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CARDIOVASCULAR UPDATE

CLINICAL CARDIOLOGY AND CARDIOVASCULAR SURGERY NEWS

David L. Hayes, MD
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Dear Colleagues:

Welcome to the first issue of Mayo Clinic's *Cardiovascular Update*. As the name connotes, this newsletter will provide regular updates on clinical research and practice in cardiovascular medicine and surgery. It will give a mix of information you can use in your daily practice, along with news about cutting-edge diagnostic and therapeutic techniques offered in our new or rapidly expanding subspecialty clinics.

In this issue, for example, we offer practical tips on treating heart failure and pulmonary hypertension and highlight the latest treatments available in those subspecialty clinics. We also feature the new Marfan Syndrome Clinic and the Women's Heart Clinic. Page 7 lists upcoming events, particularly CME opportunities. Additional information can be found at the Web site: www.mayoclinic.org/cardionews-rst/.

We are committed to providing timely appointment access for patients you may wish to refer and also are establishing phone consultation to help you manage specific cardiovascular problems. Call 507-284-8588 or e-mail cvadmin@mayo.edu for medical consultations or referrals, and we will direct you to the cardiologist with the most expertise for the given management issue. If you would like to speak with a cardiac surgeon, call 507-255-2000. These phone numbers are answered 8 am to 5 pm central time Monday – Friday.

We welcome suggestions for future newsletter content or other ways we can improve communication between our practices to better serve you and your patients.

Sincerely,

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Inside This Issue

Multidisciplinary Congestive Heart Failure Program Incorporates Research Into Clinical Practice

Robert F. Rea, MD
Margaret M. Redfield, MD
Richard C. Daly, MD

Each year, more than 400,000 people develop congestive heart failure. Most of these patients are at least 65 years old, and that demographic group (and the number of heart failure patients) likely will double over the next 40 years. These data have alarming implications for the consumption of health care resources. "Optimal heart failure therapy is cost-effective; it reduces hospitalizations as well as mortality," says Margaret M. Redfield, MD, head of the Congestive Heart Failure Clinic. "As importantly, optimal therapy enhances the quality and quantity of life for the growing numbers of patients with heart failure. Mayo Clinic's new comprehensive heart failure program aims to integrate medical, device, and surgical therapies to provide innovative inpatient and outpatient care to heart failure patients."

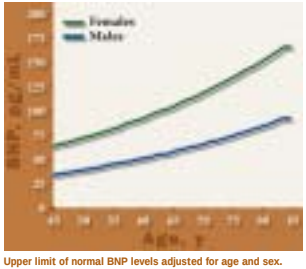
Making the diagnosis of heart failure can be challenging. Patients at risk for heart failure have — or are at risk for — other diseases that may cause similar symptoms. A new test was approved by the Food and Drug Administration in late 2000 and is currently available. This point-of-care test measures the concentration of brain natriuretic peptide (BNP) in the blood, and increased BNP levels are sensitive and relatively specific for the diagnosis of heart failure. A recent study performed at Mayo Clinic suggests that BNP should be interpreted on the basis of age-specific and sex-specific criteria (see BNP diagram). Importantly, this test can aid in the diagnosis of diastolic heart failure, a frequent diagnostic challenge. This test should prove extremely helpful to busy practitioners.

Measurements of BNP can be used therapeutically as well as diagnostically. BNP is a hormone with beneficial compensatory effects in heart failure, unlike other hormonal systems activated in heart failure that contribute to progression of the disease. Indeed, the infusion of additional BNP in the form of human recombinant BNP (hesiritide) can lower filling pressures, increase cardiac index, and improve symptoms in patients with decompensated heart failure. The FDA approved the use of hesiritide for acute therapy of decompensated heart failure in 2001. Investigators at Mayo Clinic are currently studying the effect of BNP therapy given in subcutaneous injections as chronic therapy for heart failure.

