010 to optimize patient care, convenience, and education.





With the centralized design integrating PM&R into the Musculoskeletal Center, patients now have the convenience of 1-stop access to all musculoskeletal specialties, which, in addition to all orthopedic subspecialties and PM&R, includes rheumatology, bone endocrinology, radiology, and anesthesiology.

Explains PM&R department chair Kathryn A. Stolp, MD: “From the point of view of strategic design, integration of PM&R into the Musculoskeletal Center is central to providing the highest-quality service and care.” Her colleague Jonathan T. Finnoff, DO, agrees. He sees the integration of PM&R with the Musculoskeletal Center as an ideal platform for assuring patients receive state-of-the-art, comprehensive nonsurgical care before progressing to or after surgical solutions. “The Center functions ideally as a gatekeeper,” Dr Finnoff says. If a patient does require surgery, that is easily accommodated—often starting as a hallway chat with a colleague in orthopedic surgery. “Seeing professional interactions between specialists gives patients confidence in the quality and continuity of care they receive at Mayo,” Dr Finnoff explains.

#### **From Green Screen to Patient Education**

In the gym, advanced technology, including use of a “green screen” virtual reality motion trainer, is one of the new assets used to guide PM&R exercises. Common in major sports clinics, this training technology gives patients freedom to work on range of motion and other exercises in a simulated setting projected on a wall using green screen technology.



*Kathryn A. Stolp, MD, and Jonathan T. Finnoff, DO*

The lobby area is designed to support patient education. Anatomic models help patients visualize their injuries. Electronic education kiosks answer questions about post-procedure safety and independent living.

#### **Dedicated to Restoring Function**

Through its many expanded services, the full integration of PM&R within the Musculoskeletal Center provides comprehensive care for maximal healing and recovery of function. Says Dr Stolp: “Our job is to restore patients to their full mental, emotional, physical, vocational, and avocational function. While most of medicine is organized along organ systems, we like to think that the organ systems we address are ‘function’ and ‘quality of life.’ We never have to say to a patient, ‘We can’t help you.’ There is always something we can do to improve function and thereby enhance quality of life.”



Mary K. Wehde and Edward R. Laskowski, MD

that were on average more than 50% higher than those of normal-weight employees. Additionally, obese employees are nearly 75% more likely to experience high rates of absenteeism than are normal-weight employees. Nationwide, medical spending on obesity-related conditions

was estimated to have reached \$147 billion per year in 2008, which is almost 10% of all medical spending. When combined with type 2 diabetes, the impact of obesity on the health care economy is estimated to be \$259 billion.

As codirector of the Sports Medicine Center at Mayo Clinic in Rochester, Minnesota, Edward R. Laskowski, MD, a specialist in physical medicine and rehabilitation, is often surprised that many in the lay public and also health care professionals are unaware of the magnitude of the obesity and inactivity epidemic. "One of the most common responses that I hear when I present these data is 'I knew it was bad, but I didn't realize it was this bad,'" says Dr Laskowski. "The good news is that the effects of obesity and inactivity are reversible and that physiatrists have the tools to effectively treat this population."

### The Physiatrist's Role in Prescribing Exercise

Consistent activity has been shown to offer multiple therapeutic benefits, including shorter hospital stays, fewer physician visits, and less medication use. In many cases, physical therapists, athletic trainers, coaches, physical education teachers, and other fitness specialists provide counseling for healthy adult fitness enthusiasts engaged in physical activity for weight control and cardiovascular and musculoskeletal fitness. But like medicine, exercise has an appropriate dosage, indication, contraindication, and adverse effect profile.

Acknowledging that "no one really owns the treatment of obesity" and that no single intervention provides answers for all patients, Dr Laskowski envisions a unique role for physiatrists in tackling this problem. "Physiatrists have the specific qualifications and skills to provide accurate, research-based exercise prescriptions

for a broad range of people, including healthy individuals, those with obesity-related joint complications, and inactive individuals without impairments who need to begin an activity program to optimize cardiovascular and musculoskeletal fitness," says Dr Laskowski.

