HeartWATCH

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A Newsletter Produced by the Texas Heart Institute

Texas Heart® Institute

at St. Luke's Episcopal Hospital

Sixty-four–Slice Multi-Detector Computed Tomography: A New Tool for Noninvasive Imaging of the Coronary Arteries

Abstract: Sixty-four–slice multi-detector computed tomography is a noninvasive alternative to coronary angiography in selected, low- to intermediate-risk patients.

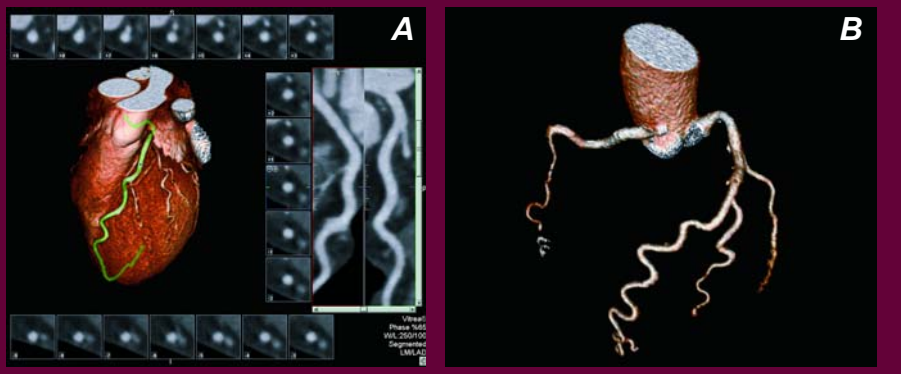
Over the past 5 years, a new technology has emerged as a promising technique for noninvasive coronary evaluation. Traditionally, coronary angiography—a costly, invasive procedure that carries a slight but definite risk of complications—has been the gold standard for assessing the coronary arteries. However, in recent years computed tomography has rapidly evolved from a single-detector system into a 64-slice system with significantly improved diagnostic capabilities, making noninvasive imaging of the coronary arteries a reality.

Sixty-four–slice multi-detector computed tomography (MDCT) has better spatial and temporal resolution than other computed tomography scanners, allowing for increased coverage of the heart and decreased breath-hold times for patients. At the Texas Heart Institute at St. Luke's Episcopal Hospital, Benjamin Cheong, MD, a noninvasive cardiologist in the Cardiovascular Magnetic Resonance Imaging/Computed Tomography unit, has been using a 64-slice computed tomography scanner (Sensation™ 64, Siemens Medical Solutions, Malvern, PA) to evaluate coronary arteries in selected patients.

"This state-of-the-art scanner allows us to 'freeze' the heart to obtain a high-quality, diagnostic image of the coronary arteries during a breath-hold of only 10 to 12 seconds, which is about half the time needed with the 16-slice scanner," explains Dr. Cheong.

Sixty-four–slice MDCT coronary angiography has a high diagnostic sensitivity, ranging from 82% to 95%, and its specificity is consistently excellent, with uniform negative predictive values of 97% to 99% (*Clin Radiol 2006; 61:174–80; Am J Cardiol 2006;98:145–8*). Therefore, 64-slice MDCT can accurately exclude coronary artery disease (CAD).

"This technology is most useful in low- or intermediate-risk patients with chest pain who cannot exercise or who have equivocal results on stress tests and might otherwise have to undergo invasive coronary angiography," says Dr. Cheong. Furthermore, the use of MDCT for triage to exclude CAD in emergency room patients with acute equivocal chest pain may significantly reduce hospital costs and length of stay (*Radiol Med 2006;111:481–96*). However, patients with typical angina and a high probability of CAD should undergo invasive coronary angiography.



A) Multiplanar reconstruction showing a normal proximal left anterior descending artery. **B**) Volume rendering of the major coronary arteries in a normal patient.

Sixty-four–slice MDCT can also be used to derive a coronary calcium score, a marker of atherosclerosis that correlates with the amount of plaque in the coronary arteries. This score is useful in predicting survival and cardiovascular events.