New data confirm the benefits of beta-blocker therapy in heart failure patients. Data from the MERIT HF study confirm earlier reports from the US carvedilol trials suggesting that lower doses of beta-blockers also confer survival benefit, if heart rate is adequately controlled on the lower dose. These findings highlight the importance of careful up-titration of drug dosage to maximal effect. Furthermore, it is important not to stop beta-blockers in decompensated heart failure. Studies also suggest that if inotropic support is needed, phosphodiesterase inhibitors are more effective than beta-agonists such as dobutamine by "bypassing" the beta-receptor and providing more potent hemodynamic effects.

The benefit of angiotensin-converting enzyme (ACE) inhibitors is well known in heart failure patients. However, the addition of angiotensin receptor blockers (ARBs) may not be appropriate in those patients on beta-blockers and ACE inhibitors. A recent study suggests that this "triple therapy" may result in a higher rate of adverse outcomes. "ARBs remain a useful option for those patients who cannot tolerate ACE inhibitors due to cough, and in this case, beta-blockers may be safely added to ARB," says Dr Redfield.

Use of the "old standard" heart failure treatment, digoxin, has become more complicated. Recent analysis from the National Institutes of Health-sponsored DIG trial indicates that, while digoxin had a neutral effect on overall mortality, analysis of data according to sex revealed a trend toward increased mortality in women treated with digoxin. This finding may be related to the higher digoxin levels observed in women. This report should not preclude use of digoxin in women with heart



Upper limit of normal BNP levels adjusted for age and sex.

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failure but underscores the need to adjust dosage for smaller body mass. One needs to remember that age and reduced muscle mass in women are associated with reduction in renal function, which is often not reflected accurately by the serum creatinine level. As we treat elderly patients with heart failure, it is probably worthwhile to calculate creatinine clearance by using the Cockcroft-Gault formula and measure digoxin levels to keep the level > 1.0 ng/mL.

Cockcroft – Gault Formula

Men: [140 – age (y)] × weight (kg) × 1.2 = Cr Cl (mL/min)

Women: [140 – age (y)] × weight (kg) × 0.85 = Cr Cl (mL/min)

Cardiac resynchronization therapy with use of biventricular pacemakers improves symptoms and reduces hospitalizations in patients with a wide QRS complex who have persistent symptoms despite maximal medical therapy. "Mayo has implanted over 160 biventricular devices with a greater than 90% success rate," according to Robert F. Rea, MD, director of the Device Implantation Service.

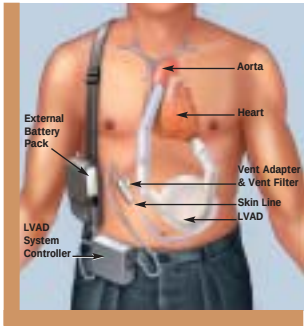
The 2002 guidelines for biventricular device implantation published jointly by the American Heart Association, the American College of Cardiology, and the North American Society for Pacing and Electrophysiology are as follows:

Indications for Biventricular Pacing

- Medically refractory congestive heart failure
- New York Heart Association functional class III-IV
- QRS duration ≥ 130 msec
- Left ventricular end diastolic dimension ≥ 55 mm
- Ejection fraction ≤ 35%

Left ventricular assist devices (LVADs) have now been approved as "destination" or permanent therapy for heart failure on the basis of positive findings in the REMATCH trial. Mayo Clinic's Cardiac Transplantation and Support Program is currently accepting referrals of patients for consideration of LVAD therapy. Patients with refractory heart failure despite maximal medical therapy are appropriate for referral.

The role of coronary artery bypass grafting (CABG) for patients with active ischemia and heart failure remains poorly defined. "Previous prospective randomized trials selected for patients with angina and excluded patients with an ejection fraction less than 35%. Thus, these trials are of little help in the management of many patients with ischemia and heart failure," according to Richard C. Daly, MD, Mayo Clinic cardiovascular surgeon. "The ability of current diagnostic tests to predict recovery of hibernating myocardium remains controversial."



Schematic of left ventricular assist device (LVAD).

