



MAYO CLINIC  
CARDIOLOGY  
CARDIOVASCULAR SURGERY  
PEDIATRIC CARDIOLOGY

*2006*





*The best interest of the patient  
is the only interest to be considered...*

*— Dr William J. Mayo*

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### RESOURCES

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*Jacksonville, Florida*



*Rochester, Minnesota*



*Scottsdale/Phoenix, Arizona*



CLINICAL PRACTICE



*Frank Cetta, MD, David L. Hayes, MD, and Hartzell V. Schaff, MD*

Dear Colleagues:

On behalf of Mayo Clinic Rochester Divisions of Cardiovascular Diseases, Pediatric Cardiology, and Cardiovascular Surgery, we are honored to have the opportunity to participate in the care of your patients. The purpose of this booklet is to provide additional insight into our practices at Mayo Clinic Rochester, Mayo Clinic Jacksonville, and Mayo Clinic Arizona as well as our regional practices. We have attempted to provide an overview of all aspects of clinical practice, research, and educational programs. Our goal is to provide seamless care for your referrals and provide the necessary expertise among all our sites. We are committed to providing timely and convenient access for patient referrals. Mayo Clinic has the unique opportunity to provide the continuum of cardiac care from before birth through adulthood. Our goal is to provide lifelong comprehensive care for your patients and their families.

The Mayo Clinic Rochester Division of Cardiovascular Surgery, Division of Cardiovascular Diseases, and Division of Pediatric Cardiology believe strongly in the Mayo Clinic Mission to “provide the best care to every patient every day through integrated clinical practice, education and research” and the institution’s Primary Value, “The needs of the patient come first.” Our goal is to fulfill the Mission and apply the Primary Value with every patient referred to us for care.

Again, thank you for trusting us with your patients through your referrals to our cardiovascular practices. We welcome your feedback, your calls, and if ever possible, your own visit to our practice.

Sincerely,

*Frank Cetta, MD  
Chair, Division of Pediatric Cardiology*

*David L. Hayes, MD  
Chair, Division of Cardiovascular Diseases*

*Hartzell V. Schaff, MD  
Chair, Division of Cardiovascular Surgery*



## Quality, Safety, and Service in the Cardiovascular Inpatient and Outpatient Practices

Mayo Clinic Rochester is well known for the quality of health care that it provides. For 16 years in a row, *U.S. News & World Report* named Mayo Clinic one of “America’s Best Hospitals.” Despite this recognition, initiatives to improve patient care are under way, including Lean Thinking, Six Sigma, and Value Network Analysis.

In 2005, the Division of Cardiovascular Diseases began transforming how care is delivered by focusing on nonprovider interactions. Tools that have been successfully applied in many businesses outside health care were implemented to improve processes, deliver higher quality and safety at a faster speed, and eliminate waste and unnecessary repetition of tasks.

These projects have included the following:

- Fast-track protocol for STEMI (ST-elevation myocardial infarction)
- Cardiovascular Health Clinic access
- Inpatient warfarin safety initiatives
- Patient flow in the catheterization and echocardiography laboratories
- Outpatient workflow redesign
- Inpatient admission triage
- Improved access to complex electrophysiology procedures

The cardiovascular inpatient practice fosters an academic approach to innovative care delivery models. Residents, fellows, nurse practitioners, and physician assistants work collaboratively with staff cardiologists and registered nurses to provide individualized, evidenced-based care to all cardiac patients. Pilot models for specific patient populations, such as congestive heart failure, acute coronary syndromes, and interventional practices, are part of evolving practice models.

The hospitals at Mayo Clinic Rochester—Saint Marys Hospital and Rochester Methodist Hospital—again received the prestigious Magnet Award for Nursing Excellence in 2005, and this year the Mayo Clinic Nursing Genomics Program also received Magnet Award status.

### PATIENT ENCOUNTERS, 2005

Inpatient admissions.....	8,690
Inpatient consultations .....	2,033
Outpatient visits .....	55,803



Jane A. Linderbaum, NP  
Cardiovascular Inpatient Operations Director

Henry H. Ting, MD  
Outpatient Medical Director

David A. Foley, MD  
Inpatient Medical Director



Malcolm R. Bell, MD, Director

#### Cardiac Intensive Care Unit

Malcolm R. Bell, MD, Director  
Gregory W. Barsness, MD  
Patricia J. Best, MD  
Krishnaswamy Chandrasekaran, MD  
Ian P. Clements, MD  
Bernard J. Gersh, MD, PhD  
Allan S. Jaffe, MD  
Andre C. Lapeyre III, MD  
Sunil V. Mankad, MD  
Joseph G. Murphy, MD  
Jae K. Oh, MD  
Abhiram Prasad, MD  
Guy S. Reeder MD  
Charanjit S. Rihal, MD  
Lawrence J. Sinak, MD  
R. Thomas Tilbury, MD  
Henry H. Ting, MD  
R. Scott Wright, MD

## Cardiac Care Unit

The Cardiac Care Unit (CCU) practice at Saint Marys Hospital continues to implement practice innovations, adopt new technology, and increase participation in clinical trials. Under the leadership of director Malcolm R. Bell, MD, the unit provides “cardiac intensive care,” not only “coronary care.” In 2005, a total of 1,544 patients were treated.

Key initiatives and interventions in the past year include the following:

- Increasing recognition that more rapid reperfusion with primary angioplasty (percutaneous cardiac intervention, or PCI) is a critical determinant of survival in patients with ST-elevation MI (STEMI) led a multidisciplinary team to develop a faster process for achieving reperfusion with primary PCI. The team, involving the emergency department, communications, catheterization laboratory, and CCU personnel, developed a process to achieve specific treatment-time goals. The median door-to-balloon time of angina patients is about 65 minutes, and approximately 90% of all STEMI patients are treated within 90 minutes.
- Many patients with STEMI present to area hospitals that do not have PCI capability. A guideline-based and evidence-based protocol was initiated facilitating rapid transfer of STEMI patients to the CCU at Saint Marys Hospital for prompt and effective reperfusion. Twenty-one referral sites are now formally enrolled in this program. A similar protocol to facilitate triage, treatment, and referral of non-STEMI patients at these sites is also being developed.
- A clinical protocol was introduced to rapidly induce hypothermia in all patients who remain comatose on admission following out-of-hospital cardiac arrest. The patient is externally cooled to 33°C for 24 hours; the initial experience has been excellent.

The CCU has led the institution’s directive to consistently perform at the highest level with respect to the various performance metrics stipulated by agencies such as the Joint Commission on Accreditation of Healthcare Organizations and the Institute for Healthcare Improvement. Currently more than 95% of patients receive all core interventions; innovative measures are being undertaken to improve this to more than 99%.



## Cardiac Catheterization Laboratory

In 2005, the cardiac catheterization laboratory provided diagnostic and therapeutic services to more than 7,000 cardiovascular patients. The objective of the lab is to provide leadership in the following areas:

**Innovative Clinical Practice.** New clinical programs have been launched, including a myocardial infarction (STEMI) treatment protocol that has led to some of the shortest door-to-balloon times in the country and collaborative programs in carotid and peripheral interventions. The Center for Coronary Physiology and Imaging offers advanced coronary artery assessment while the Interventional Cardiology Clinic and the Chest Pain and Coronary Physiology Clinic offer rapid access for patients.

**State-of-the-Art Technology.** Along with new biplane flat detector fluoroscopic imaging systems, a magnetic guidance system is now operational. In high-risk patients with left main and 3-vessel disease, the interventional cardiology team now offers percutaneous treatment with percutaneous left ventricular support devices.

**Clinical and Translational Research.** The Cardiac Catheterization Laboratory is involved in more than 50 clinical trials funded from a range of agencies, including the

National Institutes of Health, the American Heart Association, the US Department of Defense, and Mayo Clinic. In 2005, laboratory staff published more than 100 articles in major medical journals. Examples of innovative research in structural heart disease include left atrial occluder devices to prevent embolic stroke in patients with atrial fibrillation (David R. Holmes, Jr, MD); percutaneous mitral valve anuloplasty to prevent the need for surgery for some patients (Charanjit A. Rihal, MD); external counterpulsation for treatment of refractory angina (Gregory W. Barsness, MD); spinal cord stimulation for the treatment of refractory angina (Amir Lerman, MD); and gene and cell therapy (Robert D. Simari, MD).

The Coronary Interventional Database was established in 1979, and to date more than 20,000 patients with more than 27,000 procedures are being followed. This comprehensive database provides important outcome information for clinical practice and research.

**Quality and Collaboration.** Interventional cardiologists, neurologists, vascular surgeons, and interventional radiologists have formed a collaborative management team for patients with carotid and peripheral atherosclerosis.



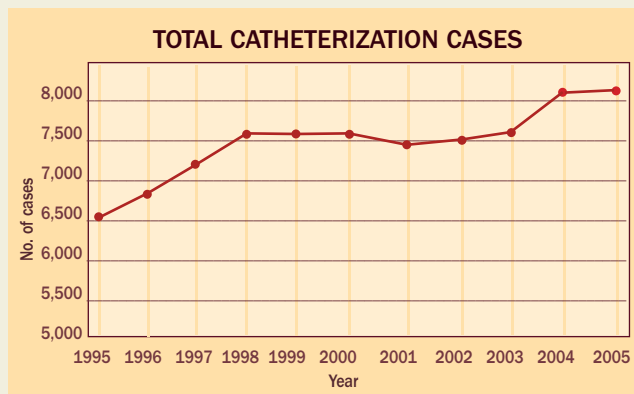
Charanjit S. Rihal, MD, Director

### Cardiac Catheterization, Therapeutics, and Interventional Cardiology Laboratory

- Charanjit S. Rihal, MD, Director  
 Gregory W. Barsness, MD  
 Malcolm R. Bell, MD  
 Patricia J. Best, MD  
 John F. Bresnahan, MD  
 Barry A. Borlaug, MD  
 Allison K. Cabalka, MD ‡  
 Charles R. Cagin, DO\*  
 Frank Cetta, Jr, MD ‡  
 Robert P. Frantz, MD  
 Richard J. Gumina, MD, PhD  
 Donald J. Hagler, MD ‡  
 David R. Holmes, Jr, MD  
 Andre C. Lapeyre III, MD  
 Amir Lerman, MD  
 Verghese Mathew, MD  
 Joseph G. Murphy, MD  
 Rick A. Nishimura, MD  
 Abhiram Prasad, MD  
 Guy S. Reeder, MD  
 Gupreet S. Sandhu, MD, PhD  
 Robert D. Simari, MD  
 Mandeep Singh, MD\*  
 Ripudamanjit Singh, MD\*  
 Paul Sorajja, MD  
 R. Thomas Tilbury, MD  
 Henry H. Ting, MD

\*Mayo Health System

‡Pediatric Cardiology



Left atrial occluder device

### CATHETERIZATION VOLUMES, 2005

Diagnostic catheterization.....	4,460
Percutaneous interventions.....	1,678
Non-PCI interventions.....	291
Septal occluders .....	144
Balloon valvuloplasty.....	40
Pediatric catheterizations.....	310
Peripheral vascular interventions....	164

**Echocardiography Laboratory**

- Fletcher A. Miller, MD, *Director*
- Jae K. Oh, MD, *Codirector*
- Patricia A. Pellikka, MD, *Codirector*
- Naser M. Ammash, MD
- Thomas Behrenbeck, MD, PhD
- Daniel D. Borgeson, MD
- Charles J. Bruce, MD
- Allison K. Cabalka, MD ‡
- Mark J. Callahan, MD
- Frank Cetta, Jr, MD ‡
- Krishnaswamy Chandrasekaran, MD
- Hong H. Chen, MD
- Roger L. Click, MD, PhD
- Heidi M. Connolly, MD
- Kevin T. Cragun, MD\*
- Raul Emilio Espinosa, MD
- David A. Foley, MD
- William K. Freeman, MD
- W. Bruce Fye, MD
- Martha Grogan, MD
- George M. Gura, MD
- Donald J. Hagler, MD‡
- John H. Haley, MD\*
- Sharonne N. Hayes, MD
- Robert J. Houlihan, MD\*
- Barry L. Karon, MD
- Lawrence R. Keenan, MD\*
- Kyle W. Klarich, MD
- Francisco Lopez-Jimenez, MD
- Joseph F. Maalouf, MD
- Sunil V. Mankad, MD
- Robert B. McCully, MD
- Michael S. Meyers, MD\*
- Rowlens M. Melduni, MD
- Hector I. Michelena, MD
- Andrew G. Moore, MD\*
- Sharon L. Mulvagh, MD
- Rick A. Nishimura, MD
- Vuyisile T. Nkomo, MD
- Patrick W. O'Leary, MD‡
- Lyle J. Olson, MD
- Steve R. Ommen, MD
- Sabrina D. Phillips, MD
- Margaret M. Redfield, MD
- Guy S. Reeder, MD
- Kent H. Rehfeldt, MD (anesthesiology)
- Veronique L. Roger, MD
- Maurice E. Sarano, MD
- James B. Seward, MD
- Clarence Shub, MD
- Lawrence J. Sinak, MD
- Peter C. Spittell, MD
- Teresa S. M. Tsang, MD
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- Carole A. Warnes, MD

\*Mayo Health System  
‡Pediatric Cardiology



Patricia A. Pellikka, MD, Codirector, Jae K. Oh, MD, Codirector, and Fletcher A. Miller, MD, Director

**Echocardiography Laboratory**

The Mayo Clinic Echocardiography Laboratory provides a full complement of echocardiographic studies, including adult, pediatric, and adult congenital transthoracic and transesophageal studies, pharmacologic and exercise stress studies, and intraoperative transesophageal echocardiographic studies. Mayo Clinic echocardiographers continue to lead the field in the development and application of new technology. The Echocardiography Laboratory has recently introduced a new modality—strain rate imaging—that is useful for detecting subtle myocardial dysfunction. In addition, this modality has been shown to be useful for selecting patients who will benefit from cardiac resynchronization therapy by measuring the degree of cardiac dyssynchrony for patients with heart failure. Three-dimensional imaging has been added as a diagnostic tool, and myocardial perfusion imaging and vascular physiology studies are about to be introduced into Mayo Clinic’s clinical laboratory practice.

The Echocardiography Laboratory provides outreach services to 25 off-campus sites. This outreach service provides same-day reporting for all inpatient studies and urgent outpatient studies with all other reports delivered to the individual sites within 24 hours.

Studies done on the Mayo Clinic Rochester campus are reviewed by a staff echocardiographer before the patient is released. In addition to performing standard echocardiographic examinations, physician-sonographer teams provide complete hemodynamic results for all studies. Teams are on call 24/7 for urgent or emergent studies.

In collaboration with the Department of Radiology, the Echocardiography Laboratory has established one of the few accredited cardiology ultrasound schools in the United States, graduating classes of 8 to 12 students each year. The program has trained numerous individuals who now direct echocardiography laboratories throughout the United States and around the world.