"The calcium score is used for risk stratification of asymptomatic, low-to-intermediate–risk patients in whom coronary calcium suggests subclinical CAD," states Dr. Cheong. "Guided by the score, we can aggressively modify risk factors such as hypertension and hyperlipidemia and can institute appropriate treatment." Additional uses for MDCT technology include evaluating aortic and peripheral vascular disease, assessing left ventricular function, studying cardiac anatomy, evaluating bypass graft patency, and mapping pulmonary venous anatomy in patients undergoing radiofrequency ablation.

Not all patients are candidates for MDCT. Obesity, a high heart rate (> 70 bpm), significant coronary calcification, and the presence of metal objects such as stents can reduce image quality and decrease diagnostic accuracy.

"Patients are routinely given beta-blockers before imaging to reduce the heart rate because a regular, slow rhythm is essential for a good image," says Dr. Cheong. Another limitation of MDCT is the radiation dose. "The radiation burden is a concern and currently prohibits the use of MDCT as a screening tool," says Dr. Cheong. "However, with ECG dose modulation, we can reduce the radiation dose by 30% to 40%, especially in patients with a low heart rate."

In a short period of time, MDCT has evolved into a technology that provides a useful, noninvasive alternative to traditional coronary angiography in select patients. "The diagnostic performance of MDCT angiography has significantly improved with the development of the latest 64-slice scanner. This technology will continue to grow as will its usefulness in cardiovascular medicine," summarizes Dr. Cheong. ●

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Proteomics: A Step Beyond Genomics

Abstract: Deciphering the human proteome, or protein complement of the genome, is the next main research goal in the prevention and treatment of disease at the subcellular level.

The Human Genome Project, completed in 2003, identified the approximately 25,000 to 40,000 genes in human DNA. The resulting data will take many years to analyze but will eventually offer unprecedented opportunities for diagnosing, treating, and preventing disease. Scientists have now begun an even more ambitious project: deciphering the human proteome, or protein complement of the genome. This goal is particularly daunting because the human proteome is believed to have up to a million different components.

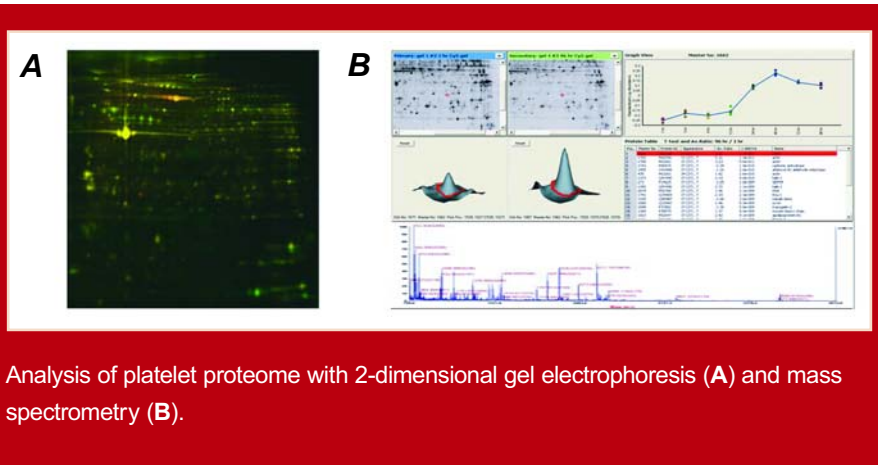
The Texas Heart Institute (THI) at St. Luke's Episcopal Hospital has been instrumental in bringing the powerful analytical capabilities of proteomic analysis to the scientific research community of the Texas Medical Center. The Institute's Molecular Biology and Proteomics Laboratory, directed by David Engler, PhD, senior scientist at THI, participates in all aspects of proteomics research.

"Unlike the human genome," says Dr. Engler, "the proteome is constantly changing. In addition, the dynamic range of the protein concentration in a single cell can extend beyond 8 orders of magnitude. The human heart alone may express tens of thousands of protein isoforms, many of which are altered in persons with cardiovascular disease."

To separate and identify proteins, the laboratory uses mainly 2-dimensional gel electrophoresis (2-DE) and mass spectrometry (MS).