Mayo Clinic is participating in the Surgical Treatment for Ischemic Heart Failure (STICH) trial, a multicenter, prospective, randomized trial that will help define the roles of modern, intensive medical management and modern surgical therapies in patients with coronary artery disease, heart failure, and left ventricular dysfunction. Additionally, the STICH trial will assess the advantage of the surgical ventricular restoration procedure. This procedure involves resection and exclusion of akinetic or dyskinetic anterior and septal left ventricular myocardium when there is associated left ventricular dilatation, resulting in reduced left ventricular volume and wall tension. The STICH trial will compare a medical treatment, CABG alone, and CABG with surgical ventricular restoration. Eligible patients will undergo comprehensive evaluation, including coronary angiography, echocardiography, magnetic resonance imaging, and neurohormonal, cytokine, and genetic testing.

Patient education, close monitoring, and frequent reassessment are required for the successful management of the heart failure patient. Mayo Clinic offers both an outpatient heart failure clinic and an inpatient heart failure service where patient care is supervised by heart failure specialists. A close partnership between the patient, the local physician, and the heart failure team provides the optimal treatment plan for patients with heart failure.

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Pulmonary Hypertension Clinic Offers New Clinical Trials, Treatments

Michael D. McGoon, MD
Christopher G. A. McGregor, MD

The Mayo Pulmonary Hypertension Clinic (PHC) provides a focused multidisciplinary approach to the intensive evaluation and management of all forms of pulmonary hypertension. The PHC integrates diagnostic modalities with the newest medical and surgical treatments. "The treatment of pulmonary hypertension has evolved rapidly and dramatically over the past decade, providing hope for reduced symptoms and longer life expectancy for patients with a spectrum of disease considered hopelessly dismal in the recent past," says Michael D. McGoon, MD, director of the clinic. Mayo Clinic has been intimately involved in all major clinical trials leading to all of the currently available medical treatments of pulmonary arterial hypertension. "We continue to participate in every national clinical research study of new drug therapies," says Dr McGoon. "This participation has permitted early access to and extensive experience with all treatment options."

Patients are evaluated with the full resources of the Mayo Clinic, including performance and accurate interpretation of comprehensive 2-dimensional Doppler and transesophageal echocardiographic examinations, lung perfusion scintigraphy, electron-beam computed tomography, detailed pulmonary function tests, appropriately tailored functional testing of exercise capacity, and full hemodynamic catheterization, including assessment of acute vasodilator responsiveness. Additionally, the PHC integrates with the adult congenital heart disease clinic, the Division of Rheumatology, the Department of Radiology, and surgeons involved in pulmonary thromboendarterectomy and transplant.

The benefit of accurate diagnosis is administration of appropriate treatment prescribed and managed by highly experienced staff. All approved and investigational treatment agents are highly complex, expensive, and potentially risky. "Careful patient selection, treatment initiation, and ongoing surveillance are absolutely mandatory," says Dr McGoon. Treatment of pulmonary arterial hypertension managed by the PHC includes continuous intravenous infusion of the prostanoid epoprostenol; continuous subcutaneous instillation of another prostacyclin analogue, treprostinil; the oral non-selective endothelin antagonist bosentan; and anticoagulation, diuresis, inotropic support, and other adjunctive therapies. The PHC nurse specialists provide essential education to the patients and their families at the initiation of drug use, a process that may involve several days for patients learning the intricacies of epoprostenol self-administration. The PHC prides itself on the low frequency of adverse events despite managing patients with central lines in place for up to 10 years. After treating hundreds of patients with epoprostenol, more than a hundred with bosentan, and dozens with treprostinil, the staff of the PHC has also developed expertise with the logistical and financial complexities associated with their use.

The PHC has participated in 2 recently completed multicenter investigational protocols of a selective endothelin A antagonist (sitaxsentan) and an oral prostanoid (beraprost) and is about to initiate enrollment into studies of a phosphodiesterase-5 inhibitor (sildenafil) and a new endothelin A antagonist (ambrisentan). The PHC will soon be exploring the usefulness of continuous transtelephonic Web-based pulmonary arterial pressure monitoring with use of implanted hemodynamic monitors.

Select patients with pulmonary arterial hypertension receive continous epoprostenol through indwelling central vein catheter and portable pump.