ECHOCARDIOGRAPHY LABORATORY PROCEDURES, 2005	
2-D echocardiography .....	28,665
Transesophageal echocardiography (TEE) .....	3,502
Stress echocardiography .....	7,730
Pericardiocentesis.....	129
Intraoperative TEE (adult) .....	1,733
Intraoperative TEE (congenital) .....	209
Congenital echocardiography .....	3,754
Fetal examinations .....	116



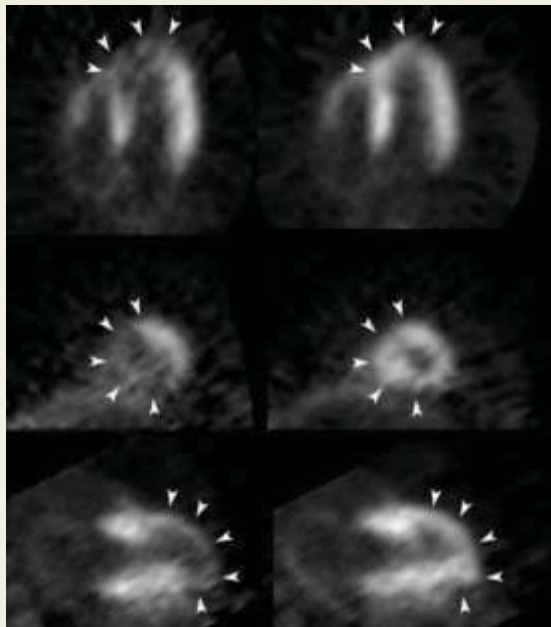


Todd D. Miller, MD, Director, and Panithaya Chareonthaitawee, MD

#### Nuclear Cardiology Laboratory

Todd D. Miller, MD, Director  
 William T. Bardsley, MD  
 Thomas Behrenbeck, MD, PhD  
 Panithaya Chareonthaitawee, MD  
 Stuart D. Christenson, MD  
 Ian P. Clements, MD  
 Raymond J. Gibbons, MD  
 John H. Haley, MD\*  
 David L. Hayes, MD  
 Donald L. Johnston, MD  
 Andre C. Lapeyre III, MD  
 Lawrence J. Sinak, MD

\*Mayo Health System



PET stress-rest perfusion with N-13 ammonia demonstrating a reversible apical and anterior defect consistent with ischemia

## Nuclear Cardiology Laboratory

The Mayo Clinic Rochester Nuclear Cardiology Laboratory provides a broad range of services, averaging 35 studies daily. The major imaging modality is stress (exercise or pharmacologic) single-photon emission computed tomographic (SPECT) imaging; 6,391 studies were performed in 2005.

The newest imaging modality is positron emission tomography (PET). The Mayo Clinic cyclotron facility is used for on-site production of the PET radioisotopes. Pharmacologic stress perfusion imaging can be performed with either rubidium-82 or nitrogen-13 (ammonia). A major advantage of stress PET perfusion imaging over conventional stress SPECT perfusion imaging is superior image quality in severely obese patients, where soft tissue attenuation artifacts degrade conventional SPECT image quality. Similar to SPECT perfusion imaging, all patients who undergo PET perfusion imaging also have calculation of ejection fraction using the gated method. A second type of PET study consists of assessment of myocardial viability using fluorodeoxyglucose (FDG) in patients with ischemic left ventricular dysfunction. PET FDG imaging is widely recognized as the gold standard for assessment of viability. The Nuclear Cardiology Laboratory performed 482 PET studies in 2005.

The laboratory is run jointly by the Division of Cardiovascular Diseases and the Division of Nuclear Medicine. All studies are read by both a staff cardiologist and a staff nuclear medicine physician to ensure study accuracy. The Mayo Clinic Rochester SPECT imaging database now includes more than 130,000 studies; since its inception in 1985, this database has been used to generate more than 200 original research manuscripts published in peer-reviewed journals. Additionally, the laboratory also serves as a core laboratory for multicenter trials to quantify infarct size. The laboratory has been used in more than 25 multicenter clinical trials. Nuclear physicists establish and maintain safety and quality control standards.





Douglas L. Packer, MD, Director

Heart Rhythm Services

- Douglas L. Packer, MD, Director
- Robert F. Rea, MD, Implantable Device Director
- Michael J. Ackerman, MD, PhD†
- Samuel J. Asirvatham, MD
- David J. Bradley, MD, PhD
- Peter A. Brady, MD
- Yong-Mei Cha, MD
- Raul Emilio Espinosa, MD
- Paul A. Friedman, MD
- Bernard J. Gersh, MD, PhD
- Stephen C. Hammill, MD
- David L. Hayes, MD
- Arshad Jahangir, MD
- Ravi Kanagala, MD\*
- Hon-Chi Lee, MD, PhD
- Margaret A. Lloyd, MD
- Thomas M. Munger, MD
- Michael J. Osborn, MD
- Co-burn J. Porter, MD†
- Win-Kuang Shen, MD
- Andre Terzic, MD, PhD
- \*Mayo Health System
- †Pediatric Cardiology

## Heart Rhythm Services

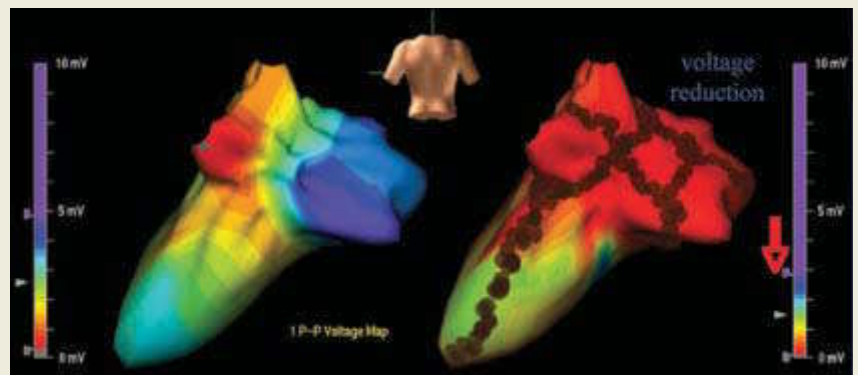
The Heart Rhythm Service (HRS) at Mayo Clinic Rochester includes the Electrophysiology and Device Implantation Laboratories, the Electrophysiology and Device Hospital Consultation Services, Heart Rhythm Center, ECG Laboratory, and Hospital Monitoring and is staffed by 22 physicians. In 2005, HRS physicians implanted 613 defibrillators, 683 pacemakers, and 204 cardiac resynchronization therapy (CRT) devices. More than 740 catheter ablation procedures were performed, including 316 pulmonary vein isolation procedures and 71 ablations for ventricular tachycardia. The staff is experienced in implanting and monitoring all pacemakers, defibrillators, and CRT devices.

The advanced imaging and mapping techniques available to the HRS physicians include electroanatomic and noncontact 3-dimensional mapping, integrated CT and MRI mapping systems, intracardiac echocardiography, and stereotactically guided mapping systems, especially useful for complex ablations such as pulmonary vein isolation (PVI). HRS physicians performed more than 300 PVI procedures last year; 75% of these patients with 1 year of follow-up were free of atrial fibrillation.

HRS outpatient activities include clinics dealing with specific problems of cardiac rhythm:

- Arrhythmia Clinic
- Atrial Fibrillation Clinic
- Implantable Device Clinic
- Long QT/Inherited Arrhythmia Clinic
- Pediatric and Adolescent Arrhythmia Clinic
- Syncope Clinic

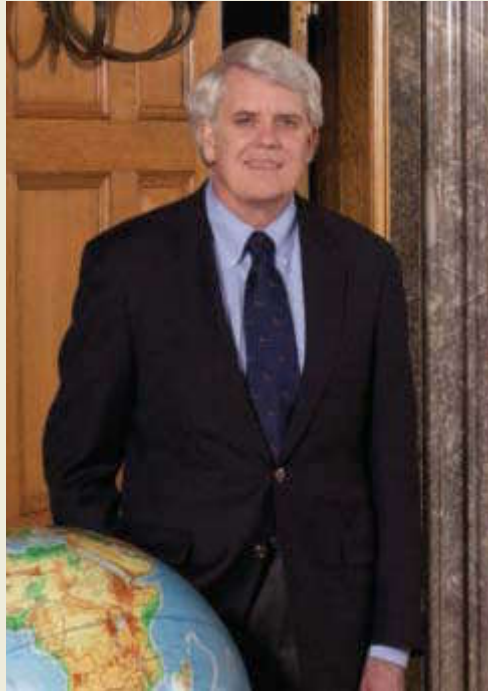
The Implantable Device Clinic actively follows 3,500 patients with implantable pacemakers and 1,200 patients with implantable defibrillators and CRT devices. This monitoring entails 5,800 patient visits per year to assess device function. A newly added aspect of device follow-up is home monitoring, which allows device interrogation over the phone to determine exactly how the device is functioning, often avoiding the need for patients to visit the emergency department or physician's office. Almost 500 patients are followed in the home-monitoring system. In addition,



Noncontact voltage map of the heart before and after ablation



Robert F. Rea, MD, Device Director



Stephen C. Hammill, MD, Education Director

**HEART RHYTHM SERVICES PROCEDURAL VOLUMES, 2005**

Diagnostic electrophysiology studies .....	151
Head-up tilt .....	335
ICD placements .....	613
ICD follow-up evaluations .....	140
Pacemaker implants .....	683
CRT pacemakers .....	10
CRT ICDs .....	194
Device revisions .....	194
Loop recorder implants .....	61
<b>Radiofrequency ablations</b>	
Atrial flutter .....	49
Atrial tachycardia .....	25
WPW/SVT .....	160
AVN .....	123
PVI .....	322
VT .....	71
Electrocardiograms .....	170,764
Holter monitors .....	8,576
Event recorders .....	1,402

AVN, atrioventricular node; CRT, cardiac resynchronization therapy; ICD, implantable cardioverter-defibrillator; PVI, pulmonary valve isolation; SVT, supraventricular tachycardia; VT, ventricular tachycardia; WPW, Wolff-Parinson-White syndrome.

the Implantable Device Clinic conducts approximately 14,000 pacemaker checks by telephone each year.

The HRS physicians are actively involved in clinical research and investigation to identify ways to improve care for patients with rhythm disorders. This research has included evaluation of advanced catheter systems to improve the rate of ablation success and shorten the length of the procedures. Systems being evaluated include the mesh catheter mapping and ablation system, cryoablation circumferential catheter ablation, and stereotactically guided catheters.

The HRS physicians are leaders in educational activities, including the 12th Annual Mayo Clinic Symposium: Arrhythmias and the Heart held in Palm Springs, California, in January 2005. The electrophysiology postgraduate training program, led by Stephen C. Hammill, MD, trains 3 to 5 fellows annually. In addition, the Mayo Clinic Rochester HRS physicians had the highest number of scientific presentations and invited lectures at the 2005 Heart Rhythm Society Annual Scientific Sessions, the main professional organization for heart rhythm disorders, as they have had for the past 5 years.



*Iftikhar J. Kullo, MD, Director*

**Early Atherosclerosis Clinic**

- Iftikhar J. Kullo, MD, *Director*
- Stephen L. Kopecky, MD
- Robert McBane, MD
- Randal J. Thomas, MD

## Early Atherosclerosis Clinic

Mayo Clinic Rochester is one of the few US medical centers with a comprehensive diagnostic and treatment program for patients at risk for early atherosclerosis. Using the latest technology and testing, cardiologists can refine cardiovascular treatment plans and more effectively manage patients at risk.

The Early Atherosclerosis Clinic serves 3 types of patients:

- Patients in whom manifestations of atherosclerosis develop at a relatively young age (<55 years in men and <65 years in women)
- Asymptomatic patients with family history of early atherosclerosis
- Patients with abnormal levels of novel risk factors

Testing to assess cardiovascular risk includes novel risk factors such as C-reactive protein, fibrinogen, lipoprotein (a), and low-density lipoprotein cholesterol particle size; CT scan of the heart to assess the degree of coronary artery calcification; arterial function tests; and consultation with a cardiologist who specializes in risk assessment and treatment.



*Sharonne N. Hayes, MD, Director*

**Women's Heart Clinic**

- Sharonne N. Hayes, MD, *Director*
- Patricia J. Best, MD
- Sharon L. Mulvagh, MD
- Teresa S. M. Tsang, MD
- Dalene M. Bott-Kitslaar, FNP

## Women's Heart Clinic

The Women's Heart Clinic was established to address the unique needs of women with and at risk for cardiovascular disease. The team comprises subspecialty cardiovascular clinicians and other specialists who provide the full spectrum of cardiac care for diverse conditions, with consultations tailored to the needs of each woman. The comprehensive assessment typically includes conventional and novel cardiovascular risk profiling and individualized treatment recommendations, taking into account the most current sex-based cardiovascular research. As part of their evaluation, women are given the "Women's Heart Clinic Risk Assessment," which provides each woman with individualized goals and recommendations for primary or secondary prevention.

Cardiologists in the Women's Heart Clinic are leaders and partners in a wide spectrum of clinical research. Ongoing research activities include risk stratification of age-related cardiovascular conditions, including atrial fibrillation, stroke, and cognitive dysfunction; assessment of the interrelationship of arterial stiffness, diastolic dysfunction, and cardiovascular outcomes; echocardiographic and physiologic biomarker predictors of cardiovascular events; clinical trials for modification of diastolic dysfunction; and the Kronos Early Estrogen Prevention Study (KEEPS), a multicenter trial to assess the cardiovascular effects of early initiation of postmenopausal hormone therapy.





## Hypertrophic Cardiomyopathy Clinic

The Mayo Clinic Rochester Hypertrophic Cardiomyopathy Clinic comprises a team of physicians, nurses, and allied health personnel that focuses on inherited cardiomyopathic processes; 604 patients were evaluated last year. Hypertrophic cardiomyopathy is the most common entity evaluated in this clinic. The physicians in the clinic have expertise in cardiac imaging, invasive and noninvasive hemodynamics, genetics, arrhythmia management, and surgical treatment of hypertrophic cardiomyopathy. Mayo Clinic Rochester has the largest single-center experience with hypertrophic cardiomyopathy; last year 105 patients underwent surgical septal myectomy or myotomy. The research findings are applied to improve clinical practice. The Hypertrophic Cardiomyopathy Clinic also manages patients with other unusual cardiomyopathies. With a focus on each individual patient and family, the team develops the optimal treatment plans and coordinates those plans with local health care providers. Physicians in the clinic published 10 manuscripts on hypertrophic cardiomyopathy last year.

Steve R. Ommen, MD, Director

### Hypertrophic Cardiomyopathy Clinic

- Steve R. Ommen, MD, Director
- Michael J. Ackerman, MD, PhD
- William K. Freeman, MD
- Bernard J. Gersh, MD, PhD
- Kyle W. Klarich, MD
- Rick A. Nishimura, MD
- Paul Soraja, MD



## Cardiovascular Health Clinic

The Cardiovascular Health Clinic provides a wide range of clinical services, including risk assessment and risk reduction. Patients may choose a one-time evaluation with follow-up by local physicians or may obtain long-term follow-up from physicians at Mayo Clinic. Patients receive a plan of action, which includes exercise, nutrition, weight loss, smoking cessation, and lifestyle modification recommendations.

The Cardiometabolic Program within the Cardiovascular Health Clinic offers a unique, personalized treatment plan for people with metabolic syndrome. Components include dietary recommendations with a teaching kitchen and hands-on learning to prepare healthy, tasty foods. This program also focuses on the behavioral changes needed to maintain a successful program to reduce cardiovascular risk.

Randal J. Thomas, MD, Director

### Cardiovascular Health Clinic

- Randal J. Thomas, MD, Director
- Thomas G. Allison, PhD
- Thomas Behrenbeck, MD, PhD
- Gerald T. Gau, MD
- J. Richard Hickman, MD
- Bruce D. Johnson, PhD
- Steven L. Kopecky, MD
- Iftikhar J. Kullo, MD
- Francisco Lopez-Jimenez, MD
- Virend Somers, MD, PhD
- Ray W. Squires, PhD
- Carmen M. Terzic, MD, PhD
- Martha A. Mangan, CNP



*Charles J. Mullany, MD, Christopher G. A. McGregor, MD, Hartzell V. Schaff, MD, Francisco J. Puga, MD, Richard C. Daly, MD, Thomas A. Orszulak, MD, Joseph A. Dearani, MD, Rakesh M. Suri, MD, PhD, and Thoralf M. Sundt III, MD*

## Cardiovascular Surgery

Hartzell V. Schaff, MD, *Chair*  
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Christopher G. A. McGregor, MD  
Charles J. Mullany, MD  
Thomas A. Orszulak, MD  
Francisco J. Puga, MD  
Thoralf M. Sundt III, MD  
Rakesh M. Suri, MD, PhD

## Cardiovascular Surgery

The Division of Cardiovascular Surgery at Mayo Clinic Rochester is an international leader in the evaluation and surgical treatment of cardiovascular disease. Mayo Clinic handles a large number of complex, high-risk cardiovascular procedures every year and has been consistently ranked in the top 2% of cardiovascular care facilities in the country. Many independent sources consider these services to be among the best in the world. The division's long history of superior clinical outcomes can be attributed, in part, to research and clinical trials that have allowed Mayo Clinic to evaluate and adopt advanced treatments of cardiovascular disease.