"With 2-DE," explains Dr. Engler, "proteins are separated in the first dimension according to their charge properties and then in the second dimension according to their molecular mass. Each cell type yields a characteristic pattern of spots in a gel medium [*Fig. A*]. Proteins in each spot are excised from the gel and then identified by MS analysis after cleavage by sequence-specific proteases [*Fig. B*]."

"With MS," he continues, "elemental isotopes are used to identify and differentiate the proteins in cells or tissues. The masses of peptides obtained from the proteolytic cleavage of individual protein spots on the gel are measured. To identify the proteins, the resulting peptide 'mass fingerprint' is compared with 'expected' peptide masses for each entry available in online protein sequence databases. A single experiment may identify thousands of proteins or their modified isoforms present in tissues during various physiologic or disease states."



Analysis of platelet proteome with 2-dimensional gel electrophoresis (**A**) and mass spectrometry (**B**).

An alternative approach, especially valuable for detecting proteins missed by 2-DE, is multidimensional chromatography followed by MS analysis.

One effort that should eventually reap untold benefits for cardiovascular patients is the study of proteins sequestered within or secreted by platelets. These proteins modulate cell signaling and are important not only to hemostasis and thrombosis but also to inflammation, tissue repair, and the immune system.

According to Dr. Engler, "In general, our current platelet proteomic studies address the correlation between expressed platelet proteins and platelet function over time with respect to particular clinically relevant scenarios. For instance, these studies may allow us to determine why atherosclerotic disease is prothrombogenic in one patient but stable in another. Future results of this research should allow selected platelet proteins to be specifically targeted by treatments that affect the signaling cascades governing platelet adhesion, activation, and aggregation, thus preventing bleeding or thromboembolic complications."

In addition, THI researchers are using proteomic analyses to study stem cell biology, gene therapy, and heart failure.

"Currently," says Dr. Engler, "our laboratory has about 30 research projects under way, some involving academic institutions nationwide. Proteomics is beginning to play a major role in translating basic biologic knowledge into clinical applications." ●

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Contents

Aortic Repairs in Patients With Marfan Syndrome

Abstract: Aortic repair patients with symptoms of Marfan syndrome have good long-term survival. These patients are freer from repair failure if Marfan syndrome is confirmed than if it is only suspected.

Marfan syndrome (MFS)—a heritable connective-tissue disorder—is believed to be rare, but its true prevalence is difficult to ascertain because the syndrome affects various systems of the body. Therefore, the diagnostic criteria for MFS comprise potential signs and symptoms in many body areas (*see Table*), especially the aorta and its branches. These cardiovascular effects significantly shorten the life expectancy of Marfan patients.

The most common Marfan-related cardiovascular conditions—aortic aneurysms and acute and chronic aortic dissection—often become severe enough to warrant surgical repair. Recently, Joseph S. Coselli, MD, chief of Adult Cardiac Surgery at the Texas Heart Institute at St. Luke's Episcopal Hospital and professor and chief of Cardiothoracic Surgery at Baylor College of Medicine, and his colleagues examined the long-term outcomes of 398 operations on the aorta or its branches that Dr. Coselli had performed in 300 patients with signs of MFS. The findings were reported earlier this year in the *Annals of Thoracic Surgery* (2006;81:2063–78).

Partial Diagnostic Criteria for Marfan Syndrome

Cardiovascular System
- Aneurysm or dissection of the ascending or descending thoracic aorta
- Mitral valve prolapse or calcification

Skeleton
- Abnormalities of the chest, elbows, wrists, fingers, hip joints, ankles, foot arches, skull, or jaw

Eyes
- Displacement of the lens
- Flattened corneas
- Elongated globes
- Underdeveloped irises or ciliary muscles

Dura
- Lumbosacral dural ectasia

Family/Genetic History
- First-degree relative with Marfan syndrome
- Mutation in the fibrillin-1 gene

"The study had two main goals," says Dr. Coselli. "First, to examine rates of survival, complications, and repair failure in Marfan patients after aortic procedures. Second, to look for differences between patients with confirmed MFS—meaning those whose medical records described a set of characteristics that met current diagnostic criteria for this condition—and patients in whom MFS was suspected but whose records did not clearly show that they met the diagnostic criteria for it."

