VANDERBILT HEART AND VASCULAR INSTITUTE

Clinical Outcomes Report 2009

WHERE
COLLABORATION
and care meet
Collaboration is at the heart of everything we do.
At Vanderbilt Heart and Vascular Institute (VHVI) a team of physicians provide the most comprehensive services in cardiology, cardiac surgery and vascular services in the region. Vanderbilt Heart is home to an exceptionally talented and experienced group of cardiovascular providers and staff. We provide our patients with the most advanced diagnostic tools, evidence-based therapies and opportunities to participate in innovative clinical trials.

The unique collaboration among our cardiologists, surgeons, and nurses is paving the way for the future of heart care, which we believe lies in exciting developments in cardiovascular treatment and research as we strive to improve the lives of those in our community one heart at a time. This is where heart is headed.

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KEITH B. CHURCHWELL, M.D.
EXECUTIVE DIRECTOR AND
CHIEF MEDICAL OFFICER

JOHN G. BYRNE, M.D.
CHAIRMAN, DEPARTMENT
OF CARDIAC SURGERY

DOUGLAS B. SAWYER, M.D., PH.D.
CHIEF, DIVISION OF
CARDIOVASCULAR MEDICINE
LEADERSHIP Q&A

with
Keith B. Churchwell, M.D., John G. Byrne, M.D., and Douglas B. Sawyer, M.D.

WHAT MAKES VANDERBILT HEART UNIQUE?

Vanderbilt Heart is a uniquely collaborative institution. Few heart programs are fully integrated with a top-20 university that includes a basic science program, an outstanding nursing school, biomedical and chemical engineering programs, a business school with expansive health care expertise, as well as programs in research, epidemiology and global health – all within a compact geography, which facilitates interaction and collaboration. The degree of integration between the cardiovascular specialists is unique and has been key in establishing standards surrounding hybrid diagnostic and therapeutic procedures.

WHAT ARE THE MAJOR ACCOMPLISHMENTS AT VANDERBILT HEART SINCE ITS INCEPTION?

We have changed the nature of cardiology and cardiac surgery at Vanderbilt from a low volume practice to a vibrant program that is becoming the preferred provider of cardiac services in the region. This explosive growth has occurred without disrupting the culture of collegiality that is important to our success and our academic programs. The growth in clinical volume has, in fact, fueled the growth in the academic mission, training opportunities and attracting trainees of the highest caliber.

WHAT IS YOUR VISION FOR THE NEXT 10 YEARS?

A major goal is to become a recognized center for generating new ideas, new therapies, and their application in clinical practice. Given the resources we enjoy, we expect this to occur in several areas, including new pharmacologic therapies, personalized medicine, devices for diagnosis and treatment of heart disease, health care informatics and communication, outcomes research and cell and regenerative therapy. We will be introducing hybrid revascularization and transcatheter valve programs and exploring advances in cardiac transplantation devices. For multiple reasons we are poised to make an impact in the biological side of personalizing medicine. We have a dedicated and committed group of nurses who set our standards around personalized medicine. We make continuous improvements in our electronic medical record and the IT resources that allow us to understand the process of care and to test the ability of interventions to improve on it. We will embark on database and large population-based studies. We are committed to improving the health disparities that limit access to, and the delivery of, care for cardiovascular disease.
Additional locations for our clinics, like Vanderbilt Health One Hundred Oaks, provide convenient care to those who need it most.
2009 YEAR AT A GLANCE

Vanderbilt University Medical Center was named one of the nine research hubs of the National Heart, Lung and Blood Institute Progenitor Cell Biology Consortium, a seven-year, $170 million research initiative to develop the field of stem and progenitor cell tools and therapies.

- Vanderbilt’s Heart and Heart Surgery specialty was ranked #17 by *U.S. News and World Report* in 2009.
- Castle Connolly named Vanderbilt Heart and Vascular Institute one of the best hospitals nationwide for coronary bypass surgery, the most common procedure performed as a result of heart disease. Vanderbilt is the only heart center in Tennessee named to the list.
- Vanderbilt University Medical Center was recognized for the second year among the top 100 U.S. hospitals that are setting the nation’s benchmarks for cardiovascular care in a study by Thomson Healthcare.
- Vanderbilt Heart STEMI Network and Vanderbilt Department of Emergency Medicine co-hosted the first Acute Cardiac Emergency Conference in November 2009. The conference provided information to 100 community physicians and pre-hospital personnel on the latest technical details, pharmacological therapies and interventional and early surgical management and latest procedural options. Amal Mattu, M.D., associate professor at the University of Maryland and a nationally recognized author, was the keynote speaker. The second annual Acute Cardiac Emergency conference is scheduled for Oct. 16, 2010.
- The Vanderbilt Transplant Center had one of its best years in terms of volumes and patient outcomes. During the calendar year 2009, a total of 638 solid organ transplants were performed — including 36 heart and 16 lung transplants.
- The Vanderbilt Valve Symposium, “21st Century Techniques for Complex Valve Surgery,” was held in October 2009 at Vanderbilt University. Sponsored by the Department of Cardiac Surgery, the surgical technique conference was attended by cardiovascular surgeons, cardiologists, anesthesiologists, residents and fellows and other health care professionals from around the country involved in the care and treatment of patients with valvular cardiovascular disease.
- Nancy Brown, M.D., and Tadashi Inagami, Ph.D., received awards at the 63rd High Blood Pressure Research Conference sponsored by the American Heart Association (AHA). Brown received the Harriet Dustan Award, which recognizes female investigators who have made...
More rapidly than in any other field of medicine, the treatment of heart disease has been transformed by extraordinary advances in basic and clinical science. Vanderbilt Heart provides an opportunity to bridge not only the two arms of science, but to improve the ways researchers and clinicians interact to increase the efficiency and effectiveness of what we do. We have achieved a real partnership between the providers, whether they are physicians, nurse practitioners or nurses, and the researchers in the labs in a way that was not possible before.
### SUMMARY OF FISCAL YEAR