The advent of heart-lung transplantation in 1982 heralded a new era in the treatment of end-stage pulmonary hypertension. "Successful transplantation resulted in a dramatic transformation of dying patients to well-rehabilitated, relatively asymptomatic individuals," according to Christopher G. A. McGregor, MD, cardiovascular surgeon and director of the Mayo Clinic William J. von Liebig Transplant Center. "The drive to explore single and double lung transplantation was the need to maximally utilize the limited number of available thoracic organs and avoid unnecessarily replacing hearts whose function was recoverable in most cases when volume and pressure overload were removed by replacing the diseased lungs."

Although early results of lung transplantation for pulmonary hypertension improved, long-term complications — in particular obliterative bronchiolitis (also called chronic lung rejection) and infection — limited medium- and long-term survival. The timing and availability of lung donors have become more unpredictable, and the lengthening transplant waiting list has increased waiting-list mortality. This leaves the physician facing 2 moving targets: the stability, improvement, or progression of disease in an individual patient and the projected availability of donor lungs. In some areas of the country, the wait for suitable lungs can exceed 3 years. Currently patients are referred for lung transplantation when they exhibit progressive symptoms despite aggressive, optimal medical therapy.

No convincing statistically significant data support the use of one lung transplant operation over another in the treatment of pulmonary arterial hypertension. At Mayo Clinic in Rochester, single right lung transplantation is considered initially, with the understanding that the donor lung be well matched with a short ischemic time. If these ideal circumstances do not pertain, bilateral lung transplantation is performed. Heart-lung transplantation is done when the heart is severely damaged, with little likelihood of cardiac recovery after transplant.

***Top*, Selective right pulmonary angiogram showing pouching defects in the right middle and lower lobe pulmonary arteries.**

***Bottom*, Equivalent surgically excised pulmonary endarterectomy specimen.**

The Mayo Clinic surgical team has 20 years of experience in lung transplantation for pulmonary arterial hypertension. The 1- and 3-year actuarial survival after lung transplantation (all types) for pulmonary hypertension at Mayo Clinic is 91.7% and 64.2%, respectively, compared with 67.6% and 48.3%, respectively, in the United Network for Organ Sharing (UNOS) annual report for 2001.

More than 500,000 survivors of acute pulmonary embolism are documented annually in the United States, and as many as 1% of diagnosed patients fail to resolve the embolic material. Since many more patients have unrecognized pulmonary embolism and only half of those with chronic thromboembolic pulmonary hypertension have a history of acute pulmonary embolism or deep venous thrombosis, it is likely that there are at least 10,000 new cases of chronic thromboembolic pulmonary hypertension annually in the United States. More than 100,000 Americans are thought currently to suffer from this disease. "Unresolved pulmonary thromboembolism leads to chronic pulmonary artery occlusion, right ventricular overload and dilatation, and subsequently right heart failure and cor pulmonale," says Dr McGregor. "In 2 major studies, prognosis was poor, especially in the presence of right heart failure, with a mean survival of only 18 months. The overall delay in making the diagnosis of chronic thromboembolic pulmonary hypertension is 2 to 3 years, so physician awareness is a critical factor in making the diagnosis."

The ventilation-perfusion scan can differentiate between thromboembolic and primary pulmonary hypertension. Presence of segmental perfusion defects indicates the need for further evaluation by pulmonary arteriography. Signs of chronic thromboembolic disease on pulmonary arteriography include vessel occlusion, intimal irregularities, vascular narrowings, webs or bands, and pouching defects. When the diagnosis of chronic thromboembolic pulmonary hypertension is confirmed and surgery considered, percutaneous placement of an inferior vena caval filter is performed.