Of the operations included in the study, the most common were thoracoabdominal aortic repairs (n=178), aortic root replacements (n=125), aortic arch repairs (n=59), and repairs of the descending aorta (n=31). Most patients (83%) were symptomatic preoperatively, and 65% had chronic dissection.

Seventeen deaths (4.3%) occurred during the first 30 days after the 398 procedures. The overall survival rate was 96.2% at 1 year, 82.7% at 5 years, and 74.6% at 10 years (mean follow-up period, 6.2 years). Twenty repair failures (ie, aneurysm or pseudoaneurysm development at the repair site, reoperation for graft infection, or severe aortic valve dysfunction after aortic valve or root surgery) occurred during a mean follow-up of 4.2 years after repair.

A review of the 300 patients' charts showed that 137 (45.7%) patients met the current diagnostic criteria for MFS, whereas this condition was merely suspected in the remaining 163 patients (54.3%). The 2 groups were similar in most respects, including risk factors and the number and types of aortic interventions. Short- and long-term survival and rates of postoperative complications were also similar. However, freedom from repair failure was significantly better in patients with confirmed MFS (90.3% at 10 years and 80.9% at 15 years) than in patients with suspected MFS (82.0% at 10 years and 61.9% at 15 years; P=0.001).

"These good short- and long-term survival prospects support aggressive treatment of aortic disease in these patients," says Dr. Coselli. "However, we can only speculate why the patients with confirmed MFS had fewer repair failures than did the patients with suspected MFS. Perhaps the patients with suspected MFS had other, more severe connective tissue disorders that increased the odds of repair failure. It is also possible that surgical techniques intended to reduce the likelihood of repair failure were used more often in patients with confirmed MFS. If so, our results suggest that these techniques could be just as valuable in patients with suspected MFS. In any case, a long-term, prospective study is needed to examine the potential causes of repair failures in patients with MFS and similar disorders." ●

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Texas Heart Institute Rises in Rank Among Top 10 Heart Centers

For 16 consecutive years, the Texas Heart Institute at St. Luke's Episcopal Hospital (THI at SLEH) has ranked among the top 10 heart centers in the nation. According to the *US News and World Report*'s annual survey, "America's Best Hospitals," the Institute ranks sixth in 2006, up from eighth in 2005. Denton A. Cooley, MD, founder, president, and surgeon-in-chief of THI and chief of Cardiovascular Surgery at SLEH, says, "The consistency of this honor reflects the unwavering dedication and outstanding work of our physicians, scientists, and nursing and support staff. We value this recognition as we move forward to expand our world-renowned leadership in education, research, and treatment of heart disease." The Texas Heart Institute at SLEH is the only heart center in the Southwest to be ranked among the top 10 heart centers by this survey.

New Clinical Trial Evaluates Promising Stem Cell Therapy for Peripheral Vascular Disease

Abstract: A special population of stem cells with the potential to enhance blood vessel growth is being evaluated for treatment of patients with peripheral vascular disease.

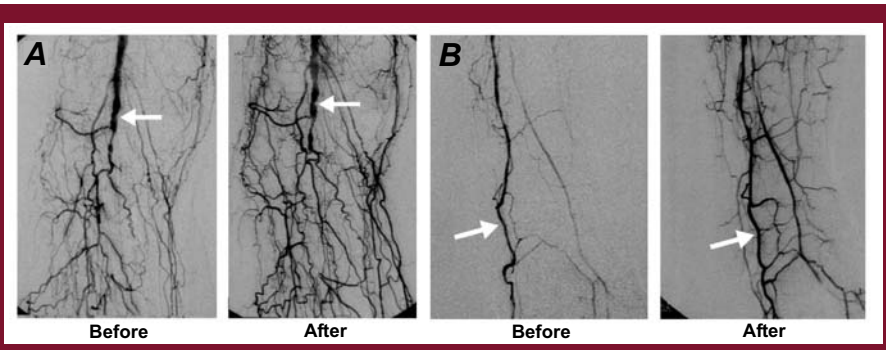
The Stem Cell Center

at the Texas Heart Institute at St. Luke's Episcopal Hospital (THI at SLEH) is a leader in researching stem cell therapies for cardiovascular disease. Stem cells are pluripotent, unspecialized cells that may differentiate into other types of cells and that secrete substances beneficial for tissue regeneration. Under the oversight of the Food and Drug Administration, stem cell treatment of heart disease is currently undergoing clinical trials at THI (*see box, p. 5*). Because stem cell therapy is associated with improved blood flow to treated areas, the potential applications may expand to treatment of other disease states involving inadequate blood flow to the lower extremities.