**2007 — 2009**

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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</thead>
<tbody>
<tr>
<td>Total Inpatient Discharges</td>
<td>5,222</td>
<td>5,769</td>
<td>5,838</td>
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<tr>
<td>Total Patient Days</td>
<td>22,993</td>
<td>25,432</td>
<td>26,607</td>
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<tr>
<td>Average Length of Stay (Days)</td>
<td>4.40</td>
<td>4.41</td>
<td>4.57</td>
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<td>Total Clinic Visits</td>
<td>56,975</td>
<td>61,844</td>
<td>70,748</td>
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<tr>
<td>Percutaneous Coronary Interventions</td>
<td>1,877</td>
<td>2,350</td>
<td>2,884</td>
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<tr>
<td>Echocardiogram Cases</td>
<td>11,460</td>
<td>13,031</td>
<td>15,991</td>
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<tr>
<td>Exercise Lab Studies</td>
<td>5,169</td>
<td>6,642</td>
<td>5,800</td>
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<tr>
<td>Myocardial Perfusion Cases</td>
<td>3,625</td>
<td>4,063</td>
<td>3,560</td>
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<tr>
<td>Cardiac Cath Lab Cases</td>
<td>N/A</td>
<td>5,867</td>
<td>5,902</td>
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<tr>
<td>Electrophysiology Cases</td>
<td>1,141</td>
<td>1,310</td>
<td>1,565</td>
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<tr>
<td>Cardiac Surgical Operations</td>
<td>1,006</td>
<td>1,150</td>
<td>1,242</td>
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<tr>
<td>Vascular Surgeries</td>
<td>1,249</td>
<td>1,151</td>
<td>927</td>
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<tr>
<td>Cardiac Surgery Operating Rooms</td>
<td>2</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Hybrid OR Surgery Suites</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Cath &amp; EP Labs</td>
<td>6</td>
<td>6</td>
<td>6</td>
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<tr>
<td>Total Cardiac Inpatient Beds</td>
<td>88</td>
<td>86</td>
<td>83</td>
</tr>
<tr>
<td>Total Cardiac Outpatient Exam Rooms</td>
<td>59</td>
<td>59</td>
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</table>
Vanderbilt Heart has made remarkable progress in developing a comprehensive quality program infrastructure that allows us to achieve and sustain performance in publicly reported quality measures, while providing a process to identify quality issues, adopt and accelerate change, and develop a culture of quality and safety throughout the organization.

The Vanderbilt Heart Quality Council is composed of physician, nursing and administrative leaders from all major clinical programs and areas, and is facilitated by the Vanderbilt Heart quality specialist and quality director. It provides a forum to share progress on quality performance and identify and prioritize new quality initiatives. It also helps us to align quality efforts with the goals and objectives of Vanderbilt University Medical Center, and maintain accountability with Medical Center leadership for our quality goals.

A new innovation in our quality program is the ImPaCT committee, which stands for Improving Patient Care Together. This is a biweekly meeting of physician leaders, nurse managers, and administrators that reviews all major adverse events, patient deaths, and contemporary patient safety issues, and facilitates rapid cycle quality improvement and patient safety efforts. It also serves as a vital link to our morbidity and mortality conferences in cardiology, cardiac surgery, and anesthesia-critical care, allowing us to “close the loop” on quality and safety issues.

Vanderbilt Heart has maintained our Joint Commission acute myocardial infarction composite score performance (defined as the percentage of eligible patients that received all applicable core measure interventions) at 96 percent. We also achieved substantial improvement in our heart failure composite score, increasing from 73 percent in the 2007 academic year, to 83 percent for the 2008 academic year. For the last six months of 2009 our composite score improved to 90 percent.

Examples of quality initiatives developed over the past year:

- The Heart Failure team in collaboration with the Department of Biomedical Informatics has developed a heart failure dashboard that automatically compiles and displays key clinical information in the electronic medical record for patients enrolled in the heart failure clinics.
- Our offsite ambulatory clinic staff developed a project to hardwire the process of medication reconciliation. Follow-up audits after project implementation have shown 98 percent compliance with medication reconciliation for patient encounters.
- To minimize the risks of transport, the CVICU team developed a “transport time-out” checklist for nurses to use prior to leaving the unit with a patient.
- The Cardiac Surgery team in collaboration with anesthesia-critical care, nursing, pharmacy and cardiology has developed a structured multidisciplinary and patient/family inclusive rounding program that facilitates communication between health care team members, patients and families.
### Clinic Visits

<table>
<thead>
<tr>
<th>Program Type</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemic</td>
<td>9,937</td>
<td>10,981</td>
<td>11,362</td>
</tr>
<tr>
<td>Interventional</td>
<td>5,879</td>
<td>7,281</td>
<td>7,631</td>
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<tr>
<td>Arrhythmia/EP</td>
<td>4,711</td>
<td>4,272</td>
<td>4,910</td>
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<tr>
<td>Vascular Surgery</td>
<td>3,427</td>
<td>3,435</td>
<td>3,568</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>3,177</td>
<td>4,231</td>
<td>4,224</td>
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<tr>
<td>Cardiac Surgery</td>
<td>1,517</td>
<td>1,685</td>
<td>1,851</td>
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<tr>
<td>Prevention</td>
<td>839</td>
<td>950</td>
<td>934</td>
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<tr>
<td><strong>Total</strong></td>
<td>29,487</td>
<td>32,835</td>
<td>34,480</td>
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### Discharges

<table>
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<tr>
<th>Program Type</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemic</td>
<td>1,363</td>
<td>1,603</td>
<td>1,444</td>
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<tr>
<td>Interventional</td>
<td>1,200</td>
<td>1,272</td>
<td>1,575</td>
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<tr>
<td>Cardiac Surgery</td>
<td>1,057</td>
<td>1,215</td>
<td>1,258</td>
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<tr>
<td>Arrhythmia/EP</td>
<td>558</td>
<td>349</td>
<td>389</td>
</tr>
<tr>
<td>Vascular Surgery</td>
<td>524</td>
<td>476</td>
<td>407</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>520</td>
<td>854</td>
<td>765</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,222</td>
<td>5,769</td>
<td>5,838</td>
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</table>

### Heart Transplant Volumes

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>36</td>
</tr>
<tr>
<td>2008</td>
<td>25</td>
</tr>
<tr>
<td>2009</td>
<td>16</td>
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</table>
John G. Byrne, M.D., chairman, Department of Cardiac Surgery (left), and David Zhao, M.D., director, Cardiac Catheterization Lab
Early graft failure is an important clinical endpoint and has an important impact on long-term survival. David Zhao, M.D., associate professor of Medicine and Interventional Cardiology and director of the Cardiac Catheterization Laboratory, and colleagues reported their experience with routine completion angiogram after CABG and simultaneous hybrid/CABG percutaneous coronary intervention (PCI) at the ACC meeting in 2009. They followed with a publication of these results in the Journal of the American College of Cardiology. “We believe this may result in improved short-term and long-term graft patency,” said John G. Byrne, M.D., chairman, Department of Cardiac Surgery.

Except for CABG surgery, every major cardiovascular intervention historically has been accompanied by before-and-after images to document procedural success. Vanderbilt’s hybrid OR, which combines the tools of a cardiac catheterization lab and an operating room into one procedural suite, is perfectly suited for completion angiography.

“What we have described is a very simple idea: measuring what we do. We have created an environment to give surgeons immediate feedback regarding graft quality. Today, in the collaborative culture we have created at Vanderbilt Heart, this is not just possible, but routine,” Byrne said.

The study team collected data on 336 consecutive patients who underwent CABG surgery either by conventional surgical bypass or hybrid CABG and percutaneous intervention. An interventional cardiologist performed coronary graft angiography. If the angiogram identified defects, the physician made revisions, either surgically or percutaneously. They repeated the angiography to ensure correction of these defects before closing the chest.

Among the 796 CABG grafts, 72 (9 percent) angiographic defects were identified. Defects included chest tube obstruction and kinks in vein grafts.