Cardiovascular surgeons at Mayo Clinic Rochester repair or replace more than 1,100 heart valves annually, making it one of the largest and most experienced medical centers in the country for this surgery. Since the program began in 1988, the Mayo Clinic cardiothoracic transplant team has performed nearly 300 heart transplants. The program has consistently produced excellent outcomes with survival rates among the highest in the country and excellent patient and family satisfaction. Since performing the first congenital cardiac repair on cardiopulmonary bypass, Mayo cardiovascular surgeons have been pioneers in the treatment of congenital heart disease. In the past 50 years, Mayo Clinic Rochester cardiovascular surgeons have performed nearly 65,000 cardiac surgical procedures.







*Francisco J. Puga, MD, Hartzell V. Schaff, MD,  
and Joseph A. Dearani, MD*

## Congenital Heart Disease

In 1955, a multidisciplinary team of surgeons, physicians, and technicians at Mayo Clinic began the era of open heart surgery using cardiopulmonary bypass to facilitate repair of congenital intracardiac defects. Much of the evolution of the surgical management of congenital heart defects and many “first” operations occurred at Mayo Clinic in the decades of the 1960s, ‘70s, and ‘80s. The majority of congenital heart anomalies can now be completely corrected within the first year of life.

This multidisciplinary team has grown to include subspecialty professionals in pediatric cardiology, adult congenital cardiology, cardiac anesthesiology, and congenital cardiac surgery who practice in the Mayo Clinic Center for Congenital Heart Disease and provide comprehensive care for neonates to adults with congenital heart disease. Approximately 500 procedures to correct congenital defects are performed annually at Mayo Clinic Rochester, 50% of which are in adults with congenital heart disease. Areas of surgical expertise and excellence include single ventricle (Fontan), arrhythmias, valve repair, transposition, hypertrophic cardiomyopathy, Ebstein anomaly, pulmonary atresia, and complex reoperations.



*Charles J. Mullany, MD*

## Radiation Heart Disease

Heart disease is a major cause of late mortality and morbidity in long-term survivors of mediastinal radiotherapy (MRT), in particular, for Hodgkin disease and breast cancer. The effects of MRT on the heart include pericardial disease, conduction abnormalities, cardiomyopathy, coronary artery disease, and valvular heart disease. Mayo Clinic Rochester has a long experience of cardiac surgery in patients after MRT. The complete spectrum of cardiac surgical care is required in these patients, including valvular repair and replacement, coronary artery bypass grafting, combined procedures, and heart transplantation. Careful patient assessment, timing of surgery, and thorough follow-up are required in radiation-induced cardiac disease because it tends to progress. Decisions regarding appropriate surgical management, such as valve repair versus replacement, the role of pericardiectomy, and the need for heart transplantation can be difficult. Surgeons at Mayo Clinic Rochester have reported a series of studies helping to clarify such issues and leading to good outcomes in this challenging group of patients.



*Douglas A. Wiegmann, PhD*

## Quality Control

A marker of surgical excellence is the ability to manage unexpected events during surgery, resulting in fewer complications and errors and greater patient safety. The Division of Cardiovascular Surgery has adopted a systems approach to identify potential failure points that may lead to procedural flow disruptions and surgical error. The application of this approach to the surgical environment will lead to a greater understanding of how to reduce error and enhance patient safety.





Christopher G. A. McGregor, MD

### CARDIOVASCULAR SURGERY VOLUMES, 2005

<b>Total operations .....</b>	<b>2,259</b>
<b>On cardiopulmonary bypass.....</b>	<b>2,071</b>
<b>Off cardiopulmonary bypass .....</b>	<b>188</b>
<b>Cardiac valve surgery .....</b>	<b>1,197</b>
<b>Mitral valve repair.....</b>	<b>327</b>
<b>Mitral valve replacement.....</b>	<b>153</b>
<b>Aortic valve repair .....</b>	<b>94</b>
<b>Aortic valve replacement.....</b>	<b>571</b>
<b>Other valve surgery .....</b>	<b>276</b>
<b>Bioprosthetic valve .....</b>	<b>564</b>
<b>Mechanical prosthetic valve.....</b>	<b>277</b>
<b>Homograft.....</b>	<b>30</b>
<b>Coronary artery bypass grafting.....</b>	<b>872</b>
<b>Congenital heart disease.....</b>	<b>567</b>
<b>Thoracic aortic aneurysm repair.....</b>	<b>194</b>
<b>Maze procedure .....</b>	<b>119</b>
<b>Myectomy/myotomy.....</b>	<b>105</b>
(hypertrophic obstructive cardiomyopathy)	
<b>Pericardiectomy .....</b>	<b>54</b>
<b>Mediastinal tumor resection .....</b>	<b>29</b>
<b>Cardiac transplantation .....</b>	<b>28</b>
<b>Pulmonary thromboendarterectomy.....</b>	<b>8</b>
<b>Carcinoid valve surgery.....</b>	<b>14</b>

## Chronic Pulmonary Thromboembolic Disease

In as many as 1% of survivors of acute pulmonary embolism (500,000 cases in the United States annually), the embolus fails to resolve, and these patients develop chronic vaso-occlusive disease of the pulmonary arteries with resultant pulmonary hypertension. The prognosis for this chronic thromboembolic pulmonary hypertension is poor, with a mean survival of approximately 18 months. Delayed diagnosis is common. Surgical treatment in the form of pulmonary thromboendarterectomy is highly effective in improving symptoms and prognosis. This specialized procedure is performed in only a few cardiac surgical centers. Surgical experience is critical for optimum outcomes. At Mayo Clinic Rochester, approximately 100 surgical procedures have been performed. Overall mortality from the beginning of the program has been 8%, with mortality of 3% in the most recent 60 consecutive patients. Pulmonary artery pressures and resistances as well as cardiac indices improve markedly after surgery. Experienced multidisciplinary patient assessment and management are essential for these excellent results.

## Healing Enhancement Program

The Division of Cardiovascular Surgery recognizes that the needs of the cardiac patient in the journey to recovery include adequate pain control as well as management of anxiety and stress, concerns beyond the traditional list of medical problems. In alignment with the Mayo Clinic Primary Value—"The needs of the patient come first"—the division has instituted a multidisciplinary program directed toward meeting these patient needs and those of the patients' families. The key elements of this "healing enhancement" program include concerted efforts to coordinate conventional pain management therapies in an evidence-based manner to minimize patient discomfort during hospitalization and afterward. These efforts include continuous narcotic infusion, patient-controlled analgesia, infusion of local anesthetic to the surgical site, and appropriate use of nonsteroidal agents. These conventional therapies are augmented by a program of massage therapy to relieve musculoskeletal discomfort that may occur as a consequence of positioning in the operating room and sternal retraction. The benefits of this program, as reported by patients, have been quite dramatic.

The program is also exploring holistic techniques, such as meditation, guided imagery, and music therapy, to allay anxiety. Most recently, the group has considered "ambient therapy" with a combination of nature sounds and calming music created by Chip Davis, composer, musician, and founder of the group Mannheim Steamroller. Special recordings mix music and sounds of nature delivered quadraphonically to produce a calming and peaceful environment in the patient's room to enhance recovery.



Chip Davis



Thoralf M. Sundt III, MD

## Aortic Disease

The Division of Cardiovascular Surgery at Mayo Clinic Rochester has long-standing interest, commitment, and experience in management of aortic aneurysmal disease. Mayo Clinic physicians played an important role in defining the natural history of aortic aneurysmal disease, dissection, and penetrating atherosclerotic ulcer. The program is among the largest in the country addressing disease of the ascending aorta, aortic arch, and descending thoracic and thoracoabdominal aorta. Consonant with the Mayo Clinic Model of Care, the program includes a multidisciplinary clinic devoted to Marfan syndrome and diseases of the thoracic aorta. As a product of this collaboration with colleagues in internal medicine and radiology, the division sponsors a biennial continuing medical education program in aortic disease. Mayo Clinic Rochester cardiovascular surgeons have been active participants in early trials of thoracic endografting and are currently using endografts in selected patients. The program to manage thoracoabdominal aneurysmal disease is conducted in coordination with colleagues in the Division of Vascular Surgery. Active laboratory investigations focus on the genetics and molecular biology of thoracic and aortic aneurysmal disease with particular focus on bicuspid aortic valve disease.



Thomas A. Orszulak, MD

## Valvular Heart Disease

Understanding the relationship among certain infections, the development of rheumatic heart disease, and the introduction of effective antibiotics during the past century led many to believe that the era of valvular heart disease was over. Although the incidence of rheumatic valvular heart disease has markedly decreased in this country, valvular heart disease is increasing because of the aging population; degenerative and calcific mitral and aortic valve diseases predominate. Mayo Clinic Rochester cardiovascular surgeons repaired or replaced nearly 1,200 heart valves last year; many procedures were complex operations with concurrent maze procedures, coronary artery bypass grafting, or additional congenital repair, or the procedures involved patients undergoing repeat operations or with severe comorbid conditions. Cardiovascular surgeons at Mayo Clinic Rochester have consistently had outstanding results with valve replacement and technically challenging valve repair.



Mitral valve repair

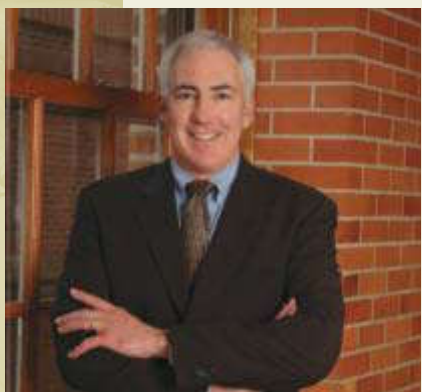




*Brooks S. Edwards, MD, Medical Director,  
Cardiac Transplantation*



*Christopher G. A. McGregor, MD, Director,  
William J. von Liebig Transplant Center*



*Richard C. Daly, MD, Surgical Director,  
Cardiac Transplantation*

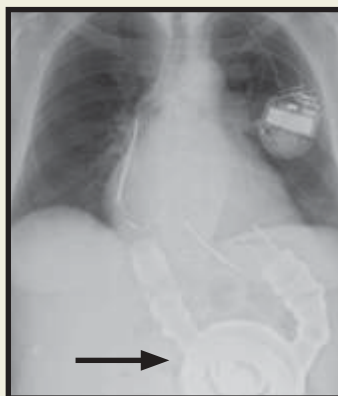
## Heart Transplantation

Mayo Clinic Rochester has performed more than 300 heart transplants since the program began in 1988. The heart transplant program at Mayo Clinic has been a patient-centered, multidisciplinary program from its inception. Individuals with transplant expertise in cardiac surgery, cardiology, infectious disease, pulmonology, anesthesiology, psychiatry, social work, and other fields are involved with each patient's care. This approach has resulted in excellent outcomes, with 1- and 5-year survival rates of 92.7% and 82.0%, respectively. Mayo Clinic Rochester is participating in national clinical trials of new mechanical devices to bridge patients to transplantation. To maintain optimal medical care, cardiologists with special expertise in heart failure evaluate and follow patients waiting for transplant. The William J. von Liebig Transplant Center has brought together all the Mayo Clinic Rochester transplant programs, which has encouraged collaboration and sharing of resources. This has also streamlined the approach to multiorgan transplant, including heart-kidney and heart-liver transplants. The long tradition of cardiac surgery for congenital heart disease has brought expertise to heart transplantation for infants, children, and even adults with complex congenital heart disease. The heart transplant program at Mayo Clinic Rochester has also developed special expertise in amyloid disease.

## Ventricular Assist Devices

The use of mechanical pumps to assist the heart and help maintain circulation in patients with heart failure is becoming more common as new pumps are developed and brought to clinical use. Most of these pumps are designed to assist only the left side of the heart and are referred to as left ventricular assist devices (LVADs). LVADs were initially developed as a means of keeping patients alive until a heart transplant could be performed. However, the limited number of heart donors has led to the development of LVADs that might be used as permanent devices implanted to improve the prognosis and quality of life in selected patients with end-stage heart failure. About 2 years ago, the first LVAD was approved as a permanent device (for "destination therapy") in the United States. Since then, a program has been developed at Mayo Clinic Rochester to offer destination therapy LVADs for appropriate,

selected patients who might benefit and are not candidates for heart transplantation. The approved, implantable LVAD is a large device that has an external drive-line that must be connected to batteries and a small control box at all times. Mayo Clinic Rochester is now participating in national clinical trials to evaluate new LVAD pumps that are smaller and quieter and may be more durable than the first-generation pumps.



*Left ventricular assist device (arrow)*

## Marfan Syndrome Clinic

### Adult Cardiology

Heidi M. Connolly, MD, *Codirector*  
Thoralf M. Sundt III, MD, *Codirector*  
Naser M. Ammash, MD  
Juan M. Bowen, MD  
Charles J. Bruce, MD  
Heidi M. Connolly, MD  
Raul Emilio Espinosa, MD  
Sabrina D. Phillips, MD  
Peter C. Spittell, MD  
Carole A. Warnes, MD

### Pediatric Cardiology

Allison K. Cabalka, MD  
Frank Cetta, MD  
David J. Driscoll, MD  
Donald J. Hagler, MD  
Patrick W. O'Leary, MD  
Co-burn J. Porter, MD

### Medical Genetics

Dusica Babovic-Vuksanovic, MD  
Noralene M. Lindor, MD  
Jay W. Ellison, MD, PhD  
Pamela S. McGrann, MD  
Virginia V. Michels, MD  
David B. Schowalter, MD, PhD

### Ophthalmology

J. Douglas Cameron, MD  
Brian G. Mohney, MD



Heidi M. Connolly, MD, *Codirector*



Thoralf M. Sundt III, MD, *Codirector*

## Marfan Syndrome Clinic

The Mayo Clinic Rochester Marfan Syndrome Clinic offers an integrated medical, genetic, and surgical team of specialized physicians to provide diagnosis and treatment for patients with suspected or confirmed Marfan syndrome. Marfan syndrome is a heritable disorder of connective tissue caused by a mutation in the gene encoding fibrillin-1 on chromosome 15. It is inherited in an autosomal dominant pattern 75% of the time; the other 25% of cases arise from spontaneous mutations.

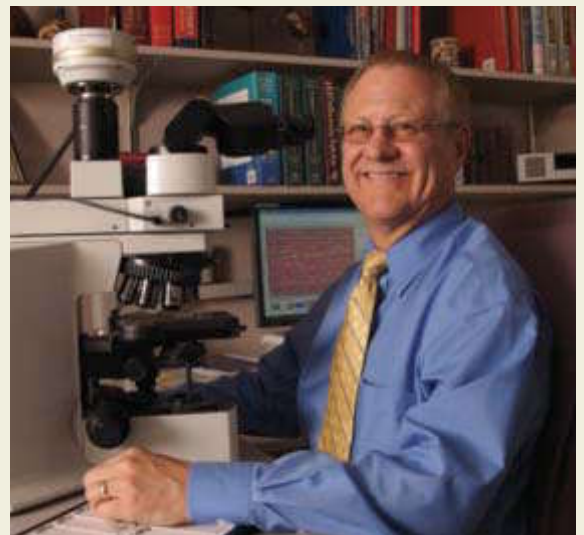
Mayo Clinic Rochester has pioneered surgical treatment for the cardiac abnormalities most frequently responsible for morbidity and mortality in Marfan syndrome. Surgeons can offer valve-sparing root reconstruction, replacement of the aortic valve and root with tissue homografts, or tissue-engineered human conduits in addition to the standard surgical approach of replacing the root with a composite valve conduit. The Marfan Syndrome Clinic provides education for patients and families regarding exercise, endocarditis prophylaxis, pregnancy, genetic implications, surgical consultation, and lifelong management.