Patients with chronic critical limb ischemia (CLI) might benefit from stem cell therapy. In CLI patients, blood supply to the extremities is so limited that the limb tissue is severely damaged. In the United States, approximately 150,000 patients per year are diagnosed with CLI. Complications include rapidly enlarging, nonhealing wounds, potentially leading to gangrene. The best treatment option is revascularization, but this is not always an option for the most seriously affected patients. Limb amputation is necessary in up to 40% of patients. Stem cells offer hope for reducing the morbidity and mortality of CLI.

Recently, the Stem Cell Center at THI at SLEH began a trial designed to test the efficacy of autologous bone marrow-derived aldehyde dehydrogenase-bright (ALDH[br]) stem cells in the treatment of CLI. These cells are characterized by their bright fluorescence and strong colony-forming ability. Because ALDH(br) populations are very primitive precursor cells, they may provide a heightened therapeutic benefit to patients with CLI.

The ALDH(br) trial has been designed for patients with chronic CLI who have no other treatment options. One leg will be injected with ALDH(br) stem cells, and the other leg will be injected with bone marrow mononuclear cells (BMMNCs), which are already being used in clinical trials to treat heart disease. In this way, researchers will be able to distinguish the therapeutic benefits of ALDH(br) cells from those of unsorted BMMNCs.



Angiographic analysis of collateral vessel formation in patients with CLI, before and after treatment with bone marrow mononuclear stem cells. Collateral branches were strikingly increased at (**A**) knee and upper-tibia and (**B**) lower-tibia, ankle, and foot before and 24 weeks after marrow implantation. Contrast densities in suprafemoral, posterior-tibial, and dorsal pedal arteries (arrows) were similar before and after implantation.

"Previous studies have shown that low doses of ALDH(br) cells can be more effective than high doses of unsorted BMMNCs in treating ischemic diseases," says Emerson Perin, MD, PhD, director of New Cardiovascular Interventional Technology and director of the Stem Cell Center at THI at SLEH.

The stem cells are removed from the marrow of the patient's pelvic bone. To isolate the ALDH(br) cells, the marrow is processed with an Aldesort Kit (Aldagen, Inc., Durham, NC) at The University of Texas M. D. Anderson Cancer Center. Drs. Perin and James T. Willerson, president-elect and medical director of THI at SLEH and president of The University of Texas Health Sciences Center at Houston, who are leading the THI trial, view stem cell therapy as an excellent option for these difficult cases of peripheral vascular disease.

"Using the patient's own bone marrow cells for treatment has many advantages," says Dr. Perin. "If these cells are removed and then reintroduced into the patient's body, they should not be rejected by the immune system."

Treatment with ALDH(br) cells has proved successful in preclinical trials. The THI trial is the first to use these special cells in humans. In a similar study done in Japan (but utilizing BMMNCs), blood flow to the limbs was increased significantly (*see Figure*) in treated patients. Their overall prognosis also improved, as reflected by longer pain-free walking times, less resting pain, and less need for amputation. The Stem Cell Center at THI at SLEH hopes to obtain equal or better results with ALDH(br) cells, thereby expanding the treatment options and improving the quality of life for patients with CLI. ●

For more information:

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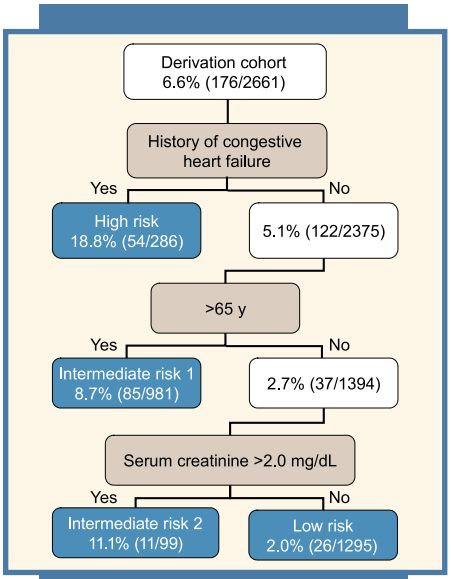
Algorithm Identifies High-Risk Patients After Coronary Revascularization

Abstract: According to this decision-tree induction algorithm, a history of congestive heart failure, advanced age, and elevated serum creatinine levels predict 3-year mortality after coronary revascularization.

Despite advances in coronary revascularization procedures, some patients who need revascularization are at substantial risk for postprocedural myocardial infarction and death. Long-term clinical outcome studies have identified risk factors for adverse outcomes (eg, 65 years or older, diabetes, and severe left ventricular systolic dysfunction). However, these potential predictors are typically reported as hazard ratios, odds ratios, and other statistics that may be difficult to apply to patients with numerous risk factors. Clinicians need a tool for identifying patients who may benefit from more intensive medical therapy or follow-up. Physicians at the Texas Heart Institute at St. Luke's Episcopal Hospital (THI at SLEH), in collaboration with colleagues from Kyoto University and The University of Texas, have developed a practical, user-friendly decision-tree induction algorithm that provides a comprehensive, hierarchical view of the relative influence of patients' risk factors on outcomes of coronary revascularization.



Decision-tree algorithm (*see text*).

"I see a decision tree as a 'divide and conquer' strategy for classifying risk factors in cardiovascular disease," says cardiologist MacArthur A. Elayda, MD, PhD, a cardiovascular epidemiologist in the department of Biostatistics and Epidemiology and manager of the THI Research Database (THIRDBase). "A decision tree allows you to set aside risk factors that are not important predictors of mortality so you can work with the factors that are important."

The decision tree to identify high-risk patients after coronary revascularization was developed from information in THIRDBase, a comprehensive, longitudinal clinical registry of outcomes of more than 181,000 patients treated for cardiovascular disease at THI at SLEH. For this study, researchers retrospectively identified 3,331 patients with complex coronary artery disease (CAD) who underwent isolated first-time coronary artery bypass graft surgery or percutaneous coronary intervention with stenting at THI between 1995 and 1999. Researchers examined all-cause mortality during 3-year follow-up in these patients.

Clinical variables extracted from THIRDBase included patient demographics, risk factors for CAD, renal insufficiency (defined as serum creatinine level >2.0 mg/dL), valvular heart disease, chronic obstructive pulmonary disease, history and severity of congestive heart failure (CHF), cerebrovascular disease, and type of revascularization (emergent or elective). Follow-up information was obtained through verbal or written communication and from the Texas vital statistics database.

Patients were randomly assigned in a 4:1 ratio to either the derivation cohort (used to develop the model) or the validation cohort (used to test the model). To develop the decision tree, researchers used a recursive process of partitioning data into sets (each representing a single risk factor) that would most accurately predict survival. The risk of 3-year mortality was calculated for each of the final risk factors identified, and these statistics were used to stratify patients' risk levels as high, intermediate, or low. The results were tested by applying the decision tree to the validation cohort.

Of the 17 variables evaluated, a history of CHF conferred the highest risk of 3-year mortality (18.8%, compared with 5.1% for patients without CHF). Patients without a history of CHF but older than 65 years had an intermediate risk of 3-year mortality (8.7% vs. 2.7%). Patients without CHF who were 65 or younger with a serum creatinine level >2.0 mg/dL had an intermediate risk (11.1% vs. 2.0% for patients without a high serum creatinine level).

"This decision tree gives physicians a practical tool for evaluating a coronary revascularization patient's prognosis," says Dr. Elayda. ●

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Clinical Trials Update: Patient Recruitment

The Stem Cell Center at the Texas Heart Institute at St. Luke's Episcopal Hospital is recruiting patients for 3 FDA-approved clinical trials. Patients must have exhausted conventional treatment options.