The authors believe that routine completion graft imaging should eventually become the standard of care in CABG surgery, but it is only possible by combining the tools of surgery with the tools of interventional cardiology.

A second focus of the study looked at whether conventional CABG patients had different outcomes than patients in whom the hybrid approach was used. The mortality rate was no different between the two groups.

“At Vanderbilt, we combined the best of both worlds by doing hybrid revascularization. This study not only provides the compelling evidence that the hybrid approach is feasible and safe, but embodies the collaborative efforts from many disciplines in the Vanderbilt Heart and Vascular Institute,” Zhao said.

“This collaboration symbolizes who we are and what we stand for. Those who benefit the most are undoubtedly our patients.”
He is a heart failure specialist whose clinical interest is cardio-oncology.

“It is clear there is a substantial overlap between cardiology and oncology with regards to patient care and management decisions,” Lenihan said.

“These two disciplines will continue to have extensive overlap because the targets for ‘personalized therapy’ are identical between them.”

As an example, he said the development of new cancer drugs with anti-angiogenic effects will likely have important cardiovascular implications. Similarly, stem cell therapy, a mainstay for treating certain hematologic malignancies, is also being studied as a way to repair cardiac cells that are damaged by ischemic heart disease.

“My true passion has always been in treating, detecting and preventing heart failure. What I really like is how much of what we do can affect patients. If the problem is untreated, undiagnosed or not considered, then it can have a dramatic impact on those patients,” he said.

It is not uncommon for cardiologists and oncologists, who are focused on their respective patients and disciplines, to fail to communicate effectively. Vanderbilt’s collaborative culture is one of the many factors that attracted Lenihan.

“Patients don’t choose to have more than one problem, but they frequently do. Whether their problem was caused by their cancer treatment or whether it pre-existed, I would say that 30 percent to 40 percent of cancer patients suffer from some form of heart disease. Our goal is to treat cancer most effectively by managing or eliminating heart problems as a complicating factor.”

Lenihan is overseeing a multi-center trial using biomarkers to predict cardiac damage in patients undergoing chemotherapy.

“My true passion has always been in treating, detecting and preventing heart failure. What I really like is how much of what we do can affect patients.”

“Conventional methods have limitations on how well they detect problems. Biomarkers are a better indicator, and are also cheaper and easier. With a simple blood draw we look for BNP and troponin and other markers of heart damage. If they are elevated during chemotherapy, it tells us there is early damage to the heart not detected by standard echocardiography or other tests,” he said. “We can intervene at the earliest point to protect the heart.”

As director of Clinical Research for the division, Lenihan will oversee more than 100 clinical research protocols.
**THE GREATEST JOB IN THE WORLD**

Former heart patient inspired to become cardiac nurse

Holly Pierce, ANP-BC was born with a host of heart problems.

But as it turns out, those problems have shaped her life in the most positive way possible. She is now an advanced practice nurse at the Vanderbilt Heart and Vascular Institute, caring for patients with the same conditions she had as a child, and working alongside one of the physicians who performed surgery on her three decades ago.

Pierce first came to Vanderbilt when she was 11 days old, in 1975, with a heart defect, setting the foundation for a lifelong relationship between Pierce, her physicians and VUMC.

As a newborn, Pierce became a patient of pediatric cardiologist Thomas Graham, M.D., who would continue to treat her until he retired two years ago.

She underwent the first of three operations at the hands of cardio-thoracic surgeon Harvey Bender, M.D. Bender repaired a co-arctation, or narrowing, of her aorta, closed a hole in her heart and performed a pulmonary artery banding to reduce blood flow and pressure in Pierce’s lungs. During that operation, he discovered that she had two additional holes in her heart, which eventually closed on their own.

Two and a half years later, Pierce, then a blond haired, blue-eyed toddler, returned to Vanderbilt to have the pulmonary artery banding removed.

Then, in 1980, at age 4 1/2, she had another repair of her co-arctation. Once again, Bender was the attending surgeon, but this time he had help from his chief resident, Michael Petracek, M.D.

Not long after her arrival as a nurse practitioner at the Vanderbilt Heart and Vascular Institute, Pierce realized she was working on the same floor of Medical Center East as Petracek, now professor of Clinical Cardiac Surgery. The two recently reunited, and Pierce described the meeting as surreal.

“It’s where I was meant to be,” she said. Since he operated on Pierce in 1980, Petracek estimates that he has performed 7,000 to 8,000 heart procedures. It’s understandable that he doesn’t remember her specific case, but he said he is always happy to be reunited with a former patient, which happens frequently given the number of patients he has cared for over the years.

“I am glad to have Holly working at Vanderbilt Heart,” he said.

Pierce said her decision to become a nurse was influenced by her childhood exposure to the Vanderbilt nurses. Despite her early health problems, Pierce has lived an active, healthy life and is grateful for the opportunity to give back and to thank those who took care of her all those years ago.

“I feel very blessed to be working for this institution. This place has a very special place in my heart,” she said.
**OBSERVED TO EXPECTED (O/E) RATIO 2009**

<table>
<thead>
<tr>
<th>Program</th>
<th>O/E Ratio</th>
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<tbody>
<tr>
<td>Cardiology Program Overall*</td>
<td>0.67</td>
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<tr>
<td>Arrhythmia</td>
<td>0.80</td>
</tr>
<tr>
<td>General Cardiology</td>
<td>0.52</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>0.80</td>
</tr>
<tr>
<td>Interventional Cardiology</td>
<td>0.92</td>
</tr>
<tr>
<td>Vascular Surgery*</td>
<td>0.80</td>
</tr>
<tr>
<td>Cardiac Surgery Overall**</td>
<td>0.87</td>
</tr>
<tr>
<td>CABG</td>
<td>0.66</td>
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* Based on MS-DRG grouping from UHC Clinical Database
** Based on STS National Database, annualized

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**STEMI NETWORK**

Collaboration between the Division of Cardiology and the Emergency Department was key to achieving excellent door-to-balloon (D2B) times for the past year. D2B measures the time of a patient’s arrival in the Emergency Department to the opening of the blocked coronary artery with a balloon catheter, also known as percutaneous coronary intervention (PCI).

For 2009, Vanderbilt had D2B times of 90 minutes or less for 100 percent of patients. The median D2B time was 58 minutes. The national standard set by the American College of Cardiology Door-to-Balloon (D2B) Alliance recommends 90 minutes or less for 75 percent of patients receiving PCI.

“I am extremely proud of this accomplishment. It is the result of dedication and teamwork and a commitment to providing outstanding care to our heart patients,” said Joseph Fredi, M.D., assistant professor of Medicine and director of the STEMI Network, Vanderbilt’s rapid response program for heart attack patients, specifically those with ST elevated myocardial infarction.