## Cardiac Pathology

William D. Edwards, MD  
Marie-Christine Aubry, MD  
Dylan V. Miller, MD

## Cardiac Pathology

Mayo Clinic Rochester has a long history of expertise in cardiac pathology. Understanding gross and microscopic cardiac abnormalities has provided the basis for planning medical treatment and surgical repair. Today, cardiac pathologists provide expert advice to physicians from around the world. Specimens can be submitted to Mayo Clinic for evaluation via local pathologists or through Mayo Medical Laboratories. Last year, almost 2,000 cardiac specimens were reviewed by Mayo Clinic Rochester cardiac pathologists. Standard stain preparations, immunohistochemical analysis, transmission electron microscopy, polymerase chain reaction, and in situ hybridization are some of the techniques used.



William D. Edwards, MD





*Thom W. Rooke, MD, Director*

#### Vascular Medicine Clinic

Thom W. Rooke, MD, *Director*  
Leslie T. Cooper, MD  
Mark G. Costopoulos, MD  
John A. Heit, MD  
Henna Kalsi, MD  
Iftikhar J. Kullo, MD  
Robert D. McBane, MD  
Ian R. McPhail, MD  
Roger F. J. Shepherd, MD  
Raymond C. Shields, MD  
Farris K. Timimi, MD  
Paul W. Wennberg, MD  
Waldemar E. Wysokinski, MD  
Vincent J. Yacyshyn, MD

## Vascular Medicine Clinic

In conjunction with vascular surgeons and vascular radiologists, the Vascular Medicine Clinic cares for patients with a broad spectrum of vascular diseases. Mayo Clinic vascular medicine physicians undertake the inpatient or outpatient evaluation and treatment of patients with disorders such as peripheral arterial disease, acute and chronic venous disease, vasospastic disorders (including Raynaud phenomenon), swollen limbs, and many other common or rare vascular conditions. All Vascular Medicine Clinic physicians are board certified in either general internal medicine or cardiovascular diseases; 8 of the section's consultants were recently credentialed by the newly established American Board of Vascular Medicine. Members of the section are extensively engaged in research and education. This year the section received a multimillion-dollar National Institutes of Health training grant to provide additional vascular medicine education for residents and fellows.

### Wound Care Clinic

The Vascular Medicine Clinic, in conjunction with selected physicians from physical medicine and rehabilitation, podiatry, and general internal medicine, operate a wound care clinic for patients with vascular ulcers, nonhealing wounds, or both. The practice is supported by more than a dozen nurses, physical therapists, nurse practitioners, and physician assistants. State-of-the-art technologies, including artificial skin grafts, intermittent pneumatic compression pumping, and ultrasonically generated mist debridement therapies, are available. The clinic is a national leader in research into new wound care technologies. In 2007, the Wound Care Clinic will open (in conjunction with preventive medicine) a hyperbaric oxygen chamber that will provide a novel treatment option for many types of wounds.

### Thrombophilia Clinic

The largest specialty clinic in the vascular center is the Thrombophilia Clinic, which addresses the needs of patients with acute or chronic clot-



Leslie T. Cooper, MD, and Raymond C. Shields, MD

**GONDA VASCULAR CENTER VOLUMES, 2005**

Vein Clinic consultations .....	268
Vasculitis Clinic consultations .....	97
Thrombophilia Clinic consultations...	26,284
Wound Care Clinic consultations .....	17,816
Vascular medicine consultations .....	7,509
Vascular surgery consultations .....	4,994
Vascular ultrasound studies .....	13,597
Peripheral vascular studies .....	8,065
Sclerotherapy procedures .....	1,120

ting problems, chronic warfarin therapy, outpatient treatment with low-molecular-weight heparin, and many others. The thrombophilia group currently holds numerous grants for the evaluation of thrombotic disorders.

**Vein Clinic**

The multidisciplinary Vein Clinic allows patients with varicose veins to see practitioners from vascular medicine, radiology, surgery, and dermatology, who offer complementary approaches to treatment of venous disorders. Evaluations are designed to ensure that the patient receives the optimal treatment modality for his or her venous condition. Treatment options include conventional vein stripping, laser or microwave catheter ablation, and sclerotherapy.

**Early Atherosclerosis Clinic**

This clinic evaluates patients with premature and unusually severe forms of atherosclerosis. Extensive diagnostic evaluation and aggressive treatment options are provided.

**Vascular Laboratory**

This laboratory, one of the largest in the world, uses ultrasound imaging (provided in conjunction with the Department of Radiology) and numerous physiologic tests to evaluate the function of arteries and veins. The ability to combine duplex ultrasound testing with noninvasive functional measurements allows the laboratory to provide a unique and comprehensive approach to noninvasive diagnostic evaluation.

**Vasculitis Clinic**

In conjunction with the Division of Rheumatology, vascular medicine provides specialty evaluation for patients with vasculitis, an unusual inflammatory condition of the blood vessels. Mayo Clinic is one of only a few practices that provide a multidisciplinary subspecialty approach to these rare diseases.

**Arteriovenous Malformation Clinic**

The newest of Mayo Clinic’s specialty clinics, this practice emphasizes an aggressive diagnostic and treatment approach to arteriovenous malformations, using the skills of vascular internists, vascular radiologists, and vascular surgeons.

**Lymphedema Clinic**

Vascular Center consultants collaborate with members of the Department of Physical Medicine and Rehabilitation to provide diagnostic and therapeutic options for patients with lymphedematous conditions.





Frank Cetta, MD, Chair, Division of Pediatric Cardiology

## Pediatric Cardiology

The Division of Pediatric Cardiology has 10 pediatric cardiologists dedicated to the care of infants, children, adolescents, and young adults with congenital heart disease. The outpatient practice is based at Mayo Clinic Rochester; however, outreach clinics are provided throughout the Upper Midwest. In addition, state-of-the-art telemedicine links Mayo Clinic with institutions in neighboring states; pediatric echocardiography services are also provided via telemedicine links.

The practice offers the full spectrum of diagnostic and therapeutic services to patients with congenital heart disease. Some examples of these specialized pediatric services include echocardiography (encompassing the fetus to adults with congenital heart disease), electrophysiology, exercise testing, and interventional cardiac catheterization. In addition, subspecialty clinics are available for pediatric patients with cardiovascular disorders such as Marfan syndrome, hypertrophic cardiomyopathy, long QT syndrome, and families with a history of sudden death.

The Division of Pediatric Cardiology at Mayo Clinic has a long tradition, of providing for children with congenital heart disease. The Congenital Heart Disease Center offers the surgical expertise of Francisco J. Puga, MD, Joseph A. Dearani, MD, and Hartzell V. Schaff, MD, who perform the full spectrum of congenital heart operations. Children cared for at Mayo Clinic have the benefit also of specialists dedicated to pediatric cardiac anesthesia and intensive care management.

The congenital cardiac catheterization laboratory at Mayo Clinic Rochester specializes in the care of children, adolescents, and adults with congenital heart disease. Interventional catheterization procedures are provided for patients from infancy through adulthood. In the past 6 years alone, physicians in the congenital cardiac catheterization laboratory have implanted more than 500 transcatheter closure devices. In the near future, cardiologists in the congenital cardiac catheterization laboratory will deliver percutaneous cardiac valve replacement technology.

The congenital echocardiography laboratory performs more than 5,000 studies annually. Patients studied in the congenital echocardiography laboratory have participated in numerous research projects that have contributed to the understanding of congenital heart disease.

The pediatric cardiac transplant program at Mayo Clinic Rochester is an integral part of the adult cardiac transplant program. Pediatric patients benefit from the experience gained in more than 300 cardiac transplants; 1-, 5-, and 10-year survival rates are 92%, 82%, and 65%, respectively. The expertise gained from a successful program in pediatric and congenital cardiac surgery contributes to the success of the pediatric cardiac transplant program.

### Pediatric Cardiology

- Frank Cetta, MD, Chair
- Michael J. Ackerman, MD, PhD
- Allison K. Cabalka, MD
- David J. Driscoll, MD
- Donald J. Hagler, MD
- Patrick W. O'Leary, MD
- Timothy M. Olson, MD
- Co-burn J. Porter, MD
- James B. Seward, MD
- Carole A. Warnes, MD



**PEDIATRIC PROCEDURES, 2005**

**Pediatric catheterizations..... 310**

**Congenital echocardiograms...3,754**



Margaret M. Redfield, MD, Director

## Heart Failure Clinic

The Heart Failure Clinic at Mayo Clinic Rochester comprises both an outpatient clinic and an inpatient service. The heart failure specialists have experience in a wide range of common and uncommon diseases that result in heart failure as well as challenging management problems related to heart failure.

Evaluation of patients across the spectrum of heart failure is offered, including patients with asymptomatic ventricular dysfunction and diastolic heart failure, and referral need not be reserved for those with advanced symptoms or confined to any age stratum. A range of services tailored to the needs of the patient and the referring physician is available:

- Evaluation of new-onset or worsening heart failure
- Patient education
- Medication titration
- Chronic disease management
- Advanced heart failure management
- Surgical and catheter-based therapies for ischemic or valvular disease
- Transplantation
- Chronic mechanical cardiac support (left ventricular assist devices)
- Cardiac resynchronization therapy
- Rhythm management
- Palliative chronic inotropic support
- Inpatient management of acutely decompensated or refractory heart failure
- Investigational therapies

The Heart Failure Clinic offers patients participation in a number of investigational device and medical therapy studies. Available protocols change frequently but include such options as cardiac contractility modulation devices, studies related to cardiac resynchronization therapy, surgical treatment for heart failure, percutaneous valvuloplasty for treatment of functional mitral regurgitation, studies related to sleep disorders in heart failure, chronic subcutaneous natriuretic peptide therapy, immunomodulation therapy, strategies related to cardiorenal impairment in patients with heart failure, and studies related to treatment of diastolic heart failure.

### Heart Failure Clinic

Margaret M. Redfield, MD, Director  
Daniel D. Borgeson, MD  
Barry A. Borlaug, MD  
John C. Burnett, Jr, MD  
Hong H. Chen, MD  
Stuart D. Christenson, MD  
Alfredo L. Clavell, MD  
Leslie T. Cooper, MD  
Brooks S. Edwards, MD  
Robert P. Frantz, MD  
Martha Grogan, MD  
Barry L. Karon, MD  
Sudhir S. Kushwaha, MD  
Wayne L. Miller, MD, PhD  
Lyle J. Olson, MD  
Richard J. Rodeheffer, MD  
Farris K. Timimi, MD





Heidi M. Connolly, MD, Director, and Joseph A. Dearani, MD

#### Center for Congenital Heart Disease

Heidi M. Connolly, MD, *Director*

#### Cardiovascular Surgery

Hartzell V. Schaff, MD, *Chair*

Joseph A. Dearani, MD

Francisco J. Puga, MD

#### Adult Congenital Heart Disease Clinic

Carole A. Warnes, MD, *Director*

Naser M. Ammash, MD

Frank Cetta, Jr, MD

Heidi M. Connolly, MD

Martha Grogan, MD

Sabrina D. Phillips, MD

#### Pediatric Cardiology

Frank Cetta, MD, *Chair*

Michael J. Ackerman, MD, PhD

Allison K. Cabalka, MD

David J. Driscoll, MD

Donald J. Hagler, MD

Patrick W. O'Leary, MD

Timothy M. Olson, MD

Co-burn J. Porter, MD

James B. Seward, MD

Carole A. Warnes, MD

#### Radiology

Philip A. Araoz, MD

Jerome F. Breen, MD

James F. Glockner, MD

Paul R. Julsrud, MD

Eric E. Williamson, MD

#### Cardiac Pathology

William D. Edwards, MD

## Center for Congenital Heart Disease

More than 18,000 patients have had operative repair of their congenital heart disease at Mayo Clinic Rochester over the past 60 years, and Mayo Clinic physicians originated many of the diagnostic modalities and therapeutic techniques used today. Last year, Mayo Clinic Rochester announced creation of the Center for Congenital Heart Disease. This center provides care for patients with congenital heart disease from the fetus to the elderly patient. Services provided include comprehensive imaging such as congenital echocardiography, CT and MRI, and congenital cardiac catheterization.

Last year, cardiovascular surgeons at Mayo Clinic performed almost 600 operations to repair congenital cardiac defects in adults and children. Additionally, techniques developed over the past 20 years allow for percutaneous treatment of many defects that in the past would have required open surgical repair, such as pulmonary valve valvuloplasty, stenting of Mustard and Senning baffles, and occluder devices for atrial septal defect. Treating children at earlier ages may prevent irreversible physiologic changes that might preclude definitive correction later in life. Nevertheless, many of these patients require long-term cardiac care.

The Center for Congenital Heart Disease also provides genetic counseling and patient and family education. Research projects are in progress to explore the genetic basis for congenital heart disease. Mayo Clinic Rochester medical and surgical specialists travel to areas throughout the world to provide care for patients and education and training for physicians and nurses.

## Adult Congenital Heart Disease Clinic

Almost 1 million adults in the United States have congenital heart disease. In the past 50 years, Mayo Clinic Rochester developed surgical approaches to congenital heart defects; as a result, many patients with congenital heart defects are now surviving to adulthood and require lifelong follow-up. The Adult Congenital Heart Disease Clinic follows more than 3,000 patients and provides comprehensive evaluation of congenital cardiac disorders. Special needs of this growing population include education regarding employment, exercise, and pregnancy; treatment of arrhythmias; risk assessment for noncardiac surgery; and management of acquired medical problems, such as hypertension and diabetes mellitus.

Studies have demonstrated that operative mortality is reduced when surgery is performed by experienced surgeons in high-volume centers. The experience and integrated approach of the Adult Congenital Heart Disease Clinic make Mayo Clinic Rochester one of the top centers in the country offering comprehensive care to these patients.



Carole A. Warnes, MD, Director

### Adult Congenital Heart Disease Clinic

Carole A. Warnes, MD, Director  
 Naser M. Ammash, MD  
 Frank Cetta, MD  
 Heidi M. Connolly, MD  
 Martha Grogan, MD  
 Sabrina D. Phillips, MD

### Pericardial Disease Group

#### Cardiology

Jae K. Oh MD, Director  
 Leslie T. Cooper, MD  
 Raul Emilio Espinosa, MD  
 Bernard J. Gersh, MD, PhD  
 Sharonne N. Hayes, MD  
 Wayne L. Miller, MD, PhD  
 Rick A. Nishimura, MD  
 Lawrence J. Sinak, MD  
 Teresa S. M. Tsang, MD  
 Douglas L. Wood, MD

#### Cardiovascular Surgery

Richard C. Daly, MD  
 Joseph A. Dearani, MD  
 Christopher G. A. McGregor, MD  
 Charles J. Mullany, MD  
 Thomas A. Orszulak, MD  
 Francisco J. Puga, MD  
 Hartzell V. Schaff, MD  
 Thoralf M. Sundt III, MD

#### Radiology

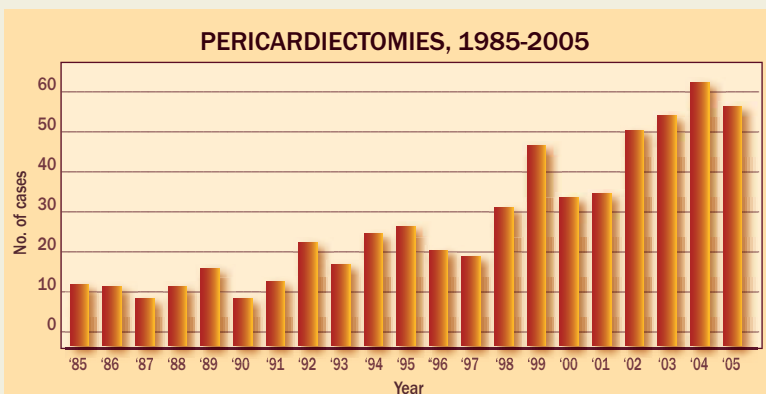
Jerome F. Breen, MD

#### Anatomic Pathology

William D. Edwards, MD

## Pericardial Disease Group

The aging population and changing medical practice have altered the course of most pericardial diseases. Today, a common diagnostic dilemma is determining whether symptoms are caused by constrictive pericarditis or restrictive cardiomyopathy. The Mayo Clinic Rochester Pericardial Disease Group consists of cardiologists, radiologists, pathologists, and cardiovascular surgeons with a special interest in pericardial disease. The group has multidisciplinary experience diagnosing and treating relapsing pericarditis, chronic constrictive pericarditis, cardiac tamponade, and effusive-constrictive pericarditis. Mayo Clinic Rochester cardiovascular surgeons performed 54 pericardiectomies last year.



