HeartWATCH

SPRING 2006

A Newsletter Produced by the Texas Heart Institute

Texas Heart® Institute

at St. Luke's Episcopal Hospital

First Clinical Trial Will Evaluate New Stem Cell Technology for Heart Failure Therapy

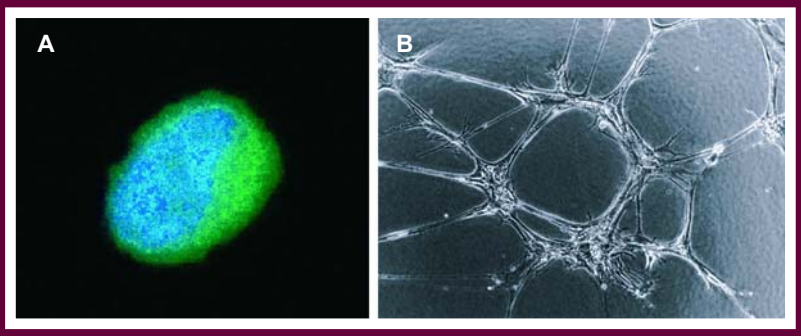
Abstract: A special population of stem cells with high angiogenic potential will be evaluated for treatment of patients with advanced heart failure.

Physicians at the Texas Heart Institute at St. Luke's Episcopal Hospital (THI at SLEH) have received the green light from the United States Food and Drug Administration (FDA) to conduct the world's first clinical trial of a new technology (ALDESORT; Aldagen, Inc., Durham, NC) for isolating a special population of adult stem cells with high angiogenic potential. The trial, led by Emerson C. Perin, MD, and James T. Willerson, MD, of THI at SLEH, will evaluate the use of these selected stem cells to treat patients with advanced heart failure.

In animal models, adult stem cells expressing a high level of the enzyme aldehyde dehydrogenase (ALDH) have been shown to be more effective than a heterogeneous population of unfractionated bone marrow cells in promoting the growth of new blood vessels (*Blood* 2005; 106:Abstract 2663). Bone marrow cells that express high levels of ALDH (called ALDH bright [br] cells), which represent less than 1% of nucleated bone marrow cells, are identified by their ability to perform an enzymatic reaction that makes them fluoresce green. Previously, cell-surface markers were used to select stem cells for heart failure therapy.

"The ALDH(br) cells are more primitive and potentially more potent than the cells we've been using," explains Dr. Perin. "We think they might be very effective in restoring cardiovascular function."

In the recently approved, randomized, double-blind trial, 60 patients aged 70 years or younger with advanced heart failure (ejection fraction < 45%) will receive either ALDH(br) stem cells or a placebo via transendocardial injection. Using 3-dimensional electromechanical mapping to guide the needle-tipped catheter, investigators will administer cells to damaged myocardial regions that have viable tissue but no blood flow. The patient's own bone marrow cells are used for this therapy. Cells are removed from the patient's pelvic bone approximately 24 hours before surgery, then are selected and processed in a specialized FDA-approved laboratory at the University of Texas M. D. Anderson Cancer Center before being administered.



A) Unique population of bone marrow stem and progenitor cells (ALDH(br) cells), which accumulate a green fluorescent enzyme reaction product in the cytoplasm. **B)** This cell population readily forms large tubule networks that are frameworks for new blood vessels when cultured on basement membrane preparations; this in vitro assay shows the potent neovascularization activity of the ALDH(br) cells.

"These patients have run out of options for revascularization," says Dr. Perin. "Most have had multiple bypass operations and multiple stenting procedures."

In earlier trials of stem cell therapy delivered via transendocardial injection, patients showed evidence of new blood vessel development and cellular regeneration (*Circulation* 2005;112: 521–6). Patients receiving stem cell therapy also had improved perfusion and increased exercise capacity (*Circulation* 2004;110 [Suppl II]:II-213–II-218).

Safety is the focus of the first phase of the new study.

"We've safely treated many patients with transendocardial injections of heterogeneous stem cells, which included some ALDH(br) cells," Dr. Perin continues. "That experience leads us to believe that administering a concentrated amount of homogeneous ALDH(br) cells will also be safe."

In the next phase of the study, the efficacy of the therapy will be assessed by measuring the patients' maximum (exercise) oxygen consumption ($V_{O_{2max}}$).