“The faster we can open a blocked artery, the less damage to the heart, which results in lives saved.”

www.VanderbiltSTEMI.com

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**CAROL R. SCOTT, FNP-BC**

**TITLE** Family Nurse Practitioner
Coordinator, Vanderbilt STEMI Network

**PATIENT CARE EMPHASIS** Cardiology

**EDUCATION**
- B.A. Randolph College, 1989;
- B.S.N. University of Tennessee, Knoxville, 1992;
- M.S.N. Vanderbilt University, 1996

**BACKGROUND** Staff RN CVICU, FNP in Primary Care Clinic, Cardiology NP in Cardiology Practice

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**JOSEPH L. FREDI, M.D.**

**TITLE** Assistant Professor of Medicine

**SPECIALTY** Interventional Cardiology and Valvular Heart Disease

**EDUCATION**
- M.D. Degree - University of Tennessee College of Medicine, 1983;
- Internship - University of Rochester Medical Center, 1984;
- Residency - University of Rochester Medical Center, 1987;
- Fellowship - Vanderbilt University Medical Center, 1990
Emily Kurtz, M.D., director of the cardiovascular prevention program
The general clinical cardiology program under the direction of Keith Churchwell, M.D., continued to experience significant growth in volume in 2008 - 2009.

**Clinical Services**

**General Cardiology**

The general clinical cardiology program under the direction of Keith Churchwell, M.D., continued to experience significant growth in volume in 2008 - 2009.

**Highlights Include:**

- Expansion of the clinical cardiac service to include a large off-campus location in Nashville (Vanderbilt Health One Hundred Oaks). We also opened additional cardiac satellite clinics in Livingston, Johnson City and Knoxville, Tenn.
- The addition of 22 stepdown cardiovascular beds in December 2009
- The addition of a night Nurse Practitioner service to help enhance patient management for the 24/7 care cycle

**The Goals for 2010 Include:**

- Quality /Safety Initiative with a goal of defining Vanderbilt Heart as the safest cardiology program in the country
- Expansion of the diagnostic imaging service with the addition of 3-D echocardiography to help in the evaluation of structural heart disease
- Formation of clinical and research groups at Vanderbilt Heart concentrating on Hypertrophic and Peripartum Cardiomyopathy, their identification and treatment

**Prevention and Lipid Program**

The Vanderbilt Heart Preventive Cardiology and Lipid programs were created to bring the best in evidence-based preventive care to our patients. The program is designed to evaluate the risk for heart disease or recurring heart and vascular problems. Using the most advanced techniques, our heart specialists determine what is best for each person's unique needs. Our personalized approach combines heart healthy lifestyle strategies with appropriate medications, if needed.

Our prevention screenings include state-of-the-art and traditional tests to identify risks of heart and vascular disease. These include:

**Laboratory Date (Biomarkers)**
- Comprehensive lab assessment
- Complete fasting lipid profile
- Lipoprotein
- High sensitivity C-reactive protein
- Fibrinogen

**Cardiac Screening Tests**
- Electrocardiogram
- Exercise treadmill test
- Coronary artery calcium score

**Peripheral Vascular Screening Tests**
- Ankle brachial index test
- Carotid artery ultrasound
- Abdominal aorta ultrasound
## CARDIAC MRI

The Cardiac MRI program, led by Mark Lawson, M.D., oversees the training of five cardiac fellows and partners with the Department of Radiology to perform magnetic resonance angiography studies. Vanderbilt’s is the only dedicated in-hospital Cardiac MRI in Tennessee. This quality care provides optimal telecommunications of cardiac structure and function.

The ability to precisely define structural abnormalities in the heart along with a precise evaluation of pathology involving the mitral and aortic valve has been extremely important in coordinating care for patients on the cardiology service. Cardiac MRI has become an important standard for the detailed evaluation of myocardial viability in the setting of complex and severe ischemic heart disease and cardiomyopathy.

An important direction for the clinical use of MRI in the coming year will be an expansion in its use for the evaluation of myocardial ischemia in the appropriate patient population.

There will be multiple clinical studies ongoing throughout the year. It will play a vital role in the evaluation of myocardial function and viability that will be important in identifying patients in need of revascularization, device therapy, and aortic valve replacement.

## NUCLEAR AND ECHO CARDIOLOGY

### NUCLEAR

Under the direction of Marvin Kronenberg, M.D., and Keith Churchwell, M.D., the Vanderbilt Heart Nuclear Cardiology program employs three gamma cameras and offers same day or next day service. The laboratory is accredited by ICANL and has continued the practice of routine single isotope studies, reducing the amount of radiation exposure to patients. A Rubidium-PET imaging program runs in collaboration with our colleagues in the Department of Radiology and Radiological Sciences, providing high quality perfusion imaging, which is especially useful for heavy patients, or for those who also require a near-simultaneous myocardial viability study.

### SEVERAL ONGOING RESEARCH PROJECTS INCLUDE:

- The role of inflammation (judged by fluorodeoxyglucose uptake on PET scans) in the expansion of abdominal aortic aneurysms
- Evaluation and reduction of energy starvation in patients with dilated cardiomyopathies (using PET and cardiac MRI)
- The role of attenuation correction in accurately identifying ischemia and infarction on standard SPECT images
- Evaluation of the usefulness of CT coronary angiography compared to standard nuclear stress imaging in patients with suspected coronary artery disease

### ECHOCARDIOGRAPHY

The Vanderbilt Echo Laboratory was the first in Tennessee to be accredited by ICAEL, and accreditation was granted for a second time in 2007. Active initiatives in quality assurance continue, according to ICAEL guidelines.

This program includes periodic peer review of study performance and interpretation. Ongoing updating of echo equipment continues, maintaining state-of-the-art imaging capabilities. Increasingly, the lab and its staff are involved in monitoring catheter-based cardiac interventions, and also in assessing LV dysynchrony before and after biventricular pacing.

### MRI CASE VOLUME FOR CALENDAR YEAR 2009

<table>
<thead>
<tr>
<th>Total MRI Cases</th>
<th>Cardiac MRI Cases</th>
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</thead>
<tbody>
<tr>
<td>2,383</td>
<td>1,183</td>
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</table>
We achieved 100 percent door-to-balloon time for acute ST elevation myocardial infarction <90 minutes. Median D2B is 58 minutes, within the top tier in the nation. Our STEMI network covers more than a dozen community hospitals and provides exceptional service to the communities covering three states.

We are funded by the National Institutes of Health for both clinical research (Cardiac Cell Therapy Research Network) and basic research (recently funded) for cardiac stem cell therapy. We formed the Center for Cardiac Regenerative Medicine. Clinical trials have been expanded to four projects including patients with acute myocardial infarction.

We expanded our interventional program for patients with hypertrophic cardiomyopathy (ETOH septal ablation).

We continue to expand the Vanderbilt multifunctional percutaneous heart program to cover bedside emergent ECMO in CCU, lung transplant, high-risk percutaneous coronary intervention and cardiogenic shock.

We continue to achieve high quality outcomes for ASD and PFO closure.

We expanded our interventional valve programs to include percutaneous valvuloplasty for mitral and aortic valves.