Jae K. Oh, MD, Director, and Hartzell V. Schaff, MD, Chair, Division of Cardiovascular Surgery





*Amir Lerman, MD, Director*

**Chest Pain and Coronary  
Physiology Clinic**

Amir Lerman, MD, *Director*  
Gregory W. Barsness, MD  
Patricia J. Best, MD  
Panithaya Chareonthaitawee, MD  
Bernard J. Gersh, MD, PhD  
David R. Holmes, Jr, MD  
Kyle W. Klarich, MD  
Abhiram Prasad, MD  
Guy S. Reeder, MD  
Gurpreet S. Sandhu, MD, PhD  
Robert D. Simari, MD  
Paul Sorajja, MD  
R. Thomas Tilbury, MD  
R. Scott Wright, MD

## **Chest Pain and Coronary Physiology Clinic**

The Chest Pain and Coronary Physiology Clinic (CPCPC) provides diagnosis and treatment for patients with chest pain who are not candidates for conventional medical or interventional approaches. Patients with chest pain and no obstructive coronary artery disease are categorized as having syndrome X or vasospastic angina and benefit from coronary physiologic and endothelial function assessment. The appropriate diagnosis of the underlying pathology is crucial for their prognosis and treatment, because coronary endothelial dysfunction is associated with increased cardiac events.

The CPCPC at Mayo Clinic Rochester has studied coronary flow reserve and endothelial function in more than 600 patients and is one of the largest referral centers for assessment of these patients. The CPCPC offers several new therapeutic protocols to these patients, such as administering endothelin receptor antagonists and performing new noninvasive diagnostic studies; genomic studies are planned for the future.

Chronic end-stage coronary artery disease affects another sizable group of patients. Recent innovations have included transmyocardial laser revascularization, therapeutic angiogenesis, and enhanced external counterpulsation. Mayo Clinic Rochester is a recognized leader in the evaluation and utilization of external counterpulsation, with clinical improvement documented in more than 90% of patients treated over the past 3 years. In collaboration with the Pain Clinic, a new investigational therapy is also offered, testing the beneficial effect of spinal cord stimulation on symptoms of myocardial ischemia. Moreover, ongoing gene transfer studies focus on the development of myocardial angiogenesis to improve myocardial perfusion.

## Pulmonary Hypertension Clinic

The management of pulmonary hypertension has become increasingly complex as awareness of the clinical variability and diverse substrates of the disease has expanded and as multiple options for treatment have emerged. The Pulmonary Hypertension Clinic provides a concentrated and efficient multidisciplinary approach to the care of patients with pulmonary hypertension. Management emphases include the option to participate in clinical trials when appropriate and coordination of care with referring physicians.

The Pulmonary Hypertension Clinic is staffed by 8 physicians and 3 clinical and research nurse specialists. Timely consultation is available in rheumatology, medical and surgical transplant services, cardiovascular surgery with surgeons experienced in pulmonary thromboendarterectomy, sleep disorders clinic, and the Congenital Heart Disease Center. State-of-the-art Doppler echocardiographic techniques, invasive hemodynamic evaluation with vasoreactivity testing, standardized 6-minute walk testing, imaging with perfusion scintigraphy, advanced CT and MRI assessment, and pulmonary angiography are readily available.

The staff is expert in the selection and application of all available treatment modalities, including prostacyclin analogues (intravenous epoprostenol, intravenous or subcutaneous treprostinil, inhaled iloprost), endothelin receptor blockade (bosentan), and phosphodiesterase inhibition (sildenafil). By careful education geared to each patient's situation, the patient becomes a full participant in his or her own health care.

The Pulmonary Hypertension Clinic has participated in clinical trials that led to the approval of each drug used in treatment today and continues to participate in numerous studies, including investigations of

- the pharmacokinetics and clinical use of oral treprostinil
- bosentan use in chronic thromboembolic pulmonary hypertension, interstitial lung disease, or portopulmonary hypertension
- use of tadalafil in pulmonary arterial hypertension
- the value of combination therapy in pulmonary arterial hypertension

A pilot study of a novel implantable pulmonary hemodynamic monitor recently has been completed, with Mayo Clinic providing the highest level of patient involvement. By participating in clinical trials, patients have early access to potentially more efficacious treatments, and the Pulmonary Hypertension Clinic personnel develop valuable experience with medications while in clinical trials.

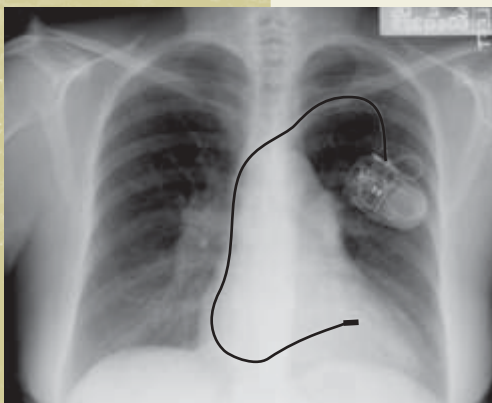
Dr McGoon is president of the Pulmonary Hypertension Association.



Michael D. McGoon, MD, Director

### Pulmonary Hypertension Clinic

Michael D. McGoon, MD, Director  
Brooks S. Edwards, MD  
Robert P. Frantz, MD  
Sudhir S. Kushwaha, MD  
Robert B. McCully, MD  
Joseph G. Murphy, MD  
Michael J. Krowka, MD\*  
Karen L. Swanson, DO\*  
\* Pulmonology



Implantable hemodynamic monitor with monitoring lead in the right ventricle, placed high on the septum. (For better visualization the lead is graphically enhanced in black.)





Maurice E. Sarano, MD, Director

Valvular Heart Disease Clinic

- Maurice E. Sarano, MD, Director
- Charles J. Bruce, MD
- Alfredo L. Clavell, MD
- Raul Emilio Espinosa, MD
- Titus C. Evans, Jr, MD
- David A. Foley, MD
- William K. Freeman, MD
- W. Bruce Fye, MD
- Bernard J. Gersh, MD, PhD
- Kyle W. Klarich, MD
- Hector I. Michelena, MD
- Joseph F. Maalouf, MD
- Sunil V. Mankad, MD
- Vuyisile T. Nkomo, MD
- Steve R. Ommen, MD
- Guy S. Reeder, MD
- Charanjit S. Rihal, MD
- Clarence Shub, MD
- Paul Sorajja, MD
- R. Scott Wright, MD

## Valvular Heart Disease Clinic

The Valvular Heart Disease Clinic offers a multidisciplinary team approach to integrate research, education, and clinical acumen for the long-term, comprehensive care of patients with valvular heart disease. The aging of the population has been accompanied by a new epidemic of degenerative valve disease. The most common valvular abnormalities seen in developed countries are mitral valve regurgitation and aortic valve stenosis. The decline in surgical morbidity and mortality has led to the concept that selected patients should be offered early operation, especially if the valve can be repaired.

Offering patients repair or replacement before they become severely symptomatic requires diagnostic certainty and a complete and accurate description of the valvular lesions to be treated. Diagnostic modalities readily available include Doppler echocardiography, electron-beam CT, MRI, and intracardiac ultrasonography. One of the most common methods of determining severity of mitral regurgitation, the PISA (proximal isovelocity surface area) method, was developed by Mayo Clinic Rochester echocardiographers.

More than 90% of Mayo Clinic patients with mitral valve regurgitation are eligible for valvular repair. More than 40 mitral valvuloplasties were performed at Mayo Clinic Rochester last year; interventional cardiologists are participating in clinical trials evaluating the safety and efficacy of percutaneous valve repair.

A new emphasis on slowing or halting the progression of degenerative valvular disease has led to the development of trials evaluating the efficacy of medical treatment. Mayo Clinic Rochester is currently participating in trials sponsored by the National Institutes of Health to assess the effectiveness of angiotensin blockade,  $\beta$ -blockade, and statins to retard the progression of degenerative disease.



## Mayo Clinic Heart Clinic in Dubai Healthcare City

The Mayo Clinic Heart Clinic in Dubai Healthcare City in the United Arab Emirates provides diagnostic and noninvasive cardiac care Sunday through Thursday. Services include comprehensive cardiac consultation, electrocardiography, standard and stress echocardiography, and Holter monitoring.

**Additional information:**

- Web site:** <http://www.mayoclinic.org/english/dubai.html>
- e-mail:** [middleeast@mayo.edu](mailto:middleeast@mayo.edu)
- phone:** 011-971-4-362-2900
- fax:** 011-971-4-362-4700

Mayo Clinic Heart Clinic in Dubai Healthcare City

- Naser Ammash, MD
- Joseph Maalouf, MD

# MAYO HEALTH SYSTEM

A network of clinics and hospitals dedicated to serving the health care needs of people in more than 60 communities in Iowa, Minnesota, and Wisconsin.



John Haley, MD, Janice Clarke, MD, Laura A. Diamandopoulos, MD, Kevin Cragun, MD, Robert Houlihan, MD, and Ripudamanjit Singh, MD

## Immanuel St. Joseph's Mankato, Minnesota

Six Mayo cardiologists serve the Mankato facility and 4 surrounding outreach sites, providing a broad range of cardiology services, including cardiovascular consultations, full-spectrum echocardiography, diagnostic and interventional cardiac and peripheral catheterization, nuclear stress testing, and pacemaker/defibrillator implantation. The marked growth in cardiology services has prompted the construction of a heart center that will be completed in 2007.



Lawrence Keenan, MD, and Andrew G. Moore, MD

## Heart Center at Austin Medical Center Austin, Minnesota

The 2 cardiologists at Austin Medical Center provide a full array of noninvasive cardiac imaging modalities, including CT angiography and CT coronary artery calcium imaging. More than 2,000 patients were seen in 2005, including those at the Heart Center Lipid Clinic and in the Cardiac Rehabilitation Center.

### AUSTIN MEDICAL CENTER PROCEDURES, 2005

Transthoracic echocardiograms.....	1,203
Transesophageal echocardiograms.....	76
Stress echocardiograms .....	221
Holtor monitors .....	274
Event recorders .....	38
Nuclear perfusion studies.....	300





Mandeep Singh, MD, Ravi Kanagala, MD, Charles R. Cagin, DO, and Michael S. Meyers, MD

## Franciscan Skemp Healthcare La Crosse, Wisconsin

The 4 cardiologists at Franciscan Skemp Healthcare provide a broad range of noninvasive, interventional, and electrophysiology services to the tristate region of Wisconsin, Minnesota, and Iowa. The group will be offering cardiac MRI and CT in the near future, and they are currently implementing the fast-track STEMI protocol.

### LA CROSSE PROCEDURES, 2005

<b>Echocardiograms .....</b>	<b>3,616</b>
<i>(includes 343 stress echo, 108 transesophageal, 124 pediatric/neonatal)</i>	
<b>Nuclear imaging tests .....</b>	<b>1,505</b>
<b>Cardiac catheterizations .....</b>	<b>691</b>
<b>Percutaneous cardiac interventions....</b>	<b>204</b>
<b>Electrophysiology studies.....</b>	<b>76</b>
<b>Radiofrequency ablations .....</b>	<b>44</b>
<b>Device implants .....</b>	<b>148</b>



Robert J. Wiechmann, MD, Chair, Cardiovascular Thoracic Surgery

## Luther Midelfort Eau Claire, Wisconsin

Eight cardiologists and 2 cardiovascular-thoracic surgeons provide care for patients in Eau Claire and surrounding communities, including Barron, Cameron, Chippewa Falls, Durand, and Menomonie, Wisconsin. Diagnostic services available include stress testing, electrocardiography, echocardiography, and electrophysiology studies. Available treatments include cardiac catheterization, ablation procedures, angioplasty, cardiac bypass graft surgery, heart valve repair and replacement, carotid endarterectomy, and repair of heart defects and aortic aneurysms.



Richard D. Hanna, MD, Chair, Cardiovascular Disease

Luther Midelfort also offers a number of specialty clinics to help patients manage existing heart conditions. These clinics include the Lipid Disorders Clinic, Pacemaker and Implantable Cardioverter-Defibrillator Clinic, Heart Failure Prevention and Treatment Clinic, and Vascular Clinic. Cardiac and cardiopulmonary rehabilitation also is available.



*Lawrence R. McBride, MD*



*J. Norman Patton, MD*

Dear Colleagues:

The Division of Cardiovascular Diseases at Mayo Clinic Jacksonville comprises a team of 15 staff physicians, midlevel practitioners, and a dedicated cadre of nurses and technicians who work collaboratively to provide comprehensive and effective care to adult patients with disorders of the heart and blood vessels. The division collaborates closely with colleagues from the Section of Cardiothoracic Surgery and the Section of Vascular Surgery to deliver integrated cardiovascular care. The Jacksonville team is supported by state-of-the-art laboratories, subspecialty clinics, and preventive health programs, providing specialized care for patients with

- Complex electrophysiologic heart rhythm disorders
- Coronary artery disease
- Valvular heart disease
- Heart failure and disorders requiring heart transplantation
- Pulmonary hypertension

Additionally, the practice offers comprehensive evaluation of the health of the heart and blood vessels through innovative noninvasive diagnostic modalities, including CT angiography and MRI of the heart and intracardiac ultrasonography.

Staff members are available to discuss difficult clinical situations, clinical trials, and transfer arrangements for your patients and to answer your questions. We welcome the opportunity to provide cardiac and cardiovascular surgical care for your patients.

*Lawrence R. McBride, MD*  
Section Head, Section of Cardiothoracic Surgery

*J. Norman Patton, MD*  
Chair, Division of Cardiovascular Diseases





*James H. Stewart, MD, Director*

## Vascular Disease

At Mayo Clinic Jacksonville, evaluation and treatment of vascular disease is multidisciplinary, involving physicians in vascular surgery, vascular medicine, neurology, cardiology, and radiology. Functional diagnostic testing is performed in the vascular laboratory and complemented when necessary with duplex ultrasonography, magnetic resonance angiography, CT angiography, and conventional arteriography.

This multidisciplinary approach includes individualized and comprehensive medical and interventional treatment of patients with vascular diseases, with special emphasis on endovascular and open approaches for treatment of thoracic, abdominal, and peripheral arterial aneurysms; endovascular and open approaches to patients with carotid, visceral, and peripheral arterial disease; a minimally invasive approach to venous disease; anticoagulation services for patients with coagulation disorders; and expertise in lipid management.



*Keith R. Oken, MD, Director*

## Cardiopulmonary Rehabilitation Program

The multidisciplinary team staffing the Cardiopulmonary Rehabilitation Program, established in 2002, includes a cardiologist, a pulmonologist, registered nurses, respiratory therapists, physical therapists, and exercise physiologists. The program is closely supported also by psychologists and dietitians. Many of these professionals have more than 15 years' experience in cardiopulmonary rehabilitation.