Indications for pulmonary thromboendarterectomy include significant symptoms, elevated pulmonary vascular resistance (> 300 dynes-s-cm^{-5}), pulmonary arterial obstruction accessible to surgical removal, and absence of major comorbid conditions. The goals of surgery are to improve respiratory function by reperfusing ventilated lung, thus reducing dead space, and to reduce elevated pulmonary artery pressures. This latter goal will lessen right ventricular compromise, prevent progressive right ventricular dysfunction, and avoid secondary microarteriopathic changes in remaining unobstructed pulmonary arteries. Surgical techniques include cardiopulmonary bypass, deep hypothermia, circulatory arrest, techniques of cerebral protection, and concomitant cardiac procedures if required (coronary artery bypass grafting, patent foramen ovale closure, etc). Mortality for pulmonary thromboendarterectomy has been significant. The University of California, San Diego group pioneered pulmonary thromboendarterectomy for chronic thromboembolic pulmonary hypertension and reports an operative mortality of 9%. The overall mortality in the Mayo Clinic series is similarly 8% with a current mortality of 2% in the last 41 consecutive cases. Surgical complications, especially in the central nervous system, have likewise been reduced. Determinants of operative risk include New York Heart Association class IV symptoms of breathlessness, severe right heart failure, pulmonary vascular resistance greater than 1,100 dynes-s-cm^{-5}, age older than 70 years, and the presence of major comorbid conditions. Significant improvements have been demonstrated in the Mayo Clinic series in mean pulmonary artery pressure, cardiac index, and pulmonary vascular resistance from pre- to postoperatively.

The Mayo Pulmonary Hypertension Clinic is closely aligned with the mission of the Pulmonary Hypertension Association, a nationwide support and advocacy group. Dr McGoon serves as chair of the Scientific Leadership Council and is also on the Board of Trustees and the Corporate Committee. The integrated approach of the Pulmonary Hypertension Clinic team as well as leadership and participation in national clinical trials allows Mayo Clinic to offer patients and their physicians the most current comprehensive care available.

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Mayo Clinic Women's Heart Clinic Provides Focused Resource for Women's Heart Health

Sharonne N. Hayes, MD

Cardiovascular disease is the leading cause of death in women, greatly outnumbering all cancer deaths, but numerous surveys have shown that this risk is greatly underestimated by women and their physicians. "Most women can readily quote the lifetime incidence of breast cancer (1 in 9), but few realize that half of all women die of cardiovascular disease (compared to 1 in 26 who die of breast cancer)," according to Sharonne N. Hayes, MD, director of the Mayo Clinic Women's Heart Clinic.

Although overall cardiovascular mortality has declined in the last 4 decades, national and Olmsted County data show that women have not experienced the same mortality reduction as men. Explanations may include sex differences in the natural history and presenting symptoms of coronary heart disease, the presence of endogenous and exogenous hormones, and the relative strength of individual cardiac risk factors. Women have tended to be less aggressively evaluated and treated for their symptoms, diagnosis in women can be more challenging because of the impact of sex on diagnostic tests, and women have been less likely than men to receive prescriptions for effective therapies after myocardial infarction. Younger women have a higher mortality after myocardial infarction and coronary artery bypass graft surgery than men. These factors, among others, led to the development of a unique resource dedicated to women's heart health – Mayo Clinic Women's Heart Clinic (WHC), which was founded to address the special diagnostic and therapeutic needs of women with heart disease.

Women's Heart Clinic Consultants

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Sharon L. Mulvagh, MD
Veronique L. Roger, MD
Teresa S. M. Tsang, MD
Dalene M. Bott-Kitslaar, FNP

In the WHC, a team of Mayo Clinic cardiologists, nurse practitioners, nutritionists, and other specialists evaluates each woman's symptoms, risk factors, and cardiac history. "The goal is to determine an accurate diagnosis, develop an appropriate treatment plan, and design an individualized program to prevent cardiovascular disease or slow its progression," says Dr Hayes.

Services provided by the Women's Heart Clinic include:

Comprehensive cardiac diagnostic evaluation

After initial history review and clinical cardiac evaluation, WHC cardiologist orders appropriate diagnostic tests and obtains consultations to develop a recommended treatment plan. Mayo Clinic's state-of-the-art cardiovascular services help optimize outcomes.

Individualized cardiovascular risk assessment and prevention plan

Before a woman visits the clinic, she completes a comprehensive risk assessment to pinpoint her individual risk factors for heart disease. This risk assessment report becomes the basis of a unique heart disease prevention plan.

Risk management

The WHC staff helps patients understand risk factors for heart disease and how they specifically affect women and provides practical help in risk management. In addition to medications, strategies may include nutrition counseling, exercise prescriptions, nicotine-dependence treatment, and instructions for a healthy lifestyle to prevent or slow the progression of heart disease on the basis of each patient's unique needs.