With close collaboration between Cardiac Surgery and Interventional Cardiology, we have been selected to be one of the sites to conduct percutaneous transcatheter aortic valve replacement studies.

We initiated a clinical trial for percutaneous left atrial appendage occlusion versus Coumadin therapy in patients with atrial fibrillation.
The Vanderbilt Autonomic Dysfunction Center was established in 1978 as the first international center for patient care, research and training, focusing exclusively on disorders of the autonomic nervous system.

Its creation brought together in one site a cadre of physicians, scientists and nurses who could foster a balanced scientific approach to education of the etiology and optimal therapy of these disorders. Over the years, many people have contributed to this effort at Vanderbilt. Many of the young scientists and physicians who have trained here have gone out and established similar centers in other parts of the world.

Others have taken positions at academic research centers and pharmaceutical firms where they are seeking improved drugs to treat these disorders.

Italo Biaggioni, M.D., professor of Medicine and Pharmacology, has research published on adenosine, nitric oxide and autonomic interactions in cardiovascular regulation. David Robertson, M.D., Elton Yates Professor of Medicine, Pharmacology and Neurology, has research published in autonomic nervous system, blood pressure regulation, noradrenergic neuronal function, catecholamines, neurodegenerative disease, gastropressor response to water ingestion.

In 2008, the Vanderbilt Center for Atrial Fibrillation opened in the Vanderbilt Heart and Vascular Institute. Its goal is to provide state-of-the-art care for patients with atrial fibrillation, bringing together the best throughout the Heart and Vascular Institute in the areas of clinical care, research and teaching.

Highlights:

The cornerstone of the Center for Atrial Fibrillation is our multi-specialty Atrial Fibrillation Clinic, where patients can be seen in consultation and followed by electrophysiologists and cardiac surgeons together to provide one stop consultation and treatment options for this challenging disease.

Our electrophysiologists perform catheter-based ablation for atrial fibrillation. They utilize state-of-the-art mapping systems including Nav-X and Cartos to guide therapy, with excellent clinical results.

Steven Hoff, M.D., and Patrick Whalen, M.D., have combined efforts to perform minimally invasive ablative procedures in the hybrid lab that optimize the use of surgical and percutaneous techniques for refractory fibrillation. This is one of the few centers in the world using this combined technique to treat this rhythm.
The Vanderbilt Arrhythmia Section is committed to utilizing modern technology to provide excellence in patient care, research and education in cardiac electrophysiology, serving as a center of excellence for the management of cardiac arrhythmias in the Southeast region.

The service includes:

- Dedicated state-of-the-art electrophysiology and device implantation laboratories that include 3-D mapping systems and intracardiac echocardiography for ablation of complex atrial and ventricular arrhythmias
- Arrhythmia and Device Hospital Consultation Services
- Vanderbilt Heart Arrhythmia Clinic, which includes outreach locations at Vanderbilt Health One Hundred Oaks in Nashville, as well as offices in Columbia, Tenn., and Franklin, Tenn.
- Vanderbilt Heart Center for Atrial Fibrillation
- Vanderbilt Heart Genetic Arrhythmia Clinic (as part of the Center for Inherited Heart Disease)
- State-of-the-art heart rhythm monitoring, including ECG, Holter monitors, event recorders and implanted recorders
- World class autonomic nervous system function testing along with full-service tilt table testing, including continuous blood pressure and transcranial Doppler monitoring
- More than 100 laser lead extractions performed annually with an exceptionally low incidence (<0.5%) of serious complications
- The Hybrid-Atrial Fibrillation Program, launched in December 2009

The Vanderbilt Heart Center for Atrial Fibrillation provides a unique multidisciplinary team approach to treating patients with atrial fibrillation.

These approaches include:

- Catheter-based ablation
- Hybrid (endocardial and epicardial) minimally invasive surgical approach for management of atrial fibrillation
- Full spectrum of surgical approaches (maze, modified-maze, mini-maze, minimally invasive epicardial approaches)
- Availability of screening for atrial fibrillation susceptibility genes
- Access to new anti-arrhythmic and non-anti-arrhythmic drugs
- Novel anti-coagulation therapies for atrial fibrillation
- Percutaneous treatment for ablation for refractory ventricular tachycardia and persistent, symptomatic ventricular ectopy.

Our physicians performed more than 120 atrial fibrillation ablation procedures last year; the vast majority of these patients were atrial fibrillation-free during the 18-month follow-up.

**ICD Implantations (Cases)**

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<thead>
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<th>Year</th>
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<tbody>
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<tr>
<td>2008</td>
<td>438</td>
</tr>
<tr>
<td>2009</td>
<td>465</td>
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**Pacemaker Implantation (Cases)**

<table>
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<tbody>
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<td>2007</td>
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<td>2008</td>
<td>392</td>
</tr>
<tr>
<td>2009</td>
<td>456</td>
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</table>
Patrick Whalen, M.D., implants a device to remotely monitor a patient’s heart rhythm.
The Heart Failure program experienced substantial growth in patient volume in 2008-2009. In addition to comprehensive inpatient and outpatient services, the program supports several clinical studies of stem cell therapies, novel pharmacological agents, heart failure care delivery systems and exercise training.

**Highlights**

- The Heart Failure Longitudinal Disease Management program continued steady growth in enrollment and staffing.
- The Inherited Heart Disease Clinic, a joint venture between faculty in Heart Failure, Electrophysiology and Pediatric Cardiology, provided sophisticated molecular diagnostics and clinical services to patients and families with familial heart diseases.
- The Left Ventricular Assist Device Program expanded its repertoire to include HeartMate II devices.
- The Advanced Heart Failure and Heart Transplant program extended outreach to East Tennessee, a great convenience to patients and their families.
- The Heart Failure patient registry began.
- Planning phase of our dedicated heart failure inpatient unit was completed, and opened in January 2010.
- A multidisciplinary intervention to reduce hospital readmission for heart failure was designed.
- An electronic data dashboard was established to permit “remote” identification of heart failure patients throughout VUMC.
- Daniel Lenihan, M.D., and Carrie Geisberg, M.D., joined the heart failure faculty.

**Plans for the Heart Failure Program 2010:**

- Continued development of the distinct service lines that involve multidisciplinary teams, including a Cardio-Oncology Clinic, and a dedicated inpatient facility for care of patients with heart failure.
- Further expansion of heart failure disease management, including computerized patient identification and management tools.
- Expansion of clinical research and trial offerings for Vanderbilt Heart’s patients.
- Expansion of clinical outreach programs with the eventual aim of providing heart failure and transplant services to the entire region.
Rather than undergo an invasive procedure in the catheterization lab, heart transplant patients at Vanderbilt University Medical Center now have the option of having a simple blood test to monitor signs of rejection — a technique that is getting favorable reviews from clinicians and patients alike.

AlloMap testing, created by molecular diagnostics company XDx, looks for genes associated with an increased risk of heart rejection, said Mark Wigger, M.D., medical director of the heart transplant program at the Vanderbilt Transplant Center (VTC).