"We expect patients who receive the ALDH(br) cell therapy to have less angina, less shortness of breath, and a better quality of life," Dr. Perin says. He expects improvement to become evident within about 6 weeks after therapy, and the newly injected cells may promote further improvement for up to a year.

"We have growing evidence that cardiac stem cell therapy improves people's lives," Dr. Perin says. "We're working very hard to make that happen."

Dr. Perin is director of New Cardiovascular Interventional Technology and director of the Stem Cell Center at THI at SLEH. Dr. Willerson is president-elect and medical director of THI at SLEH and president of The University of Texas Health Sciences Center at Houston. ●

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Antifibrinolytic Agents May Increase Mortality Risk by Promoting Microthrombus Development

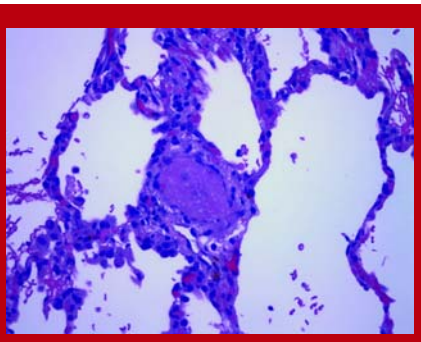
Abstract: Fatal thrombotic complications occurred in 9 patients who received antifibrinolytic therapy and who subsequently developed high pulmonary artery pressures caused by pulmonary microthrombi.

Maintaining hemostasis is challenging in end-stage heart failure patients undergoing cardiac surgery. These patients have chronic hepatic insufficiency, which results in derangement of coagulation. Additionally, they commonly receive both systemic anticoagulation (with warfarin or heparin) and antiplatelet therapy.

Although cardiac surgery is generally associated with an initial hypocoagulable state, hypercoagulability may manifest later in the postoperative period. Heparin use, platelet dysfunction, protein denaturation by cardiopulmonary bypass (CPB), hemodilution, hypothermia, inflammatory mediator release, and hyperfibrinolysis are among the many factors that can contribute to bleeding during and after surgery. Preoperative factors such as liver and renal dysfunction and anticoagulant use may also contribute to a hypercoagulable state.

Pharmacologic therapy has been used as an adjunct to treat bleeding encountered after CPB. Antifibrinolytic therapy has been shown to reduce hyperfibrinolysis and to mitigate inflammatory disturbances that may contribute to coagulopathy (*Ann Thorac Surg* 2001;72: S1821–31). The perioperative use of antifibrinolytics, such as aprotinin, has been shown to reduce the incidence of blood loss, allogeneic blood transfusion, mediastinal re-exploration, and mortality after cardiac surgery.

In 1997, O. H. Frazier, MD, director of Cardiovascular Surgical Research and chief of Cardiopulmonary Transplantation at the Texas Heart Institute at St. Luke's Episcopal Hospital, implanted a left ventricular assist device (LVAD) in a high-risk recipient who subsequently developed suprasystemic pulmonary artery pressures and fatal right-sided heart failure despite insertion of a right ventricular assist device. An intraoperative wedge biopsy of the lung showed multiple recent microthrombi in the small vessels—a finding not previously identified in such patients. During the next 7 years, 9 additional patients who died during cardiac surgery were identified. All had received antifibrinolytic therapy immediately before and throughout the CPB period. Intraoperative frozen section and postmortem examination confirmed the presence of multiple microthrombi within the capillaries and within small and, less frequently, medium-sized pulmonary arterioles in these patients.



Fibrin microthrombus in a small vessel within the alveolated lung parenchyma (H&E stain, original magnification ×400).

"It was after the reversal of heparin with protamine that the catastrophic pulmonary hypertension occurred and the right ventricular failure developed," says Dr. Frazier. "We addressed the right-sided failure with a right-sided pump; however, this intervention was ineffectual, because no flow could be obtained in the pulmonary circuit, even with pressures greater than 300 mm Hg. That, along with the uniform lack of response to pharmacologic therapy for pulmonary hypertension, indicates the extent of the microthrombotic occlusion of pulmonary arterioles and capillaries." He notes that whereas antifibrinolytic therapy may be a factor in the syndrome he observed, other factors such as liver and renal dysfunction may also be involved.