Hormone replacement therapy

Hormone replacement therapy is not recommended for the prevention or treatment of cardiovascular disease and has known risks, but many questions about this issue remain unanswered. WHC staff help women make careful decisions about postmenopausal hormone therapy on the basis of the latest scientific information.

Referrals

Because women's health is often complex, the WHC can refer patients to other resources that prevent and manage women's health problems. Often, this means working with the patient's primary care physician to determine the best approach.

Follow-up care

WHC physicians consult with the patient's physician and offer recommendations for follow-up care so that patients can conveniently manage their risk factors with their regular doctor. Specialized longitudinal management of hyperlipidemia, hypertension, and other risks is also available in the Women's Heart Clinic.

Upcoming Courses

Continuing Medical Education, Mayo Clinic

To register for or obtain information about programs, visit www.mayo.edu/education or call 800-323-2688.

10th Annual Mayo Clinic State-of-the-Art Symposium: Arrhythmia Management
Feb 27-Mar 1, 2003, Napa, Calif

Valvular Heart Disease
June 6-8, 2003, Rochester, Minn

8th Annual Mountain Course: Success With Failure: New Strategies for the Evaluation and Treatment of Congestive Heart Failure
Aug 10-12, 2003, Whistler, BC

Mayo Cardiovascular Review Course for Cardiology Boards and Recertification
Sept 20-25, 2003, Rochester, Minn

Echocardiography in Congenital Heart Disease
Oct 12-15, 2003, Rochester, Minn

Update in Cardiovascular Diseases: A Case-Oriented, Interactive Approach
Oct 30-31, 2003, Rochester, Minn

American College of Cardiology Programs

To register for or obtain information about programs, visit www.acc.org or call the ACC Resource Center at 800-253-4636, ext 694. Outside the United States and Canada, call 301-897-2694 or fax 301-897-9745.

The 10th Annual Echocardiographic Workshop on 2-D and Doppler Echocardiography at Vail
Mar 3-6, 2003, Vail, Colo
Directed by George M. Gura, Jr, MD, FACC; Thomas Ryan, MD, FACC

The 8th Annual Cardiology at Cancún 2003
Mar 3-7, 2003, Cancún, Mexico
Directed by A. Jamil Tajik, MD, FACC; Guy S. Reeder, MD, FACC

Basic Echocardiography for Physicians: 2-D, Doppler, Color Flow Imaging, TEE, and Stress Echo Practical Review
Mar 10-12, 2003, Heart House, Bethesda, Md
Directed by Fletcher A. Miller, Jr, MD, FACC; Janel M. Mays, BA, RN, RDCS

ACC '03 – 52nd Annual Scientific Session
Mar 30-Apr 2, 2003, Chicago, Ill

Mayo Clinic cardiologists are leading the planning for ACC '03 in Chicago. ACC President W. Bruce Fye, MD, MA, FACC (center), will preside over the 52nd Annual Scientific Session Mar 30-Apr 2; David R. Holmes, Jr, MD, FACC (left), and Bijoy K. Khandheria, MBBS, FACC, are cochairs of the program committee.

The 17th Annual Echocardiographic Symposium on 2-D and Doppler Echocardiography at Vail
July 27-31, 2003, Vail, Colo
Directed by George M. Gura, Jr, MD, FACC

Cardiac Device Therapy—2003: Update in Pacemaker, ICD, and Cardiac Resynchronization Therapy
Aug 7-9, 2003, Chicago, Ill
Directed by David L. Hayes, MD, FACC

Cases in Echocardiography: TEE, Doppler, and Stress—Interpretation and Clinical Decision Making for the Advanced Echocardiographer
Oct 30-Nov 1, 2003, Seattle, Wash
Directed by Rick A. Nishimura, MD, FACC; Fletcher A. Miller, Jr, MD, FACC

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Mayo Clinic Establishes Multidisciplinary Marfan Clinic

Heidi M. Connolly, MD
Kenton J. Zehr, MD

Marfan syndrome is a heritable disorder of connective tissue caused by a mutation in the gene encoding fibrillin-1 on chromosome 15. Abnormalities in this structural protein are responsible for the clinical manifestations of the disease, affecting the skeletal, ocular, and cardiovascular systems. The disease is inherited in an autosomal dominant pattern 75% of the time; the rest arise from a spontaneous mutation.