Vanderbilt was the first center in the state to use the new monitoring tool.

“This testing modality is now being used throughout the country at 15-20 centers,” said Wigger. “Although this is not a perfect test, it is a rather accurate predictor that there is no presence of ACR (acute cellular rejection) or high-grade rejection.

“The patients absolutely love it,” said Wigger. “It is a much easier process, more comfortable and costs less. It is a quality of life issue. The tests are done every 4-6 months.”

Previously, the only means to monitor rejection was through an endomyocardial biopsy. Traditionally, patients would have more than 20 biopsy procedures during the first year after their heart transplant, eventually tapering down to two or three a year for the rest of their lives.

Recently the FDA approved the use of AlloMap testing in patients who are at least six months post transplant. VTC only allows the new testing on patients who are at least two years post transplantation.

“The risk of rejection is a lot lower two years out, while the risk of complications from a biopsy is higher the further out a patient is from transplant,” said Wigger. “So it’s a calculated risk. I am sure we will begin to move back our time frame, but for now our patients are happy and we are very pleased with the outcomes.”

Wigger anticipates that researchers will identify more genes specifically targeting low-grade rejection in the hope that clinicians will be able to rely on AlloMap testing and resort to biopsy methods under extreme circumstances. In an effort to better serve patients, specialized labs have been opened in Memphis and Knoxville for AlloMap testing.

Vanderbilt recently developed an extensive outreach program in Johnson City, Knoxville and Lebanon with locations in Jackson and Hopkinsville, Ky., in the works.

“There are times when a patient cannot get back to VTC,” said Wigger. “We are able to offer this convenience in their own communities. This way they can stay with their own primary care physician and cardiologist and we provide community physician counseling and guidelines so that the local doctors will have a better understanding of post transplant complications and how we can work together.”

Heart transplants at VTC are seeing a marked increase. There were 22 heart transplants performed during fiscal year 2008, up from 13 in fiscal year 2007.

“We have grown into a coalesced team with good transplant and surgical experience and a nationally recognized advanced heart failure program,” said said Steven Hoff, M.D., assistant professor of Cardiac Surgery. “We have improved and have exceptional patient survival and quality of life outcomes. We are giving patients more options to bridge them to transplant, or some kind of recovery without transplant, through newer technologies.”
In 2009, the Vanderbilt Heart Transplant team performed 36 heart transplants, including 15 adult transplants and 21 pediatric transplants.

**HIGHLIGHTS:**

With FDA approval for the newest generation of long-term mechanical assist devices, Vanderbilt joined other high-end transplant programs around the country and began successfully implanting these devices.

Daniel Lenihan, M.D., professor of Medicine, joined the Advanced Heart Failure Team. He came to Vanderbilt from the University of Texas M.D. Anderson Cancer Center, and his areas of clinical interest are advanced heart failure and cardio-oncology. Lenihan will serve as the director of clinical research for the Division of Cardiology.

Vanderbilt’s team continued to extend its experience with alternative mechanical support using axillary intra-aortic balloon counter pulsation. The device provides excellent, cost-effective mechanical support for the failing left ventricle and allows patients to get out of bed and ambulate, not generally feasible with other short-term assist devices. Patients are better candidates for transplantation with improved clinical status. Our team successfully bridged several patients to transplantation using this technique in 2008.

In cooperation with the Oncology service, our advanced heart failure team is actively involved in experimental protocols utilizing stem cells to treat heart failure. This exciting line of investigation may bring significant advances in the areas of chronic congestive heart failure and affect the need for transplantation.

### 2009 GRAFT SURVIVAL RATE
*Actuarial as of January 5, 2010*

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<th>PEDIATRICS</th>
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<tr>
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<td>86.66%</td>
<td>100.00%</td>
<td>97.44%</td>
</tr>
<tr>
<td>1 YEAR</td>
<td>86.66%</td>
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<td>97.44%</td>
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### 2009 PATIENT SURVIVAL RATE
*Actuarial as of January 5, 2010*

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<tbody>
<tr>
<td>1 MONTH</td>
<td>93.33%</td>
<td>100.00%</td>
<td>97.22%</td>
</tr>
<tr>
<td>1 YEAR</td>
<td>93.33%</td>
<td>100.00%</td>
<td>97.22%</td>
</tr>
<tr>
<td>TXPS#</td>
<td>15</td>
<td>21</td>
<td>36</td>
</tr>
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</table>
Several faculty presented their work at major national and international meetings, including the American College of Cardiology, the American Association for Thoracic Surgery, and the Southern Thoracic Surgical Association.

The Department of Cardiac Surgery was also chosen to be a site for the first NIH-sponsored clinical trial on hybrid coronary revascularization. This feasibility trial, sponsored by NHLBI, involves 15 major academic centers nationwide.

The department was the second largest enroller of patients in the first human clinical trial of the aortic valve Trifecta (St. Jude Medical). This new aortic prosthesis promises to be helpful in patients who may be prone to patient-prosthesis mismatch.

The department was also chosen as one of the Core Valve trial sites. This trans-catheter aortic implantation device will likely be helpful in high risk aortic stenosis patients.

**HIGHLIGHTS:**

- The hybrid operating room is a fully functional catheterization laboratory and operating room. Research activity during the last year was centered in creating the outcomes research lab within the cardiac surgery division and a “hybrid lab” focused on the outcomes in the hybrid operating room.
- We refined a technique for open heart surgery through a small (5 cm) right-anterolateral thoracotomy without the need to arrest the heart. The Vanderbilt experience with this technique was published in several peer-reviewed journals including the *Annals of Thoracic Surgery*.
- The results of the Vanderbilt minimally invasive coronary bypass surgery were presented at the Southern Thoracic Society in November 2009 and will be published in the official journal of the society (*Annals of Thoracic Surgery*).
- Our goal for 2010 is to develop an effective clinical outcomes enterprise within Vanderbilt Heart, creating the largest single-center database of cardiovascular patients modeled on the Framingham Heart Study. Our goal is to study the impact of different therapy modalities for cardiovascular patients. All Vanderbilt Heart patients will enter into the registry after giving formal consent, thus creating a database that will allow genetic testing and other tests.
The Division of Vascular Surgery continues to provide regional and national leadership in pursuit of less-invasive techniques for the comprehensive management of aortic aneurysms, carotid and peripheral arterial occlusive disease.

Particular attention is focused on the appropriate selection of patients for novel and less-invasive therapies and optimization of long-term outcomes. As the use of less-invasive initial therapies for peripheral arterial diseases has become more common, more referrals of patients who have failed such procedures are being made to Vanderbilt Heart. A new focus is being directed toward optimal remedial treatments for this complex group of patients. Members of the division continue to pursue standard operative and endovascular procedures for complex arterial and venous reconstructions.