Other studies that have also recently questioned the use of antifibrinolytics—specifically aprotinin—include the large-scale comparative study conducted by researchers for the Multicenter Study of Perioperative Ischemia Research Group (an association of 160 international medical centers) and the Ischemia Research and Education Foundation, an independent, nonprofit organization. In this study, 1295 of the 4374 patients undergoing revascularization were given aprotinin. The remaining patients received the lysine analogues aminocaproic acid and tranexamic acid. The findings raised concerns about the possible association between aprotinin use and the incidence of cardiovascular and cerebrovascular thrombosis (*N Engl J Med* 2006;354:353–65).

In critically ill patients, careful perioperative monitoring of anticoagulant and antifibrinolytic therapy must include strict attention to adequate heparinization throughout the surgical procedure, which may be particularly prolonged in patients with advanced heart failure.

"These catastrophic consequences occurred despite our adherence to state-of-the-art recommendations for antifibrinolytic therapy and monitoring," says Dr. Frazier. "We still use antifibrinolytics in routine redo cases and have adjusted our monitoring of patients with advanced heart failure undergoing prolonged surgical intervention. Not all patients who receive antifibrinolytics will develop fatal pulmonary microthrombi, but all who did develop them in our series had received antifibrinolytic therapy." ●

For more information:

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Contents

Transcutaneous Near-Infrared Spectroscopy for Monitoring Spinal Cord Blood Flow During Thoracic Aortic Surgery

Abstract: Transcutaneous near-infrared spectroscopy is a potentially valuable tool for monitoring spinal cord function during surgery on the thoracic aorta.

Among the most devastating complications of thoracic aortic surgery are postoperative paraplegia and paraparesis caused by intraoperative spinal cord ischemia. To reduce the risk of these complications, various adjuncts—including cerebrospinal fluid drainage, aggressive reattachment of intercostal arteries, and distal aortic perfusion—have been developed to maintain spinal cord perfusion during thoracic aortic procedures. These techniques can be used to greater effect when guided by real-time data about spinal cord oxygenation.

Spinal cord monitoring techniques currently being used in clinical settings involve the measurement of evoked potentials (see *Heart Watch,* Winter 2004, texasheart.org), ie, measurable neural or muscular responses produced by the electrical stimulation of neurons in the somatosensory or motor tract. The magnitude of these responses can indicate how well spinal cord neural pathways are functioning. However, evoked-potential monitoring techniques have some important limitations. For example, changes in somatosensory evoked potentials may lag behind changes in spinal cord oxygen levels, and motor evoked potentials cannot be used in procedures involving total neuromuscular blockade. Additionally, both techniques require continuous monitoring by a neurophysiologist during the procedure.

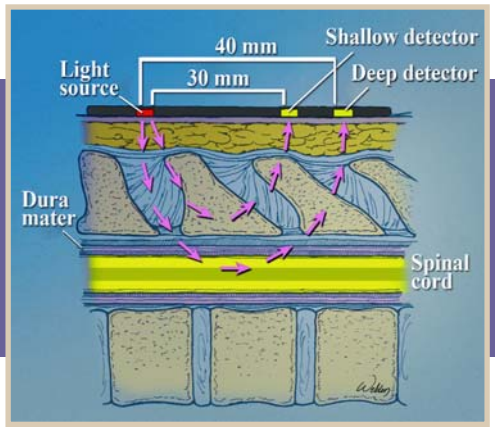
A possible alternative means of monitoring spinal cord oxygenation during thoracic aortic surgery is transcutaneous near-infrared spectroscopy (NIRS). This technique, which is already used to measure cerebral oxygenation during cardiovascular surgery, exploits differences in the degree to which hemoglobin, oxyhemoglobin, and cytochrome a,a_3 absorb or reflect near-infrared light that is beamed into the spinal cord. The characteristics of the reflected light provide information about both the oxyhemoglobin fraction in the spinal cord tissues and the use of energy by cells in that region (see figure).

Scott A. LeMaire, MD, cardiovascular surgeon at the Texas Heart Institute at St. Luke's Episcopal Hospital and associate professor of surgery at Baylor College of Medicine, has been working with colleagues at both institutions to conduct preliminary tests of NIRS as a potential tool for spinal cord monitoring in patients undergoing surgery for aneurysms or other lesions of the thoracic aorta.