Autologous Bone Marrow Mononuclear Stem Cells (BMMSCs) for Cardiac Angiogenesis (FOCUS HF). Cells are injected into ischemic areas of viable heart muscle in patients with severe ischemic cardiomyopathy (LVEF <45%).

Intramyocardial Injection of Aldehyde Dehydrogenase-Bright (ALDH[br]) Stem Cells (FOCUS Bright). Adult ALDH(br) cells, which have been shown to be more effective than unfractionated stem cells, are injected into the periphery of damaged areas of heart muscle in patients with ischemic cardiomyopathy.

Critical Limb Ischemia With ALDH(br) Stem Cells (CLI). Researchers will compare the therapeutic benefits of ALDH(br) and BMMSCs in patients with CLI (*see story, p. 4*).

For details, contact the Stem Cell Center at 832.355.9404 or plea@heart.thi.tmc.edu; see also texasheart.org/Research/stemcellctr.cfm.

Heart Sounds and Murmurs Website Offers Training Tool for Physicians

Abstract: The Texas Heart Institute Heart Sounds and Murmurs website offers a much-needed tool for training new physicians in the skill of cardiac auscultation.

Among some cardiologists, an ongoing concern is the decreasing amount of training that medical students and residents are receiving in cardiac auscultation. Clinicians who have not had proper instruction in auscultation often order invasive or expensive tests more than would otherwise be necessary.

For this reason, on July 7, 2006, the Texas Heart Institute at St. Luke's Episcopal Hospital (THI at SLEH) launched the Heart Sounds and Murmurs Download Site (cme.texasheart.org), which includes 40 labeled anomalous heart sounds and murmurs that can be heard online or downloaded to an MP3 player. The project is an ongoing attempt by the Continuing Medical Education department, under the direction of James M. Wilson, MD, to revive the waning skill of auscultation. The website gives medical students, residents, and practicing physicians an opportunity to learn the distinguishing features of abnormal heart sounds. In a study done at Drexel University College of Medicine in Philadelphia, researchers found that medical students who had listened 500 or more times to several different heart sounds could identify—with only a stethoscope—the specific cardiac problems indicated by those sounds more accurately than could students who did not listen to the sounds (*Am J Med 2006;119:73–5*).

"If you know heart sounds well enough, you can predict some anomalies more accurately with auscultation than with echocardiography," says Dr. Wilson. For this reason, internists are now being tested on their auscultation skills during the board recertification process. The THI online auscultation library is an ideal training tool for these clinicians.

The Heart Sounds and Murmurs library is an ongoing project that began under the direction of Robert J. Hall, MD, former director of Cardiology Education at THI and a proponent of complete bedside evaluations. During Dr. Hall's tenure at THI, the Heart Sounds and Murmurs library grew to include recordings from more than 2,500 different cases, ranging from the most common conditions to the most rare.