Techniques to improve the safety and efficacy of thrombolytic therapy for both arterial and venous thrombosis include:

- Thrombolysis augmented by continuous low-frequency intravascular ultrasound, a procedure that shortens overall treatment time and dose of thrombolytic agent
- Minimally-invasive endovenous laser ablation of varicose veins and other therapeutic and venous procedures
- UHC O/E mortality is 0.80.

**Highlights:**

- Pivotal Study of the Aptus Endovascular AAA Repair System
- RNA Expression Profiling from *In Vivo* Carotid Atherectomies (REPLICA): A carotid plaque observational study
- Use of TRC Autologous Bone Marrow Cells in Patients with Peripheral Arterial Disease to Treat Critical Limb Ischemia
- Evaluation of Conformable Thoracic Endoprosthesis for Treatment of Traumatic Transection of the Descending Thoracic Aorta – enrolling
- Endovascular Repair Using the Talent Stent Graft in Abdominal Aortic Aneurysms – enrolling
- Carotid Stenting for High Surgical-Risk Patients. Evaluating outcomes through collection of clinical evidence. (CHOICE)
A variety of heart and vascular diseases are inherited, affecting multiple members in a single family. For example, the No. 1 cause of sudden cardiac death in young athletes is a specific type of heart muscle disease called hypertrophic cardiomyopathy, which is almost always hereditary. In many cases, immediate relatives of patients with inherited heart diseases feel well, and may not recognize that they could carry the same genetic mutation that puts them at an increased risk of heart failure and/or sudden death. In the general population, this condition affects up to one in 500 people, but in immediate family members the risk is much greater - up to one in two.

The Center for Inherited Heart Disease (CIHD), a unique joint effort by the Vanderbilt Heart and the Division of Pediatric Cardiology at Monroe Carell Jr. Children’s Hospital, provides clinical and genetic screening for inherited cardiovascular disease, and follow-up care to immediate family members who are at risk of developing the disease. The Center provides expert consultation on inherited forms of heart and vascular disease, including hypertrophic and dilated cardiomyopathies, cardiac amyloidosis, heart rhythm disorders, and inherited vascular diseases such as Marfan syndrome.

Due to medical and surgical advances over the last 50 years, more than 85 percent of people born with congenital heart disease now can expect to reach an adult age. As adults, these people have special problems that require care from health care providers with special expertise in congenital heart disease.

The Vanderbilt Heart Adult Congenital Program is dedicated to providing the expert care necessary for these adults to have the highest quality of life.

This expertise in both childhood and adult cardiology enables us to offer a comprehensive adult congenital heart program and lead the field in care, research and education. The program has continued to grow with respect to volume of outpatient evaluations, interventional catheterization, and operative management of congenital heart disease. We are staffed by a highly specialized team of cardiovascular specialists, cardiologists, electrophysiologists, cardiothoracic surgeons, adult pulmonary hypertension specialists, maternal fetal medicine/high risk obstetrics, nurses and administrative support. All of these team members are focused on the unique needs of adults with congenital heart disease.
The Division of Cardiovascular Medicine Fellowship Training Program, under the direction of Julie Damp, M.D., and Lisa Mendes, M.D., is currently training 32 clinical and research fellows.

Fellows in the program received competitive awards and grants from the American Heart Association, the American College of Cardiology, and the Heart Failure Society of America. Fellows are involved in multiple research projects, diversifying the division’s activity, including studies in molecular pharmacology, stem cell biology, advanced cardiovascular imaging of atherosclerosis and ischemia, as well as aspects of geriatric cardiology. Fellow graduates increasingly pursue academic careers upon completion of their training. Recent graduates have taken faculty positions at competitive academic institutions including Case Western Reserve University and Emory University.

We continue to attract a stellar group of clinical trainees from many of the best internal medicine training programs in the country who began their training in July 2009.

This year the division received approximately 550 applicants for eight fellowship training positions that begin in summer 2010.
Vanderbilt Heart is focusing on personalized medicine and doing the right thing for the right patient at the right time.
When cardiac patient James Nadolski was admitted to Vanderbilt, he was given a nickname that he embraced with pride: “Nine Lives” Nadolski.

Thanks to the collaborative effort of Vanderbilt cardiac surgeons and cardiologists and an arsenal of cool technology, Nadolski may just beat the odds that were stacked against him.

He suffered his first heart attack 14 years ago at the age of 37 while working as a homicide investigator in Wisconsin. He suffered another heart attack in 2009, and received two stents to open his blocked cardiac arteries. Two months later, one of his stents collapsed. This time he was in real trouble.

“There was nothing they could do for me,” Nadolski said.

He lingered near death in the ICU of a community hospital until Betty Kim, M.D., assistant professor of Cardiac Surgery, decided there was hope for him if she could get him to Vanderbilt Heart and Vascular Institute, which had all of the resources of a large academic medical center. She placed a call to Steve Hoff, M.D., assistant professor of Cardiac Surgery, who agreed to take the case.

Nadolski was admitted to Vanderbilt “on death’s doorstep,” Hoff recalls.

Nadolski immediately went to the cardiac cath lab and was placed on extracorporeal membrane oxygenation (ECMO). In the Cardiovascular Intensive Care Unit, John McPherson, M.D., assistant professor of Medicine, used the relatively new therapeutic hypothermia protocol to cool Nadolski’s body temperature to 86 degrees in order to help preserve his brain function.

Cardiac surgeons Hoff and Rashid Ahmad, M.D., and cardiologist Mark Wigger, M.D., evaluated Nadolski for heart transplant. A few days later, Hoff and Ahmad put Nadolski on the Centrimag biventricular assist device to take over the pumping of his heart while he waited for a donor heart to become available.

Nadolski developed multiple life-threatening problems, including a severe allergic reaction to heparin, which required emergency removal of his ventricular assist device. It would be up to his heart to pump on its own.

“We were unsure that we could get him through with medicines alone,” Hoff said.

Nadolski slowly improved over the next two months to the point where he could go home on milrinone infusion. Milrinone is a medication that improves hemodynamics and biventricular function in patients with congestive heart failure. Nadolski is hooked up to an IV that is stored in a backpack that he wears 24 hours a day.

“His heart has continued to slowly improve, and we are now weaning his milrinone as an outpatient,” Wigger said. “It’s possible he may get off IV medicines altogether. We’re not certain that he is stable enough that he won’t need a heart transplant, but he is remarkably better.”
Two years ago, Haffner was a healthy, active 55-year-old who loved the outdoors, particularly taking care of her horses. Then, one day she started to feel different. She was fatigued, retaining fluid, experiencing shortness of breath. Routine diagnostic testing by her physicians did not reveal the cause of her heart failure. As the months dragged on, her health deteriorated. A friend encouraged her to call Vanderbilt Heart and Vascular Institute and gave her the name of cardiologist Joseph Fredi, M.D. Fredi had a good idea what was wrong with Haffner after her first visit in July 2008.

Several tests and a biopsy later, he delivered the bad news to her as she lay in the recovery room.