The program treats a wide range of patients, including high-acuity individuals listed for heart or lung transplantation (or both), as well as those undergoing rehabilitation for more traditional cardiac and pulmonary indications. Focus areas include education, risk factor management, symptom monitoring, and exercise prescription.

Currently, the program is evenly divided between cardiac and pulmonary rehabilitation but is expanding to include patients with recent angioplasty, heart valve surgery, and cardiac transplantation.

The program is involved in both locally initiated research as well as national multicenter trials, such as HF-ACTION, to determine the long-term safety and efficacy of traditional cardiac rehabilitation for patients with congestive heart failure.



*Robert E. Safford, MD, PhD, Director*

#### Nuclear Cardiology

Robert E. Safford, MD, PhD, *Director*  
Joseph L. Blackshear, MD  
James H. Chesebro, MD  
Thomas R. Flipse, MD  
Thomas C. Gerber, MD  
E. Eugene Page, MD  
Jorge F. Trejo-Gutierrez, MD

## Nuclear Cardiology Laboratory

Seven cardiologists and 4 radiologists supervise and interpret nuclear cardiac scans at the 2 Mayo Clinic Jacksonville campuses; more than 2,600 studies were performed last year.

Acute perfusion scanning of patients is done in the emergency department; this service is available at only a few medical centers in the United States. In patients who have chest pain at rest and nondiagnostic electrocardiograms and cardiac enzyme levels, emergency department physicians inject technetium-based cardiac imaging pharmaceutical agents. A nuclear medicine technician then performs rapid scanning of the patient and electronically transfers the images to an on-call nuclear cardiologist or radiologist for immediate interpretation. Typically, reports are available to the emergency department physician within 1 hour of the injection.

The Nuclear Cardiology Laboratory participates in the academic mission of Mayo Clinic as well. Residents in radiology and the transitional-year programs rotate through the laboratory. Currently the lab is participating in the Nuclear Ancillary Substudy of HF-ACTION, which will attempt to clarify whether a formal, structured exercise program improves the prognosis and symptoms of patients with severe heart failure and whether nuclear cardiac scans at rest can help predict the patient's prognosis and response to heart failure treatments.



Heart Transplantation and  
Mechanical Circulatory Support

Lawrence R. McBride, MD, Director  
John A. Odell, MD

Heart Failure and  
Transplant Medicine

Daniel S. Yip, MD, Director



Lawrence R. McBride, MD, Director



Daniel S. Yip, MD, Director

## Heart Transplantation and Heart Failure

The Mayo Clinic Jacksonville Advanced Heart Failure and Transplantation Service is multidisciplinary and an integral part of the Department of Transplantation, Division of Cardiovascular Diseases, and Section of Cardiothoracic Surgery. The team provides seamless, comprehensive care for patients with heart failure, especially important for those patients who go on to cardiac transplantation.

The service participates in clinical practice, research, and education of advanced heart failure and transplantation and includes full-time heart failure/transplant physicians and surgeons, an advanced-practice nurse specializing in heart failure, clinical nurse coordinators who manage all aspects of heart failure, mechanical assist devices, and transplantation, and a research nurse coordinator dedicated to heart failure and heart transplant research. In addition, dedicated case managers, financial coordinators, dietitians, pharmacists, physical and occupational therapists, and cardiac rehabilitation specialists provide support.

The surgeons involved with the Advanced Heart Failure and Transplantation Service perform high-risk cardiothoracic procedures, including high-risk bypass surgery, mitral valve repair, and ventricular remodeling. A mechanical circulatory support program implants pulsatile and axial flow ventricular assist devices as a bridge to transplant or as destination therapy (for those who are not eligible for transplantation). All types of thoracic transplantation are performed—including heart, lung, and combined heart-lung transplants.

### MAYO CLINIC JACKSONVILLE HEART TRANSPLANT STATISTICS

**Median time to transplant 4.6 months**

**1-month survival 100%**

**1-year survival 100%**

**3-year survival 89%**

**From the Scientific Registry of Transplant  
Recipients, January 2006**



Gary E. Lane, MD, Director

#### Cardiac Catheterization Laboratory

Gary E. Lane, MD, Director  
Thomas C. Gerber, MD  
Timothy E. Paterick, MD, JD  
J. Norman Patton, MD

## Cardiac Catheterization Laboratory

The Cardiac Catheterization Laboratory, a state-of-the-art facility located at St. Luke's Hospital, offers a full range of technical evaluations and treatments, including advanced diagnostic and interventional procedures. The laboratory performed more than 2,000 cardiac catheterizations in 2005.

The lab, staffed by 4 physicians and approximately 30 support staff, has developed special expertise in studies before and after transplantation, with an emphasis on patient safety. The lab is involved in research and clinical protocols, including those related to primary percutaneous coronary intervention in acute myocardial infarctions.



Fred Kusumoto, MD, Director

#### Electrophysiology Laboratory

Fred Kusumoto, MD, Director  
Thomas R. Flipse, MD

## Electrophysiology and Pacemaker/Defibrillator Services

The Mayo Clinic Jacksonville Electrophysiology and Pacemaker/Defibrillator Services provide a full range of electrophysiologic diagnosis and subsequent treatment. The Electrophysiology Lab, which opened in September 2004 at St. Luke's Hospital, extends the division's reach, performing approximately 500 arrhythmia procedures per year. Outpatient services are performed at the Davis Building on the Mayo Clinic campus.

Approximately 200 cases of radiofrequency catheter ablation for complex arrhythmias, including atrial fibrillation, are performed each year. Advanced technology such as electroanatomic mapping, MRI, intracardiac echocardiography, and cryoablation help physicians evaluate and treat even the most difficult arrhythmias.

Clinics within the division offer 2 different focus areas. The Device Clinic individualizes the therapeutic benefit of implantable cardiac devices. The Atrial Arrhythmia Clinic integrates interventional cardiology and surgical and medical approaches for patient-specific therapy.





*Thomas C. Gerber, MD, PhD, Director*

#### Cardiac CT/MR Imaging

Thomas C. Gerber, MD, PhD, Director  
Ronald Kuzo, MD

## Cardiac CT/MR Imaging

Imaging the heart with CT and MRI is rapidly gaining importance in cardiovascular medicine. New imaging modalities can be used, for example, to recognize the very early stages of coronary artery disease or to clarify the exact nature of congenital coronary or cardiac anomalies.

The cardiac CT and MRI program at Mayo Clinic Jacksonville has been in place since 2000. The program is a joint effort between the Division of Cardiovascular Diseases and the Department of Radiology. Approximately 1,800 cardiac CT and MRI studies are performed per year, and all are interpreted by staff members from both departments with expertise in cardiac catheterization, nuclear cardiology, and chest radiology and long-standing experience in cardiac CT and MRI. The program is supported by 2 physicists who provide strict quality control.

The cardiac CT and MRI program at Mayo Clinic Jacksonville has conducted more than 10 investigator-initiated clinical and technical studies. More than 30 peer-reviewed original manuscripts, book chapters, and books on aspects of cardiovascular CT and MRI have been written or edited by program members. Members of the program serve on national and international practice guideline committees.



*Ramon Castello, MD, Director*

#### Echocardiography Laboratory

Ramon Castello, MD, Director  
Joseph L. Blackshear, MD  
Gary E. Lane, MD  
Keith R. Oken, MD  
E. Eugene Page, MD  
Timothy E. Paterick, MD, JD  
J. Norman Patton, MD  
Robert E. Safford, MD, PhD  
Steven Ung, MD

## Echocardiography Laboratory

The Echocardiography Laboratory at Mayo Clinic Jacksonville is completely digitized and offers all echocardiographic modalities, including transthoracic, exercise, dobutamine, and transesophageal studies. These state-of-the-art evaluations are conducted at 3 locations: the main campus, where approximately 1,000 studies are performed each month, St. Luke's Hospital, and a satellite office in St. Augustine.

Current research interests include heart disease in women, the value of stress testing in hypertensive patients, contrast echocardiography, and cardiac resynchronization therapy.



*Charles D. Burger, MD, Director, and Robert E. Safford, MD, PhD*

#### Pulmonary Hypertension Clinic

**Charles D. Burger, MD, Director**  
Javier F. Aduen, MD  
Francisco Alvarez, MD  
Kenneth T. Calamia, MD  
David B. Erasmus, MD  
Cesar A. Keller, MD  
Robert E. Safford, MD, PhD

## Pulmonary Hypertension Clinic

Pulmonary arterial hypertension, often a devastating disorder with poor patient survival and quality of life, is a consequence of numerous complex disorders involving the heart, lung tissue and blood vessels, and clotting system. It also has genetic and immune system components. The care of patients with pulmonary hypertension is complex and requires the coordinated efforts of pulmonologists, cardiologists, rheumatologists, critical care specialists, anesthesiologists, thoracic and cardiovascular surgeons, nurses, respiratory therapists, pharmacists, and rehabilitation specialists. The Mayo Clinic Jacksonville Pulmonary Hypertension Clinic manages the broad range of patients with these disorders. The testing modalities needed to make a diagnosis and implement treatments ranging from oral medications to continuously infused drugs and surgical procedures to repair or replace damaged hearts and lungs are available to patients with pulmonary hypertension. Participation in major national and international research registries and trials provides access to state-of-the-art treatment and contributes to research that may improve therapies in the future





*Francisco A. Arabia, MD, and Bijoy K. Khandheria, MD*

Dear Colleagues:

The Division of Cardiovascular Diseases at Mayo Clinic Arizona is composed of a team of staff doctors, midlevel practitioners, and nurse practitioners committed to providing the best collaborative care for patients with disorders of the heart, arteries, veins, and lymphatic vessels. Members of the division saw more than 5,000 patients last year.

The practice—which is supported by laboratories, subspecialty clinics, preventive health programs, and basic and clinical research programs—is moving toward a subspecialty model for general cardiology, providing specialized treatment for adults with

- Congenital heart disease
- Myocardial disease
- Complex electrophysiologic heart rhythm disorders
- Heart failure
- Transplant needs

The practice also provides comprehensive evaluation of the health of the heart and blood vessels through innovative noninvasive diagnostic modalities.

Clinical research programs give patients opportunities to participate in experimental therapies not available elsewhere. Additionally, a soon-to-launch translational research program will enhance clinical research, allowing Mayo Clinic researchers to convert research findings directly to patient care strategies. Advanced integration of patient care, education, and research will be enabled through the creation of a new multidisciplinary program for pulmonary hypertension and metabolic syndrome and a new cardiovascular outreach program.

We welcome the opportunity to collaborate with you in the care of your cardiac patients.

A handwritten signature in black ink that reads "Francisco Arabia".

*Francisco A. Arabia, MD*  
*Chair, Division of Cardiovascular and Thoracic Surgery*

A handwritten signature in black ink that reads "Bijoy Khandheria".

*Bijoy K. Khandheria, MD*  
*Chair, Division of Cardiovascular Diseases*



Steven J. Lester, MD, Director

**Echocardiography Laboratory**

- Steven J. Lester, MD, Director
- Christopher P. Appleton, MD
- Hari P. Chaliki, MD
- Pamela Hsu, MD
- R. Todd Hurst, MD
- Bijoy K. Khandheria, MD
- John J. Lynch, MD
- Sylvia A. Mamby, MD
- Farouk Mookadam, MD
- A. Jamil Tajik, MD
- Susan Wilansky, MD

## Echocardiography Laboratory

The cardiac ultrasound laboratory at Mayo Clinic Arizona offers advanced tests and technologies for patient diagnosis and research investigations. The lab performs and interprets more than 18,000 echocardiographic procedures annually, including transesophageal, intraoperative, intracardiac, exercise, and dobutamine stress echocardiography.

The laboratory’s sonographers and physicians have applied cardiac ultrasound techniques in the evaluation of cardiac physiology and function, including 3- and 4-dimensional imaging and novel strain imaging techniques. New ultrasound technologies include information management and new software programs to analyze returning sound waves.

In addition to its mission of clinical excellence, the echo lab remains committed to education and research. To complement to the cardiology clinical fellowship program, the echo lab provides infrastructure for graduate medical education. Established programs include advanced training in echocardiography fellowships and a number of educational symposia.

As the volume of echo procedures continues to increase, the lab will be ever more integrated in translational research, developing and taking imaging programs to clinical practice.

### ADDITIONAL CARDIOVASCULAR SERVICES OFFERED AT MAYO CLINIC ARIZONA

- Cardiovascular outreach
- Congenital heart disease in adults
- Disorders of the aorta
- Heart health clinic
- Heart rhythm
- Hypertrophic cardiomyopathy
- Pulmonary hypertension
- Refractory chest pain
- Valvular heart disease





Luis R. P. Scott, MD, Director

#### Electrophysiology Laboratory

Luis R. P. Scott, MD, Director  
Gregory T. Altemose, MD  
Komandoor Srivathsan, MD

## Electrophysiology Laboratory

Increasing life expectancies for patients with congestive heart failure has made rhythm management an important cardiovascular specialty. Electrophysiologists in the Division of Cardiovascular Diseases at Mayo Clinic Arizona have seen more than a 60% increase in patient load during the past year, as they provide a full range of services for adult patients, including noninvasive diagnostic testing and analysis, innovative drug therapies to control atrial fibrillation, ablation, and implantation of medical devices, such as pacemakers and defibrillators.

Of the approximate 550 rhythm management procedures performed last year, 375 involved devices, such as pacemakers and defibrillators, and the remaining 175 were ablation procedures. Ablation techniques and technology continue to advance beyond conventional radiofrequency ablation—which remains useful in many cases—to include cryoablation, which presents decreased risk of heart block, especially when correcting specific types of tachycardias or when working in intermediate septal pathways close to the atrioventricular node. Additionally, in situations when ablation from the endocardial surface would not be effective, a cutting-edge, safe, and effective epicardial approach is used to map the heart's outer surface. Electrophysiologic studies that do not require ablation are also performed.



Robert L. Scott, MD, Director

#### Heart Failure and Transplant Medicine

Robert L. Scott, MD, Director  
D. Eric Steidley, MD

## Heart Failure Clinic

The Heart Failure Clinic at Mayo Clinic Arizona supports the heart transplant program—the only heart transplant program in the Phoenix area. This multidisciplinary team specializes in the care and management of pretransplant cardiac patients, systolic and diastolic heart failure patients, and patients with pulmonary hypertension. To determine the type and progression of each patient's heart failure, Mayo cardiologists work closely with special diagnostic areas, including echocardiography, cardiac catheterization, and electrophysiology.

In 2005, the dedicated heart failure team—including transplant heart failure physicians, a heart failure nurse practitioner, and a heart failure registered nurse—evaluated and treated approximately 1,000 patients using innovative therapies, including

- Internal defibrillators
- Specialized cardiac pacemakers
- Inotropic medications to help the heart contract with greater force
- Aquapheresis, which uses a specialized intravenous catheter to remove large volumes of fluid from patients with decompensated heart failure, thus avoiding patient hospitalizations while preserving kidney function



*Francisco A. Arabia, MD, Chair, Patrick A. DeValeria, MD, and Louis A. Lanza, MD*

#### Cardiovascular and Thoracic Surgery

Francisco A. Arabia, MD, *Chair*  
Patrick A. DeValeria, MD  
Louis A. Lanza, MD

## Cardiovascular and Thoracic Surgery

The Cardiovascular and Thoracic Surgery Program at Mayo Clinic Arizona serves patients with congenital and acquired diseases of the heart, lungs, esophagus, and great vessels, as well as patients with thoracic cancers, especially cancers of the lung and esophagus.

The Heart Transplant and Ventricular Assist Device Program began evaluating patients in September 2005 and is now an integral part of the Multidisciplinary Heart Failure program at Mayo Clinic Hospital in Phoenix, with 13 successful transplants in its first year.

The Cardiovascular and Thoracic Surgery Program's overall goal is to provide the highest-quality surgical care available for all patients and to serve as a referral resource for all physician colleagues in the community.