"We simulated the ischemic effects of thoracic aortic surgery in 4 anesthetized pigs," explains Dr. LeMaire, "by sequentially ligating the segmental arteries that supply the lower portion of the spinal cord, from T6 through L1. During the ligations, the pigs were monitored with NIRS sensors that were placed on the skin over the upper (T6–T7) and lower (T9–T11) thoracic vertebrae and that were connected to an oximeter to measure regional oxygen saturation (rSO_2)."

"We found that, in each pig, the sensors detected consistent rSO_2 levels in the upper thoracic spinal cord, where blood flow was largely unaffected by the segmental artery ligations. In contrast, rSO_2 had decreased significantly in the lower thoracic spinal cord," Dr. LeMaire says. "Furthermore, clinical and spinal cord histopathologic examinations performed after the procedure suggested that the rSO_2 data provided by transcutaneous NIRS in our porcine model were not only accurate but also clinically relevant, because they predicted both impaired postoperative neurologic function and detectable neuronal injury."

"Next, a trial is needed to determine whether transcutaneous NIRS data could be used to guide intraoperative interventions for spinal cord ischemia in patients undergoing surgical repair of the thoracic aorta. Transcutaneous NIRS should also be tested as a means of detecting spinal cord ischemia in conscious postoperative patients recovering from thoracic aortic surgery, which could help clinicians prevent delayed-onset paraplegia in these patients." ●



In NIRS monitoring, near-infrared light is beamed through the surface tissues and into the spinal cord to measure tissue oxygenation. A processor in the oximeter uses the input from the shallow sensor to filter surface-tissue data out of the input from the deep sensor, thereby producing a purer estimate of spinal cord oxygenation than could be obtained with the deep sensor alone.

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Monitoring Sensor Inserted With Abdominal Aortic Aneurysm Stent-Graft Implant Shows Promise

Abstract: A recently developed stent-graft sensor improves and simplifies the monitoring process for patients with abdominal aortic aneurysms.

Abdominal aortic aneurysms

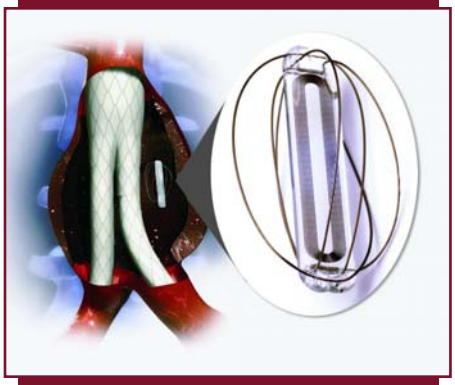
(AAAs) most often develop in patients older than 50 years who have 1 or more risk factors: high blood pressure, smoking, high cholesterol levels, obesity, or a family history of arterial aneurysms. A rupturing AAA can result in immediate death. Endovascular repair options include a stent-graft implant to relieve pressure on the ballooning vessel. Since 1996, Zvonimir Krajcer, MD, director of the Peripheral Vascular Disease Service at the Texas Heart Institute at St. Luke's Episcopal Hospital (THI at SLEH), has performed these procedures, along with 2 of his colleagues, Ali Mortazavi, MD, and Neil E. Strickman, MD.

Dr. Krajcer has pioneered an endovascular repair technique that necessitates only a local anesthetic and no incisions. A stent graft is inserted via a catheter placed in the femoral artery and threaded into the abdominal aorta. This method of AAA repair has offered many benefits to patients treated with this technique at THI.

"With this less invasive procedure, we can avoid complications associated with general anesthesia and surgical incisions," states Dr. Krajcer.

Traditionally, computed tomographic (CT) scans have been used to monitor the postprocedural condition of the aneurysm and stent graft, each of which requires long-term observation. According to Dr. Krajcer, rare complications of endoluminal AAA repair include continued enlargement of the aneurysm, leaks that allow blood flow into the aneurysm, and a downward shift of the stent graft.

Recent technology—originally developed for monitoring the pressure in turbine engines—may revolutionize the monitoring process. One device, the EndoSure™ Wireless AAA Pressure Measurement System (CardioMEMS, Inc., Atlanta, GA), has received United States Food and Drug Administration approval but has not yet been approved by Medicare. During stent-graft implantation, the sensor is inserted into the aneurysmal sac outside the stent graft.