Physiatrists can also provide guidance in proper technique for strength training, stability and flexibility exercises, and aerobic conditioning. "These are all essential elements in developing an effective exercise prescription that prevents injury," says Dr Laskowski. "And because physiatrists treat patients with musculoskeletal and medical problems that impair movement, we have learned to prescribe exercise in a way that is gradually progressive and unique to each individual."

At Mayo Clinic, physiatrists play a role in the clinic's own workforce LiveWell program, which promotes regular physical activity and other healthy lifestyle choices. This program utilizes Mayo Clinic's on-site resources such as employee fitness programs, nutrition education, health fairs, an employee assistance program, the Nicotine Dependence Center, collaboration with community health and wellness organizations, telephonic and Web-based resources, and print communications.

Patients who are not part of the Mayo workforce can see Mayo Clinic physiatrists and physical therapists for evaluation and treatment of an array of obesity-related conditions. As with other parts of their practice, Mayo physiatrists work closely with other specialists, including endocrinologists, orthopedic and bariatric surgeons, psychologists, and physical and occupational therapists. "We evaluate and treat musculoskeletal conditions that impair activity and function, and we use various modalities for diagnosis and treatment, including ultrasound-guided corticosteroid injections," explains Dr Laskowski. Mayo physiatrists can also assist in the treatment of patients preparing for bariatric surgery.

According to Mayo Clinic physical therapist Mary K. Wehde, Mayo Clinic providers also address the physical, mental, and social triad that plays an important role in wellness. "In the past, therapists tended to treat a patient's medical condition, such as lack of motion or weakness. We know now that to prevent further problems, we must also help patients manage issues in their lives that affect their overall well-being and their ability to participate in exercise programs and to lead more active lives," says Ms Wehde.

# Research Highlights

## Brain Rehabilitation

- **Improving quality of life after stroke:** Clinical factors associated with quality of life following stroke and acute rehabilitation
- **Predicting stroke outcomes:** Clinical profiles that predict outcomes after inpatient stroke rehabilitation

## Cardiac Rehabilitation

- **Stem cell-based cardiac repair**
- **Neuromuscular diseases:** Muscular dystrophies

## Cancer Rehabilitation

- **Impact of rehabilitation and exercise on the patient's quality of life**
- **Optimal management of lymphedema caused by cancer or its treatment**

## Musculoskeletal Rehabilitation

- **Understanding pain in runners:** Hip strength and knee pain in high school runners

## Sports Medicine

- **Musculoskeletal ultrasound:** Identifying key diagnostic and therapeutic uses and advantages
- **Platelet-rich plasma:** Evaluating efficacy for chronic tendinopathies

## Spinal Cord Rehabilitation

- **Helping patients breathe independently:** Freeing people with quadriplegia from being tethered to ventilators
- **Repairing the myelin sheath and promoting nerve regeneration:** Antibodies have been developed that may play a critical role in repair of the myelin sheath

## Comprehensive Spine Center

- **Spine biomechanics:** Disk characteristics and response to stressors

## Pediatric Rehabilitation

- **Understanding postural orthostatic tachycardia syndrome in adolescents:** Evaluating and understanding normal orthostatic blood pressure and heart rate values



• To read more about Mayo Clinic physical medicine and rehabilitation research and patient care, visit [www.mayoclinic.org](http://www.mayoclinic.org).

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## Education Opportunities

### Advanced Lymphedema Management

January 28-29, 2011, Rochester, MN

Contact: 507-266-0940 or 507-284-2608 or e-mail [pmrconf@mayo.edu](mailto:pmrconf@mayo.edu)

### Spatial Neglect, Apraxia, and Visual Perceptual Deficits: Assessment and Intervention Strategies

March 12-13, 2011, Rochester, MN

Contact: 507-266-0940 or 507-284-2608 or e-mail [pmrconf@mayo.edu](mailto:pmrconf@mayo.edu)

### 14th Annual Mayo Health System Regional Rehabilitation Provider Conference

September 11, 2011, Location to be determined

Contact: 507-266-0940 or 507-284-2608 or e-mail [pmrconf@mayo.edu](mailto:pmrconf@mayo.edu)

### 21st Annual Mayo Clinic Symposium on Sports Medicine

November 11-12, 2011, Rochester, MN

Contact: 507-266-7835 or e-mail [cme@mayo.edu](mailto:cme@mayo.edu)

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