Areas of expertise include the following:

- Heart transplantation
- Mechanical circulatory support
  - Bridge to recovery
  - Bridge to heart transplantation
- Cardiac surgeries for
  - Atrial fibrillation
  - Complex coronary artery disease
  - Heart failure
  - High-risk reoperative cardiac surgery
  - Reconstructive valvular heart surgery
- Esophageal cancer
- Lung cancer
- Pleural and chest wall cancers
- Emphysema
- Treatment of thoracic aortic aneurysms



*Henry D. Tazelaar, MD*

## Cardiac Pathology

As Mayo Clinic Arizona expands its clinical, research, and education programs, the Department of Laboratory Medicine and Pathology continues to collaborate with physician specialists and researchers to advance and implement new findings in patient diagnosis and care.

The department's cardiac pathologists recently reported the pathologic findings on surgical material from more than 500 living patients with ascending aortic aneurysms—an exceptional study, because most literature on the condition has been based on autopsy findings. One of the most important study findings was that some patients with the condition who have an inflammatory aortic disease would conventionally be prescribed corticosteroids. However, an outgrowth of this study found that some patients do not benefit from corticosteroid treatment and therefore may avoid its often severe complications.

The department is also working closely with Mayo Clinic Rochester where a xenotransplant initiative is under way—a multidisciplinary collaboration among surgeons, immunologists, cardiologists, and pathologists. The group now has some of the longest-living recipients of intraspecies heart transplants, with the long-term goal of alleviating the current shortage of heart transplant donors.



*John P. Sweeney, MD, Director*

## Cardiac Catheterization Laboratory

The Cardiac Catheterization Laboratory at Mayo Clinic Arizona provides a full spectrum of services for the treatment of coronary artery disease. Additionally, the lab performs peripheral interventions using state-of-the-art techniques and imaging equipment.

The lab's innovative multidisciplinary vascular workgroup pools the talents of physician specialists in vascular medicine, vascular surgery, cardiology, and radiology. Physicians and researchers in the catheterization lab are involved in a number of protocols, including the use of gene therapy to alleviate chest pain in patients with refractory symptoms, new pharmacologic agents for the treatment of patients with acute myocardial infarction, and new arterial closure devices.

### Cardiac Catheterization Laboratory

**John P. Sweeney, MD, Director**

David F. Fortuin, MD

Richard W. Lee, MD





R E S E A R C H



*Veronique L. Roger, MD  
Theme Leader, Heart, Lung, and Blood Research, Mayo Clinic*

*Robert D. Simari, MD  
Vice Chair for Research, Division of Cardiovascular Diseases*

Research at Mayo Clinic Rochester is widely recognized as representing the best of bench-to-bedside investigation. A large cadre of physician-scientists and basic scientists strive to discover the basic underpinnings of cardiovascular disease and to apply these discoveries to improve patient care and outcomes. This strategy of linking discovery to the care of patients encourages Mayo scientists and clinicians to work together to develop new therapies. Through funding from the National Institutes of Health, the American Heart Association, the state of Minnesota, and industry partners and with broad support from the Mayo Foundation, the research effort within the Division of Cardiovascular Diseases has had unparalleled growth over the past 5 years. This growth has resulted in recognized expertise in the areas of congestive heart failure and coronary artery disease and the application of new stem cell technologies to cardiovascular disease.

In the area of congestive heart failure, Mayo investigators are striving to understand the important role of natriuretic peptides in the pathophysiology and therapy of left ventricular dysfunction. The goals of these studies include defining the function of the natriuretic peptides in various cardiovascular diseases as well as testing for the first time in humans new peptides generated at Mayo.

Research in coronary artery disease at Mayo Clinic ranges from studies in cells and preclinical models to unique patient groups, such as the well-defined population of Olmsted County, Minnesota. These studies have begun to define the importance of thrombotic regulation and endothelial function and dysfunction in the progression of atherosclerosis. Studies in identifying novel biomarkers for atherosclerosis will enhance our prognostic abilities.

Cell therapies have great potential for the treatment of patients with cardiovascular disease. Defining and applying stem and progenitor cell populations to preclinical models of disease have led Mayo investigators to identify how these studies might be translated to patients. Preclinical studies on cardiac repair after myocardial infarction are under way.

Mayo Clinic Rochester is a leading center for translational research—research aimed to discover and to apply those discoveries to improve patient care.



## Xenotransplantation

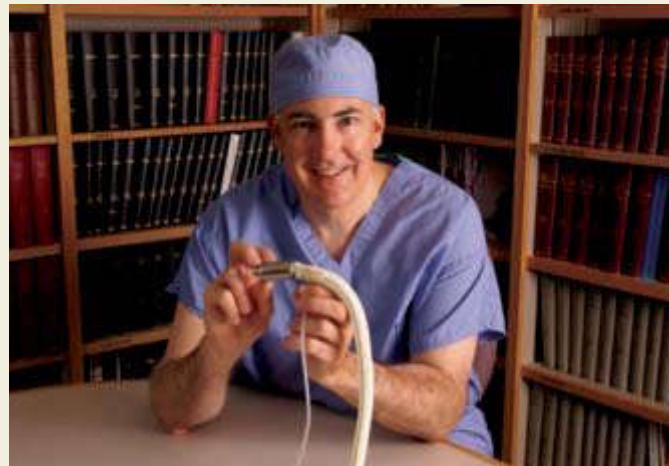
The xenotransplantation group at Mayo Clinic Rochester has achieved the longest median survival—96 days—of pig hearts transplanted in nonhuman primates. This is an important step toward the use of tissues and organs from specially bred animals to ease the worldwide shortage of organs for humans whose survival depends on receiving a heart transplant. Led by Christopher G. A. McGregor, MD, the work of the xenotransplantation team has been acknowledged by a \$4.5 million grant from the National Institutes of Health to support this groundbreaking research.



*Christopher G. A. McGregor, MD*

## Jarvik 2000

Mayo Clinic Rochester was the first medical center in Minnesota to use the Jarvik 2000 left ventricular assist device as a bridge to cardiac transplant. This valveless, electrically powered pump fits directly into the left ventricle to continuously circulate blood throughout the body. Because of the device's small size, the surgical procedure is less invasive and results in lower rates of device-related infection.



*Richard C. Daly, MD*

## Echocardiography Research Center

The Echocardiography Research Center is recognized by the National Institutes of Health as a satellite of the General Clinical Research Center. Currently ongoing are more than 150 research studies involving vascular imaging, valvular heart disease, myocardial perfusion, drug and device testing, congenital heart disease, cardioversion, systolic and diastolic function, and stress testing. These studies are funded through the National Institutes of Health, the American Heart Association, the American Society of Echocardiography, industry, and Mayo Clinic Rochester intramural programs. Investigators include researchers from the Division of Cardiovascular Disease, Department of Neurology, Department of Physiology and Biomedical Engineering, Division of Cardiovascular Surgery, Division of Nephrology and Hypertension, and Division of Endocrinology, Diabetes, Metabolism, and Nutrition.



*Patricia A. Pellikka, MD*





## Left Ventricular Function and Congestive Heart Failure

For nearly 20 years, Richard J. Rodeheffer, MD, has been supported by the National Institutes of Health in his study of left ventricular dysfunction in approximately 2,000 randomly selected residents of Olmsted County, Minnesota. This population study seeks to identify members of the community with asymptomatic left ventricular dysfunction and to determine factors that predict and contribute to the development of congestive heart failure. Efforts are being directed toward understanding genetic factors that contribute to the development of left ventricular dysfunction and overt heart failure.



*Richard J. Rodeheffer, MD*

## Novel Therapies for Congestive Heart Failure

Researchers at Mayo Clinic Rochester have been awarded \$11 million by the National Institutes of Health to pursue investigations into the function of cardiac peptides and how they may be used to develop innovative therapies to treat congestive heart failure. John C. Burnett, Jr, MD, the project director, has long pursued the link between the heart, kidneys, and vascular bed in cardiac and renal failure. Other project leaders include Margaret M. Redfield, MD, Robert D. Simari, MD, and Horng H. Chen, MD. The research team is pursuing a highly translational strategy to delay the progression of heart failure through the prevention of myocardial remodeling and systolic and diastolic dysfunction. Additionally, the team is targeting cardiac fibrosis and vascular and renal dysfunction through highly innovative protein therapies, originated in part by the group.



*John C. Burnett, Jr, MD, and Margaret M. Redfield, MD*

## Risk Factors for Myocardial Infarction and Stroke

More than 65 million people in the United States have hypertension and hyperlipidemia. Many of these individuals will develop manifestations of arteriosclerosis, such as renovascular disease, coronary disease, and cerebrovascular disease. Iftikhar J. Kullo, MD, is the principal researcher of a study to identify new, more accurate biomarkers to diagnose disease in patients at increased risk for arteriosclerosis. The National Institutes of Health has awarded \$3.8 million for the study, which will investigate 50 proteomic markers that may impact inflammation, thrombus formation, lipid metabolism, remodeling of arteries, and oxidative stress in 2,300 individuals with family histories of hypertension.



*Iftikhar J. Kullo, MD*

## Aging and Heart Disease

Arshad Jahangir, MD, leads the Mayo Clinic Rochester Cardiogerontology Research Laboratory, which studies the effect of aging on cardiac function in health and disease and applies a multiparametric approach using tools from molecular biology, basic cardiac electrophysiology, imaging, pharmacology, genomics, proteomics, and bioinformatics to study changes in heart function with aging. The focus is on transcriptional and proteomic profiling, with detailed functional assessment of cellular and mitochondrial pathways regulating cardiac energetics and cellular excitability in both young and elderly subjects, to obtain insights into the molecular basis for the increased susceptibility of the aging heart to electrical instability and mechanical dysfunction. His work is supported by grants from the National Institute on Aging, the American Heart Association, the Society of Geriatric Cardiology, and the Mayo Foundation.



*Michael J. Ackerman, MD, PhD, and Arshad Jahangir, MD*

## Sudden Death Genomics Laboratory

Michael J. Ackerman, MD, PhD, is director of Mayo Clinic's Sudden Death Genomics Laboratory. The research program involves comprehensive bench-to-bedside investigations related to sudden death in infants, children, adolescents, and young adults. The research focuses on the most common cause of autopsy-positive sudden death in the young, hypertrophic cardiomyopathy, and the most common causes of autopsy-negative sudden death in the young, the cardiac channelopathies (particularly congenital long QT syndrome and catecholaminergic polymorphic ventricular tachycardia), sudden infant death syndrome, and unexplained drowning.

Research projects concern novel gene discovery, genotype-phenotype correlations, and physiologic General Clinical Research Center studies with mutation-positive subjects. Dr Ackerman is an investigator in the International Long QT Syndrome Registry. Currently, his research program is supported extramurally by the CJ Foundation for SIDS, the Dr. Scholl Foundation, the Doris Duke Charitable Foundation, the American Heart Association (Established Investigator Award), and the National Institutes of Health.





*Virend K. Somers, MD, DPhil*

## **Sleep Disorders and Cardiovascular Disease**

Virend K. Somers, MD, DPhil, directs a broad-based research program focusing on the relationship between normal and disordered sleep and cardiovascular disease. A major component of this research examines mechanisms by which sleep apnea may increase the risk of cardiac and vascular conditions, such as hypertension, atrial fibrillation, ischemic heart disease, and heart failure. His laboratory has recently demonstrated strong interactions between sleep apnea and the risk and recurrence of atrial fibrillation. A second area of interest is death during sleep, with special focus on the role of mutations in genes regulating cardiac ion channels. Research from his group has shown that sleep apnea may also increase risk for death during sleeping hours.

The early morning hours after waking from sleep are widely recognized as a time of increased cardiovascular risk and represent a third area where his group is active. Here they are seeking to determine the specific physiologic changes that occur in the early morning after waking and might explain increased cardiac and vascular vulnerability. More recently, his laboratory has initiated studies of sleep deprivation, in particular addressing the question of why sleep deprivation may predispose not only to increasing obesity but also to increasing cardiovascular risk.

Recent and current support for their work includes funding from the National Institutes of Health, the American Heart Association, the Dana Foundation, and the Mayo Foundation.



*Amir Lerman, MD*

## **Center for Coronary Physiology and Imaging**

The research program at the Center of Coronary Physiology and Imaging is focused on the mechanism, detection, diagnosis, and treatment of patients with coronary artery disease. Under the direction of Amir Lerman, MD, the program pursues investigations in 2 patient populations: patients with early coronary disease and patients with severe coronary artery disease who are not candidates for revascularization. Endothelial function, coronary physiology, novel imaging, and tests for novel risk factors can be performed. Patients are offered novel therapeutic options, including gene and cell delivery protocols, spinal cord stimulators, and new pharmacologic treatments. The center is supported by funding from the National Institutes of Health, the American Heart Association, the University of Minnesota, and the US Department of Defense.





## Molecular Pharmacology and Experimental Therapeutics

Andre Terzic, MD, PhD, is associate chair for cardiovascular research at Mayo Clinic Rochester. He holds the Marriott Family Professorship in Cardiovascular Research, serves as director of the J. Willard, Jr. and Donna Marriott Heart Disease Research Program, and is codirector of the Robert and Arlene Kogod Program on Aging. The focus of this National Institutes of Health-funded multidisciplinary program is to decipher pathways of stress tolerance and to identify the genetic basis of maladaptation in human disease. This work has evolved on the principle of metabolomic networks applied to the pathogenetics of dilated cardiomyopathy and atrial fibrillation.

This integrative research has led to the discovery of the role for metabolic sensors in decoding energetic distress. Failure in metabolic decoding, due to heritable genetic mutations in KATP channel subunits or abnormal signal transmission, is identified as a risk factor for cardiac disease. The future promise is the translation of principles of stress maladaptation into broader diagnostic and therapeutic modalities for patients, including individual early detection of the defining genetic basis of disease risk, treatment by targeted repair, including regenerative therapy, and diagnosis of deficits in stress intolerance. Dr Terzic is an American Heart Association Established Investigator and is past president of the American Society for Clinical Pharmacology and Therapeutics.



*Andre Terzic, MD, PhD*



*David R. Holmes, Jr, MD,  
received the 2006 American  
College of Cardiology Distinguished  
Scientist Award.*

## The Regulation of Ion Channels

In his laboratory, Hon-Chi Lee, MD, PhD, works to understand the regulation of ion channels in the cardiovascular system, especially the role of lipids and lipid metabolites in the regulation of ion channels in the heart and vasculature. He has shown how metabolites of polyunsaturated fatty acids protect the heart against ischemia-reperfusion damage. He has also determined that in animals, altered regulation of important ion channels may in part account for the impaired vascular function in diabetes. Current studies include the regulation of ion channels in vascular endothelial cells using microdomain targeting. Dr Lee's work is funded by the National Institutes of Health and the American Heart Association.



*Hon-Chi Lee, MD, PhD*



## Cardiovascular Genetics Laboratory

Genetic factors play an important, increasingly recognized role in the development and progression of cardiovascular disease. The objective of this research program is to identify mutations in genes that cause or confer susceptibility to mechanical dysfunction and electrical instability in the heart. These studies, sponsored by the National Institutes of Health, focus on 2 heritable disorders in humans: idiopathic dilated cardiomyopathy, the most common disease in patients undergoing cardiac transplantation, and atrial fibrillation, the most common sustained arrhythmia, reaching epidemic proportions in the elderly.

Experimental strategies include genetic linkage analysis to map the genomic location of novel disease genes in familial cases and hypothesis-based mutational analyses of candidate genes. These investigations use technologically advanced, automated systems for high-throughput DNA analysis and capitalize on genomic information derived from the Human Genome Project. The long-term objective of this research is to gain new insights into molecular mechanisms for congestive heart failure and arrhythmias and apply this knowledge to improve diagnosis, treatment, and prevention of heart disease.



*Timothy M. Olson, MD*

In support of Mayo Clinic's mission of integrating clinical practice, education, and research, the Division of Cardiovascular Diseases at Mayo Clinic Jacksonville recognizes the importance of academic research and scholarly activity.