The monitoring sensor's coils transmits information about the pressure within the aneurysm's walls.

Dr. Krajcer is one of the first physicians in the United States to place a pressure sensor in an AAA patient. The 10-mm sensor consists of 2 copper coils, each embedded within a glass plate. During a monitoring session, an antenna held over the implant site on the patient's torso excites the copper coils. The resulting signal is transmitted to an electronic monitoring device that measures the pressure between the glass plates. A monitor's screen shows the pulse-pressure line in the aneurysm. This interrogation process lasts approximately 5 minutes. Until monitoring occurs, the sensor sends no signals.

The sensor, which can be left in place indefinitely, has strong advantages over the CT scan procedure, which is usually performed at 1 month, 6 months, and 12 months after stent-graft implantation and annually thereafter.

"The sensor finds leaks that CT scans cannot detect. In addition, CT scans are costly, are time consuming, and have potential side effects. For instance, the contrast agent used to enhance the image can be toxic to the kidneys, especially if the renal system is already compromised," Dr. Krajcer says. Other side effects may be caused by the exposure to radiation over time. With the newer monitoring system, a CT scan can be postponed until the sensor detects a problem.

By removing the need for a CT scan, sensors inserted with the graft implant are expected to improve outcomes. Patients who have received such sensors have already noted increased peace of mind. A monitoring session can occur any time a patient experiences symptoms. "We believe that 5 to 10 years from now, many different conditions will be monitored with sensors similar to the EndoSure device, benefiting patients with heart failure, high blood pressure, and many other conditions," says Dr. Krajcer. He notes that the sensor is still in an early stage of development and predicts that, "over time, the sensors will get smaller. They will be delivered through tiny catheters to any location from which we need information." ●

For more information:

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Miracle Workers

William (Billy) E. Cohn, MD, director of Minimally Invasive Surgical Technology and a cardiovascular surgeon at the Texas Heart Institute at St. Luke's Episcopal Hospital, is 1 of a team of 2 doctors and 2 nurses hosting a new reality television series.

Miracle Workers showcases the latest medical advances and features patients who do not have access to, or the resources to get, the medical attention they need. The series' hosts do not perform the procedures; instead, they offer advice and link the patients to physician specialists for cutting-edge treatment.

The show follows 2 patients each week through their entire medical journey—from the initial consultation to the treatment procedure to its life-changing aftereffects.

The series, which premiered in March, airs on Monday nights at 9 PM Central Standard Time on ABC.

Left Ventricular Size and Shape: Determinants of Mechanical Signal Transduction Pathways

Abstract: Left ventricular remodeling contributes to the progression of heart failure and may be a target for adjunctive treatment strategies.

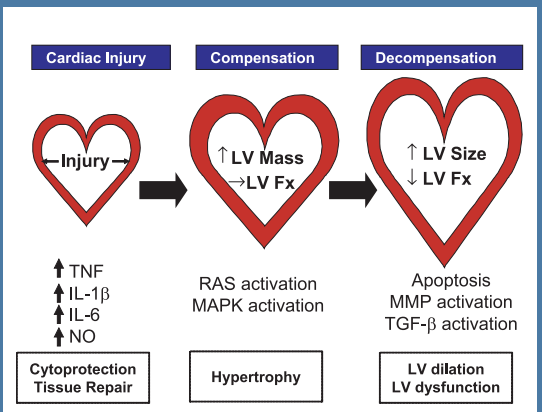
Few medical conditions have received as much attention as heart failure (HF). Nearly 5 million Americans are living with this progressive, ultimately fatal disorder, and 550,000 new cases are diagnosed each year. Despite increased understanding of the pathophysiology of HF, mortality rates remain high and medical therapy is limited. Advances in treatment are likely to come from agents that attenuate left ventricular (LV) remodeling, a milestone in the development of HF.

Heart failure begins after an "index event," such as a myocardial infarction, reduces the pumping capacity of the heart. Initially, patients are asymptomatic because various compensatory mechanisms keep LV function within its normal range. These initially adaptive changes within the myocardium, known collectively as LV remodeling, alter cellular metabolism and cardiac morphology. Over time, these changes become counterproductive and contribute to the development of symptomatic HF.