Mayo Clinic has established a comprehensive, multidisciplinary Marfan Syndrome Clinic, headed by cardiologist Heidi M. Connolly, MD.

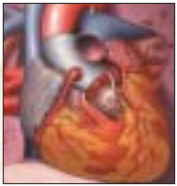
"The diagnosis of Marfan syndrome can only be made by a comprehensive clinical evaluation which includes a family and medical history, complete physical examination, and genetic evaluation, as well as recognition of typical manifestations in target organs," according to Dr Connolly. Additional testing required to secure a diagnosis includes echocardiography and ophthalmology and detailed skeletal examinations.

Cardiovascular involvement is the most common cause of morbidity and mortality in Marfan syndrome. The aortic valve and aortic root are most often affected; progressive root dilation is typical and eventually results in aortic valve regurgitation and propensity to aortic dissection if untreated. Beta-blockade slows the rate of aortic root enlargement.

Cardiac surgery has resulted in marked improvement in the survival of patients with Marfan syndrome. "Operation should be considered in patients with an aortic root dimension of 50 to 55 millimeters," says Kenton J. Zehr, MD, Mayo Clinic cardiovascular surgeon. Cardiac surgical advances such as composite aortic root replacement and valve-sparing surgery for aortic root disease have revolutionized the management and improved the life expectancy of Marfan patients. Standard surgical therapy involves replacement of the diseased aortic root with a composite valve-conduit. Mechanical valves provide durability but require long-term anticoagulation and, in some series, are more prone to infection. "In our series, there are surprisingly few of these complications. Only 2% have had infections, 9% neurological events, and 2% life-threatening bleeding with up to 24 years of follow-up," says Dr Zehr. Mayo in-hospital mortality is 2.5% for those undergoing nonemergent aortic root reconstruction over the past 3 decades.

Alternatives to standard surgical therapy include the following:

- Valve-sparing aortic root reconstruction for those patients in whom chronic anticoagulation is not ideal. This technique carries a risk of failure due to progressive aortic valve regurgitation and is not suitable for patients with valvular abnormalities such as cusp prolapse, thinned valve leaflets, or an aortic annular diameter of more than 27 mm.



- Replacement of the aortic root and valve with a homograft. These conduits are less durable, lasting 10 to 15 years, but do not require chronic anticoagulation and are usually more appropriate for select patients.
- A tissue-engineered human conduit, which has become available only recently. The donor cells are enzymatically removed, leaving behind a connective tissue framework, which is then repopulated with recipient cells. Mayo Clinic has the largest clinical experience with these new conduits and is one of the few centers in the United States currently implanting and evaluating this conduit as part of a clinical protocol.

In patients with Marfan syndrome, mitral valve prolapse is often severe and frequently leads to disruption of the valve apparatus and clinically important mitral valve regurgitation. The abnormalities of the mitral valve lend themselves to standard repair techniques and rarely require mitral valve replacement.

Marfan syndrome management consists of regular follow-up with specialists who are familiar with the complications of the disorder. Orthopedic care is often needed for scoliosis and problems with the hips and feet, particularly early in life. Annual eye examinations focus on the status of the lens and retina. Cardiac follow-up includes annual echocardiography and other imaging studies. Family screening is recommended and provided for patients with a new diagnosis or an indeterminate family history. Annual postoperative cardiovascular consultation is suggested to review the status of the surgical repair and exclude the presence of new complications.

The Marfan Syndrome Clinic offers an integrated medical, genetic, and surgical team of specialized Mayo Clinic physicians to provide diagnosis and state-of-the-art treatment for patients with suspected or confirmed Marfan syndrome as well as education regarding exercise, endocarditis prophylaxis, pregnancy, genetic implications, surgical consultation, and lifelong management.

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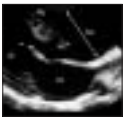

2-D Echo image of dilated aortic root.