All 15 specialists participate in various forms of basic science and clinical research. Developing investigator-initiated protocols allows staff members to "advance the science" and broaden their expertise in ways that benefit their delivery of patient care. Participation of staff members in multicenter clinical trials provides patients access to developing forms of diagnosis and treatment.

Cardiology research at Mayo Clinic Jacksonville builds on areas of clinical strengths, in particular cardiovascular imaging and management of heart failure. In 2005, members of the division were engaged in 21 research protocols, many funded by competitive extramural grants, and authored or coauthored 19 publications in traditional and electronic media, including highly ranked general medicine and cardiology journals and widely used Web-based knowledge resources.

A core group of cardiologists forms the Cardiovascular Research Committee, which, with the Mayo Clinic Jacksonville Research Committee, reviews, prioritizes, and approves research protocol submissions. Additionally, members of the division collaborate with colleagues at Mayo Clinic Rochester on various research projects.

The Division of Cardiovascular Diseases at Mayo Clinic Jacksonville is committed to providing outstanding health care to patients that includes access to developing innovative diagnostic and therapeutic modalities.



*Davis Building*





Physicians and researchers in the Division of Cardiovascular Diseases at Mayo Clinic Arizona are pursuing a number of protocols to identify and prevent cardiac problems before they occur.

A large-scale clinical study is investigating the atrial booster chamber to identify patients at risk for arrhythmia, potentially allowing physicians to take preventive action so patients can avoid life-long drug therapies.

Working with noninvasive ultrasound techniques, physician researchers also are creating a risk model and profile engine to identify the seeds of heart failure—which exist at birth—long before patients become symptomatic. For the first time, new computer technology allows researchers to view the heart as it contracts and relaxes in all 3 dimensions: as it shortens, thickens, and twists; and as it untwists, lengthens, and widens. Much as a person’s face may look older than that person’s years, physicians are now able to determine whether a patient’s heart looks younger or older than its age.

Additionally, division physicians have recently published abstracts detailing improved ultrasound tests to help predict patient suitability for transplant surgery—an invaluable tool because patients face an increased risk of dying from a cardiac event after undergoing transplantation. New technology is helping to develop a better echocardiographic test to screen patients before liver transplant, and the test also helps physicians identify patients at high risk of cardiac events for 5 years after surgery.



*Christopher P. Appleton, MD*



*In the foreground is the Mayo Clinic Collaborative Research Building and in the background is the S.C. Johnson Research Building.*



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EDUCATION

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## Thoracic and Cardiovascular Surgery Training Program

Mayo Clinic Rochester offers a 3-year thoracic surgery residency that provides comprehensive exposure to a large volume of surgical procedures in general thoracic surgery, surgery for adult acquired cardiac disease and congenital cardiac disease, training in an academic environment with an opportunity to publish in peer-reviewed journals and to present at national specialty meetings, extensive and comprehensive didactic and problem-solving conference schedules, including an active visiting faculty program, and a professional and collegial atmosphere between medical and surgical specialties in all areas of medicine.

The thoracic surgery training program was established in 1951, and since then 120 residents have graduated. Currently, 2 trainees complete the program annually: one in the cardiovascular surgery track and one in the general thoracic surgery track. A considerable portion of the residency is devoted to the medical diagnosis of general thoracic and cardiovascular diseases, endoscopy, and the study of respiratory and cardiovascular physiology. Surgical treatment of general thoracic and cardiovascular diseases is emphasized throughout the program.

The Division of Cardiovascular Surgery also sponsors a cardiovascular surgery fellowship. This fellowship is offered to individuals who have already successfully completed an approved thoracic surgery residency or its equivalent and wish to supplement their training in cardiovascular surgery. Emphasis may be placed on any of the areas of adult cardiac disease, congenital heart disease, or cardiopulmonary transplantation.



*Joseph A. Dearani, MD, Director*



*Timothy J. Gardner, MD, medical director of the Center for Heart and Vascular Health at Christiana Care Health System in Newark, Delaware, was the 16th annual John W. Kirklin Visiting Professor in Cardiac Surgery, shown here with Hartzell V. Schaff, MD, Chair of the Division of Cardiovascular Surgery at Mayo Clinic Rochester.*





## Cardiovascular Training Program

The cardiovascular training program at Mayo Clinic Rochester was begun in 1961. The program currently has 40 active fellows, and 8 or 9 fellows are selected from more than 400 applicants each year.

Three tracks are available. Most fellows participate in the 4-year clinical program in cardiovascular disease. The first 2 years are devoted to core clinical rotations in various cardiac laboratories and inpatient clinical settings. In the third year, the fellow typically undertakes a 1-year research project under the direction of an experienced cardiac researcher. The fourth year focuses on advanced training in a cardiovascular discipline. Common selections include advanced echocardiography, adult congenital heart disease, vascular disease, nuclear cardiology, and, more recently, a combined imaging program with exposure to echocardiography, nuclear imaging, computed tomography, and magnetic resonance imaging. Additional programs offer more intensive research experience.

The 4-year clinician-investigator program includes 18 months of research with a research mentor. A National Institutes of Health training grant offers a 5-year program with 2 years dedicated to research and 3 years of clinical training. Between 1 and 3 individuals are recruited yearly into these 2 programs, in addition to those in the clinical program. Completion of the 4-year clinical program, the clinician-investigator program, or the NIH training grant program leads to board certification in cardiovascular disease.

The 1-year interventional cardiology program offers focused advanced training in coronary interventional procedures; the invasive electrophysiology program also spans 1 year and provides training in diagnostic and interventional electrophysiology. In addition, a limited number of highly competitive 1-year positions are available for individuals who have finished their core rotations but seek focused, advanced training in a particular discipline in cardiology. These areas include nuclear cardiology, echocardiography, combined cardiac imaging, heart failure, adult congenital heart disease, vascular disease, and advanced catheterization techniques.



*Guy S. Reeder, MD, and Paul A. Friedman, MD, Directors*



*Elizabeth G. Nabel, MD, director of the National Heart, Lung, and Blood Institute was the 10th annual Robert L. Frye, MD, visiting lecturer, shown here with Dr Frye himself.*



*Allison K. Cabalka, MD, Director*

## **Pediatric Cardiology Training Program**

Mayo Clinic College of Medicine's 3-year pediatric cardiology fellowship is designed to prepare individuals for a full-time academic career in pediatric cardiology. The curriculum includes 2 years of comprehensive, clinical training in all aspects of pediatric cardiology. Because Mayo Clinic has a comprehensive Congenital Heart Clinic, fellows in training receive wide exposure to inpatient and outpatient pediatric cardiology (from the fetus to the adult with congenital heart disease), intensive training in transthoracic, transesophageal, and intracardiac echocardiography, electrophysiology, hemodynamic and interventional cardiac catheterization, cardiovascular intensive care, and congenital cardiovascular surgery. One year of the pediatric cardiology program is devoted to research, which includes a clinical research curriculum and faculty mentoring to assure successful completion of projects, presentation at regional and national meetings, and publication of results in peer-reviewed journals.

The pediatric cardiology fellowship currently has 3 fellows in training and has received approval to expand to a total of 6 fellows (2 per training year). Graduates of this program can function independently as program directors, supporting staff, or laboratory investigators in academic medical centers.

The pediatric cardiology fellowship began in 1960, and since then, more than 70 physicians have completed pediatric cardiology training at Mayo Clinic. Many of these graduates now act as division chairs in academic institutions or remain on the staff of the Division of Pediatric Cardiology at Mayo Clinic Rochester. In addition to these physicians, many others now active internationally in the field of pediatric cardiology received part of their training at Mayo Clinic.



## Cardiology Education Leadership

The Mayo Clinic commitment to education is reflected by the leadership provided at all levels.



*Raul Emilio Espinosa, MD, received the 2005 Mayo Clinic Rochester Department of Medicine Laureate Award. Raymond J. Gibbons, MD, is the 2006 president of the American Heart Association*



*Thomas M. Munger, MD, Vice Chair of Cardiovascular Education*



*Joseph G. Murphy, MD, Chair of the Section of Scientific Publications*



*Rick A. Nishimura, MD, received the 2006 American College of Cardiology Gifted Teacher Award. Dr Nishimura has also been named to the College Board of Trustees.*



*William K. Freeman, MD, Director of Internal Medicine/ Cardiovascular Education*



*2005 Cardiology Teaching Award recipients: Samuel J. Asirvatham, MD, Rick A. Nishimura, MD, Krishnaswanes Chandrasekarn, MD, and Gerald T. Gau, MD*





## E D U C A T I O N    J A C K S O N V I L L E



*James H. Chesebro, MD, Director*

### Cardiology

The cardiology training program integrates practice, education, and research in the unique multicultural patient environment that Jacksonville has to offer. Trainees receive experience in acute cardiac care and consultative cardiology. Research opportunities are available in various imaging modalities, interventional cardiology, and the pathogenesis of atherosclerosis. Trainees have the opportunity to obtain experience in multiple imaging modalities, including magnetic resonance angiography, MRI, CT, echocardiography, and nuclear imaging.



*Lawrence R. McBride, MD, Director*

### General Surgery Rotation

Mayo Clinic Jacksonville offers a rotation for general surgery residents on the cardiothoracic surgery service. Residents receive extensive exposure to both cardiac and thoracic procedures.

A wide array of thoracic surgery procedures are performed, especially in the areas of esophageal and lung cancer. Residents oftentimes function as the primary surgeon in these procedures. In addition, Mayo Clinic Jacksonville has an active lung transplant program that provides a unique experience for residents in lung transplantation.

The residents also receive broad exposure to complex adult cardiac procedures, including valve repair and replacement, coronary revascularization, the maze procedure, repair and replacement of the thoracic aorta, cardiac transplantation, and mechanical circulatory support.



## E D U C A T I O N    S C O T T S D A L E / P H O E N I X



*Susan Wilansky, MD, Director*

### Division of Cardiovascular Diseases

The Division of Cardiovascular Diseases at Mayo Clinic Arizona is in a tremendous growth phase. In addition to the existing cardiology fellowship program, the division offers a 3-year core program, which had its first graduate in 2002. To date, the program has sponsored 2 fellows per year, and in 2008, that number will increase to 3 fellows annually. Echocardiography and electrophysiology fellowships are planned to begin in July 2006, and July 2008 will see the beginning of an interventional fellowship to provide specialized training in the cardiac catheterization laboratory as a supplement to the diagnostic training that all fellows receive.

Serving practicing clinicians is an ever-expanding continuing medical education (CME) program. The division participates in 10 to 12 national and international CME events annually, many of which are cosponsored by the American Society of Echocardiography and other CME providers.

# RESOURCES

Multiple subspecialty clinics within the cardiovascular divisions have worked closely with national professional societies and patient advocacy and patient education groups. The following list is not intended to be all-inclusive but includes those groups and societies with whom Mayo Clinic has had the opportunity to interact for the purpose of enhancing patient outcomes, access, satisfaction, and advocacy.

**American Heart Association**

Dallas, Texas  
[www.americanheart.org](http://www.americanheart.org)

**American College of Cardiology**

Washington, DC  
[www.acc.org](http://www.acc.org)

**American Society of Echocardiography**

Raleigh, North Carolina  
[www.asecho.org](http://www.asecho.org)

**American Society of Nuclear Cardiology**

Bethesda, Maryland  
[www.asnc.org](http://www.asnc.org)

**Heart Rhythm Society**

Washington, DC  
[www.hrsonline.org](http://www.hrsonline.org)

**Sudden Arrhythmia Death Syndromes (SADS) Foundation**

Salt Lake City, Utah  
[www.sads.org](http://www.sads.org)

**Cardiac Arrhythmias Research & Education (CARE) Foundation Inc**

Duvall, Washington  
[www.longqt.org](http://www.longqt.org)

**Hypertrophic Cardiomyopathy Association (HCMA)**

Hibernia, New Jersey  
[www.4hcm.org](http://www.4hcm.org)

**Pulmonary Hypertension Association**

Silver Spring, Maryland  
[www.phassociation.org](http://www.phassociation.org)

**WomenHeart: The National Coalition for Women With Heart Disease**

Washington, DC  
[www.womenheart.org](http://www.womenheart.org)

**Heart Healthy Women (Cardiovascular Research Foundation)**

New York, New York  
[www.hearthealthywomen.org](http://www.hearthealthywomen.org)

**Anticoagulation Forum**

Boston, Massachusetts  
[www.acforum.org](http://www.acforum.org)

**National Alliance for Thrombosis and Thrombophilia (NATT)**

Washington, DC  
[www.nattinfo.org](http://www.nattinfo.org)

**National Marfan Foundation**

Port Washington, NY  
[www.marfan.org](http://www.marfan.org)

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## **Mayo Medical Transport Services**

**Gold Cross Ambulance Service** provides emergency paramedical services throughout southeastern Minnesota and west central Wisconsin and nonemergency interfacility and routine medical transport throughout the region.



**Mayo One**, an emergency medical helicopter service, offers “critical care in the air” for patients in a 200-mile radius of Rochester and Mankato, Minnesota, and Eau Claire, Wisconsin. Mayo One teams provide critical care during inter-hospital transport and at emergency medical and trauma scenes.



**Mayo MedAir Ambulance** offers fixed-wing (jet) medical transport from anywhere in the world to or from any of the Mayo Clinic sites. This service, staffed by Mayo personnel, is individualized, depending on the health care needs of the patient.

**Mayo Emergency Communications Center**  
**800-237-6822 (US only) or 507-255-2808**  
**[www.mayomedicaltransport.com](http://www.mayomedicaltransport.com)**

# CONTACT INFORMATION

## Mayo Clinic, Rochester, Minnesota

Cardiology Appointments (Mon-Fri, 8-5 CT): 800-471-1727

Fax: 507-266-5278

Cardiovascular Surgery Appointments (Mon-Fri, 8-5 CT): 866-827-8810

Fax: 507-255-7378

Online Appointments: [www.mayoclinic.org/cardiovascular-rst/appointments.html](http://www.mayoclinic.org/cardiovascular-rst/appointments.html)  
[www.mayoclinic.org/cardiacsurgery-rst/appointments.html](http://www.mayoclinic.org/cardiacsurgery-rst/appointments.html)

## Saint Marys Hospital Emergency Department (24/7 transfers): 507-255-2910

CCU On-Call Consultant (24/7): 507-255-5123

Cardiovascular Surgery On-Call Consultant (24/7): 507-255-5123

Mayo Clinic Switchboard (24/7): 507-284-2511

Mayo Transport Services (24/7): 800-237-6822

*(Gold Cross Ground Ambulance, Mayo One Helicopter Service, MedAir Fixed Wing Service)*

## Mayo Clinic, Scottsdale and Phoenix, Arizona

Appointments: 480-301-6539 (Local), 866-629-6362 (National)

Fax: 480-301-4071

Referring Physician Web Site: [www.mayoclinic.org/medicalprofs-sct/](http://www.mayoclinic.org/medicalprofs-sct/)

## Mayo Clinic, Jacksonville, Florida

Appointments (Mon-Fri, 8-5 ET): 904-953-2934 (Local), 800-634-1417 (National)

After Hours: 904-953-2000

Fax: 904-953-0759

Referring Physician Web Site: [www.mayoclinic.org/medicalprofs-jax/](http://www.mayoclinic.org/medicalprofs-jax/)

## Mayo Clinic Regional Practices

**Austin, Minnesota** Appointments: 507-434-1262

**LaCrosse, Wisconsin** Appointments: 608-785-0940

**Mankato, Minnesota** Appointments: 877-720-5412

On Call (24/7): 866-CALL-ISJ (866-225-5475)

## Mayo Clinic Heart Clinic in Dubai Healthcare City

Dubai, United Arab Emirates

Appointments: 011-971-4-362-2900

Fax: 011-971-4-362-4700

E-mail: [middleeast@mayo.edu](mailto:middleeast@mayo.edu)



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