Because of his interest in the molecular mechanisms of LV remodeling, Douglas L. Mann, MD, chief of Cardiology at the Texas Heart Institute at St. Luke's Episcopal Hospital, has studied the factors responsible for progression from an asymptomatic, compensated condition to a failing heart.

"In early HF, the body attempts to maintain normal systemic and renal perfusion by activating various vasoactive neurohormonal systems, such as the renin-angiotensin and the adrenergic systems, which cause vasoconstriction and retention of salt and water," says Dr. Mann. During LV remodeling, the heart increases in size and changes from its normal elliptical shape to a more spherical one, which results in increased wall stress and thinning of the LV wall.

"These morphologic changes place mechanical burdens on the heart by altering the filling and ejection of the left ventricle and activating maladaptive signal transduction pathways. The end result is a large, dilated, poorly contracting ventricle," states Dr. Mann.



Paradigm showing the involvement of LV remodeling and proinflammatory cytokines in the progression from an index event to a failing heart. IL, interleukin; MAPK, mitogen-activated protein kinase; MMP, matrix metalloproteinase; NO, nitric oxide; RAS, renin-angiotensin system; TGF, transforming growth factor; TNF, tumor necrosis factor.

In addition to neurohormones, another group of biologically active molecules appears to contribute to the progression of HF—proinflammatory cytokines. The myocardial stretching associated with LV remodeling triggers signaling cascades that result in the production of cytokines normally associated with innate immunity. Studies have shown increased levels of tumor necrosis factor-α (TNF-α), interleukin-1β, and interleukin-6 in the blood and myocardium of patients with HF (*J Am Coll Cardiol* 1996;27:1201–6). These molecules have a direct toxic effect on the myocardium and may mediate disease progression by inducing myocardial hypertrophy, fibrosis, and myocyte death.

Although medical therapy for HF has traditionally been aimed at inhibiting neurohormones and improving hemodynamic status, recognition of the role of proinflammatory mediators in cardiac remodeling led to clinical trials targeted at neutralizing TNF in patients with moderate to advanced HF. These trials showed that anti-TNF therapy either worsened or had no effect on HF.

"Although these findings are disappointing, they do not necessarily invalidate the use of anticytokine therapy. Rather, they underscore the intricacies of the cytokine network. Treatment regimens that target a single component of the inflammatory pathway may not be sufficient in a complex disease like heart failure," explains Dr. Mann.

Therapies with broader anti-inflammatory properties may be more beneficial. For example, statins, which are pleotropic drugs with anti-inflammatory properties, may improve the outcome in patients with HF. Clinical trials of the efficacy of statins in the treatment of HF are ongoing.

Progressive LV remodeling has been linked to later deterioration of LV function and a less favorable clinical course in patients with HF. Increased size and sphericity of the left ventricle are strong predictors of morbidity and mortality.

"The clinical implications are that adjunctive strategies to prevent or attenuate LV remodeling will be important in treating heart failure," says Dr. Mann. "Future therapy will likely require a multifaceted approach involving existing neurohormonal strategies and newer regimens that address LV remodeling at the cellular and molecular levels." ●

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Ethical Issues in Scientific Publishing

Abstract: A new ethics course helps physicians and other authors understand attribution principles and copyright practices.

South Korean stem cell researcher Woo Suk Hwang, DVM, PhD, resigned in December 2005 after a Seoul National University committee determined that his claims of having "established stem cell lines from several individuals, achieved in each case by transferring the nucleus of a somatic cell from the individual into an enucleated human egg," were falsified (*JAMA* 2006;295:265). The report had been published in *Science* earlier that year. This case, albeit extreme, emphasizes the importance of ethics in scientific publishing.

Normally, medical authors are concerned with more common ethical issues. For example, credibility is heightened by the careful, accurate documentation of the author's sources. By adhering to established conventions, one may avoid legal and ethical problems in areas such as copyright and Internet use. A course offered by the Texas Heart Institute at St. Luke's Episcopal Hospital titled "Ethics: Copyright, Plagiarism, and the Internet" (texasheart.org/education/cme/explore/events/eventdetail_5018.cfm) offers a convenient and efficient way to learn about these publishing concerns. Physicians and others seeking Continuing Medical Education (CME) credits or just information about this topic may use the site.