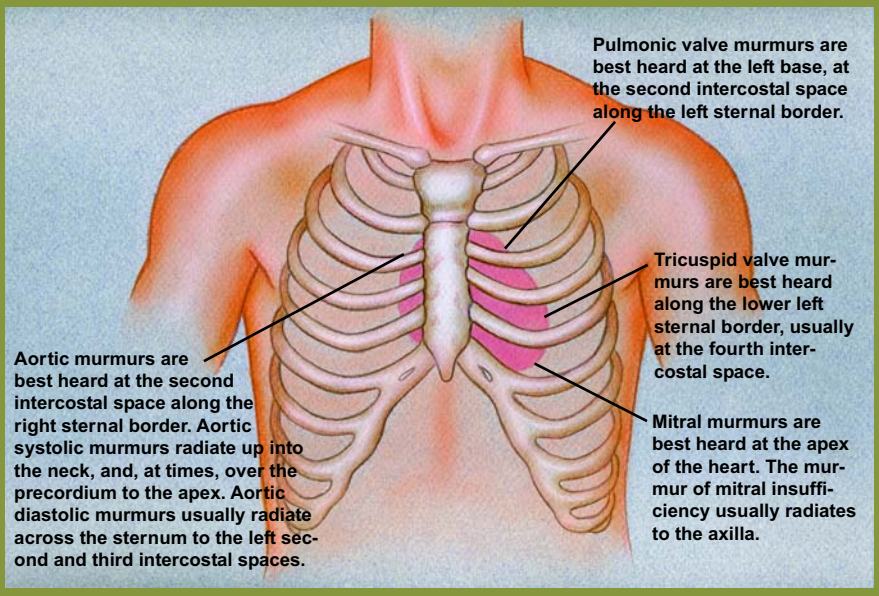

Diagram showing specific locations from which to detect various types of heart murmurs. Adapted from "Where to Listen" on the *Auscultation: Heart Murmurs* CD-ROM, the Texas Heart Institute at St. Luke's Episcopal Hospital, 2006.

Now, 23 years later, part of the collection Dr. Hall began is available as a training tool to anyone with a computer. This is especially helpful for physicians in remote areas, who have limited access to high-tech imaging equipment and must often rely on their own auscultation skills. In addition to the library of sounds, the website offers a presentation by Dr. Wilson that includes multimedia links showing the key connections between a heart sound and a corresponding electrocardiogram (EKG).

Some of THI's training tools introduce users to visual aspects of cardiac abnormalities in addition to aural aspects. *The Auscultation: Heart Murmurs* CD-ROM offers split-screen video of patients with their real-time EKG tests, giving users a complete range of information about the patient's cardiac condition. The sounds are synchronized with the EKG results, allowing physicians to see and hear abnormalities. The disc shows complete bedside cardiovascular evaluations of patients with varying conditions, and it indicates the best auscultation sites for appreciating the timing and character of various abnormalities.

Auscultation may be a skill in danger of dying out, but its benefits remain apparent, as do the benefits of a complete bedside cardiac evaluation.

"Although the current library of heart sounds is enormous," says Dr. Wilson, "patient variability is even greater. Therefore, we are continuing to expand the library started by Dr. Hall and to explore new, computer-based methods of storing, analyzing, and delivering those sounds to interested healthcare personnel." ●

For more information:

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HeartWATCH

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For physician referrals,
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Cover: Sculpture donated by Cheryl and Philip Burguieres for the Celebration of Hearts display in the Wallace D. Wilson Museum of the Texas Heart Institute at St. Luke's Episcopal Hospital—The Denton A. Cooley Building.

Calendar of Events

Texas Heart Institute Continuing Medical Education Symposia

Advances in the Prevention and Treatment of Cardiovascular Disease
October 6–7, 2006 • McAllen, TX

Acute and Long-Term Treatment of Cardiovascular Disease: Bringing Science to the Bedside
November 11, 2006 • Chicago, IL

Eighth Symposium on Cardiac Arrhythmias: New Pharmacologic and Interventional Strategies
February 17, 2007 • Houston, TX

Selected Upcoming National and International Meetings

American Heart Association Scientific Sessions 2006
November 12–15, 2006 • Chicago, IL

Society of Thoracic Surgeons 43rd Annual Meeting
January 29–31, 2007 • San Diego, CA

American College of Cardiology 56th Annual Scientific Session
March 24–27, 2007 • New Orleans, LA

International Society for Heart and Lung Transplantation 27th Annual Meeting and Scientific Sessions
April 25–28, 2007 • San Francisco, CA

American Surgical Association 127th Annual Meeting
April 26–28, 2007 • Colorado Springs, CO
Abstract submission ends: November 10, 2006

European Society for Cardio-Vascular Surgery
May 17–20, 2007 • Venice, Italy
Abstract submission ends: January 20, 2007

International Society for Heart Research 19th World Congress
June 22–26, 2007 • Bologna, Italy
Scientific Chair: James T. Willerson, MD
Abstract submission ends: January 31, 2007

For information about the Texas Heart Institute CME activities listed above, please e-mail cme@heart.thi.tmc.edu or call 832.355.2157. To view selected CME presentations and other physician resources online, visit cme.texasheart.org.

For 16 consecutive years, the Texas Heart Institute at St. Luke's Episcopal Hospital has been ranked among the top 10 heart centers in the United States by *U.S. News & World Report*'s annual guide to "America's Best Hospitals."

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