The first lesson, "Copyright Law," clarifies copyright, ownership, the scope of copyrightable material, and the appropriate symbols to use to signify copyright protection on works. The lesson also discusses aspects of academic publishing such as "fair use" and newer publishing trends such as "open access." Participants learn how works are registered with the Library of Congress and how recent legislation provides greater protection against copyright infringement. Copyright protections for multimedia materials, graphics, and digital images, along with image manipulation guidelines, are explained.

The integrity of images is also discussed. The importance of this point is illustrated by the Hwang case. Once Hwang's assertions about cloning were called into question, the authenticity of his images also came under scrutiny (*Science* 2005;310:1595).

The ideas of others must be credited, and authors are responsible even for unintended instances of plagiarism.

The second lesson, "Plagiarism," distinguishes 4 recognized forms of improper attribution: direct plagiarism, mosaic plagiarism, unacceptable paraphrasing, and insufficient acknowledgement. Examples are given that explain the various forms of plagiarism. The course's instructional designer and developer, Donna Stewart, RN, MEd, says that "mosaic plagiarism refers to the lifting of words and ideas from the original text and incorporating them within your own work, creating a confusing mix that leaves the reader wondering which work belongs to which author." Participants learn how to maintain distinctions between one's own work and the work of others—an important facet of citing works properly. The ideas of others must be credited, and authors are responsible even for unintended instances of plagiarism.

The final lesson, "The Internet," addresses problems with materials accessed online, informs participants about how to adapt text and graphics for citation purposes, and presents advice on how to protect one's own information once it has been posted. Most journals are published in both electronic and print versions, which are subject to the same copyright rules. Cautions about file sharing and linking to other sites increase awareness of additional online challenges. For example, providing a link to a site implies an endorsement of quality, so a writer needs to consider that implication in advance.

Throughout the course, numerous examples and sidebars containing frequently asked questions provide additional information. A post-course assessment verifies participants' comprehension of the material.

According to Ms. Stewart, "Scientific authors and publishers worldwide should realize the importance of ethical issues in publishing and the potentially high price to be paid for ignoring them." ●

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Douglas L. Mann, MD, Appointed Chief of Cardiology

at the Texas Heart Institute at St. Luke's Episcopal Hospital

Cardiologist Douglas L. Mann, MD, has been appointed the new chief of Cardiology at the Texas Heart Institute (THI) at St. Luke's Episcopal Hospital. He assumes this position from James T. Willerson, MD, who is president-elect and medical director of THI. Dr. Mann is also the chief of Cardiology, the Don W. Chapman Chair and professor of Medicine and Molecular Physiology and Biophysics, and director of the Winters Center for Heart Research at Baylor College of Medicine. His primary area of research is the molecular and cellular basis of heart failure.

"Dr. Mann is internationally respected as an educator and as a basic and clinical scientist," says Dr. Willerson. "In assuming the leadership of THI's cardiology service, he will supervise more than 125 cardiology specialists. He will be an enormous asset to THI's research and education activities, and his medical expertise will greatly benefit our patients."

HeartWATCH

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For physician referrals,
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Cover: Venetian glass lovebirds donated by Allen and Shirley Becker 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

Texas Heart Institute 6th Texas Update in Cardiovascular Advancements
Program Director: James T. Willerson, MD
March 31–April 1, 2006 • Houston, TX

Selected Upcoming National and International Meetings

International Society for Heart and Lung Transplantation 26th Annual Meeting and Scientific Sessions
April 5–8, 2006 • Madrid, Spain

American Surgical Association 126th Annual Meeting
April 20–22, 2006 • Boston, MA

American Association for Thoracic Surgery 86th Annual Meeting
April 29–May 3, 2006 • Philadelphia, PA

European Society for Cardiovascular Surgery 55th International Congress
May 11–14, 2006 • St. Petersburg, Russia

Western Thoracic Surgical Association 32nd Annual Meeting
June 21–24, 2006 • Sun Valley, ID
Abstract submission ends April 6, 2006

American College of Chest Physicians
October 21–26, 2006 • Salt Lake City, UT
Abstract submission ends April 24, 2006

American Heart Association Scientific Sessions 2006
November 12–15, 2006 • Chicago, IL
Abstract submission ends May 26, 2006

For information about the 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, please visit cme.texasheart.org

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" for 15 consecutive years.

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