Haffner has primary AL amyloidosis, a plasma cell disorder that originates in the bone marrow. Amyloidosis is typically treated the same way as cancer: chemotherapy and a stem cell transplant. Because the disease had taken up residence in Haffner’s heart, she was in heart failure.

“I asked Dr. Fredi if it was fatal, and he held back for a minute, and he said, ‘I’m afraid it could be,’” she recalled. “I said to him, ‘Well, it won’t be this time.’” Before Haffner could undergo treatment, she needed a heart transplant.

She met with a team of Vanderbilt cardiologists, surgeons and hematologists who jointly agreed to take her case despite the high risks associated with it.

“Primary AL amyloidosis is a rare and deadly disease. It is rare to get it, and rarer to survive long enough to get a heart transplant with such advanced heart involvement,” said Doug Sawyer, M.D., chief of the Division of Cardiovascular Medicine and one of Haffner’s physicians. “It is also rare to be in a part of the country where a medical center will take on this challenge.”

Haffner had a heart transplant on Nov. 29, 2008. She cleared the first hurdle in her journey back to good health. It would pale in comparison to the second.

After recovering at home, she re-entered Vanderbilt University Hospital and had her stem cells harvested.

She was admitted to the isolation unit where she stayed for 23 days. She underwent chemotherapy to kill the plasma cells in her bone marrow that were the source of the protein causing the amyloidosis, which still affected her esophagus, lungs and intestines.

She became violently ill from the effects of the powerful drugs, but she never gave up hope and would not tolerate anything but optimism from her family, friends or caregivers.

“All of my doctors exude confidence. I never had a worry. This is going to work. I know it is,” Haffner said. “I could not have gotten through this without the wonderful doctors at Vanderbilt Heart. Not only are they brilliant physicians, they are also compassionate people of great character.”
Defibrillator support group takes shock out of heart failure

On July 22, 2002, 32-year-old Carrie Romero received the shock of her life.

She had just finished performing for the first time in front of a crowd near Cinderella’s Castle at Walt Disney World. It was her dream job, and she was energized as she left the stage and walked toward the breezeway of the castle.

She could hear the celebratory fireworks that always end the show as she leaned against the wall, raised her fist in the air and was about to proclaim a triumphant “yes!” when the shock came.

At first she thought she had been hit by an errant firework, but within seconds she realized the sudden jolt she felt inside her chest was the internal defibrillator and pacemaker delivering a life-saving electrical shock to her heart. She had the device for five years, and this was the first time it had done what it was designed to do — restore a normal rhythm to her heart.

“It’s horrible. It feels like you’ve been shot by a gun. The instinct is to grab the chest and get it to stop,” Romero said.

When Romero was 28 she was diagnosed with dilated cardiomyopathy, a condition marked by an enlarged left ventricle, which leaves the heart unable to pump blood effectively. Her physician, Walter Clair, M.D., assistant professor of Medicine, told her that the best insurance policy was to get an implantable cardioverter defibrillator (ICD).

An ICD is a generator with a battery and computer circuits that is implanted in the patient’s chest or abdomen. Electrical wires run from this generator to the heart. The heart is monitored for fast rhythms, and the generator will rapidly pace or shock the heart back to a normal rhythm. It stores the information so that the doctor can review it.

Many patients say the jolt feels like a horse kick to the chest. Fear of the ICD doing its job is matched only by the fear of it malfunctioning.

To help address the concerns of patients with ICDs, Vanderbilt Heart and Vascular Institute offers a defibrillator support group — affectionately known as Vanderbilt Shockers — that meets with cardiologists and nurses.

Dawn Sabin, R.N., cardiology case manager, has spearheaded the support group since its inception in 2007.

“Having an internal defibrillator is a life-altering event as a patient,” Sabin said. “Many of the patients who come to the support group for the first time are overwhelmed by the number of people who have them. It’s a really special group to come and talk with.”

Romero joined the support group last year and was pleasantly surprised to find that other patients have similar concerns. The participants share their fears, ask questions of physicians and listen to guest speakers.

“I think the benefit is to know there are other people going through what you’re going through,” she said.
Our scientists participate in more than 100 ongoing studies and receive more than $10 million in extramural research funding.
Hybrid coronary revascularization (HCR) is the combination of coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI). The HCR strategy combines grafting of the left anterior descending artery (LAD) coronary artery using the left internal mammary artery (LIMA) and PCI of non-LAD coronary stenoses. Essentially, stents are substituted for saphenous vein grafts (SVG) for non-LAD lesions allowing the LIMA-LAD bypass to be performed, ideally through a limited access, minimally traumatic approach.

Preliminary observational data suggest that HCR has the potential to disseminate widely and become the third major interventional alternative for patients with multi-vessel CAD. The NHLBI is sponsoring the first clinical observational study on hybrid revascularization. The study will be conducted at 16 major cardiac surgery hospitals in the country, such as Cleveland Clinic, Brigham and Women’s Hospital, Emory and Vanderbilt University. This observational study will assess the feasibility of hybrid revascularization and the clinical outcomes at 12 months, 18 months and 21 months. The clinical outcomes will be collected for patients who have undergone HR and multi-vessel PCI.
Vanderbilt University Medical Center has been named one of the nine research hubs of the National Heart, Lung and Blood Institute Progenitor Cell Biology Consortium, a seven-year, $170 million research initiative to develop the field of stem and progenitor cell tools and therapies.

Vanderbilt will receive $1.2 million per year to study cardiac stem cells whose biological properties are poorly understood and investigate how disease affects their usefulness for therapeutic applications.

“This award places Vanderbilt on the forefront of stem cell research and heart regeneration,” said Antonis Hatzopoulos, Ph.D., associate professor of Medicine. “Vanderbilt is also part of the five clinical centers in the Cardiovascular Cell Therapy Research Network (CCTRN). Only two medical institutions in the country play leading roles in both the clinical and basic science arms of stem cell research.

“The parallel clinical and basic science studies create a unique environment for truly translational research,” said Hatzopoulos, director of the Vanderbilt portion of the project. “This translational setting provides unique opportunities for novel discoveries.”

The award brings together experts from heart, lung, blood and technology research to create 18 multi-disciplinary teams of investigators whose goal is to identify and characterize progenitor cell lines, direct the differentiation of stem cells and progenitor cells to desired cell fates, and develop new clinical strategies to address the unique challenges presented by the transplantation of these cells.

There are three investigators involved in the Vanderbilt research team — Hatzopoulos, Doug Sawyer, M.D., chief of the Division of Cardiovascular Medicine, and Scott Baldwin, M.D., chief of the Division of Pediatric Cardiology and co-director of the Pediatric Heart Institute.

“The prospect of cell therapy as a strategy to repair organs such as the heart is very exciting,” said Sawyer. “At Vanderbilt, we are fortunate to be part of a number of studies, including clinical trials, in this arena.”

He applauded the NIH/NHLBI for committing enough resources to allow the field to “grow up.”

“Most grants from the NIH last four or five years, a very short time in the world of clinical and basic research. The benefits to having seven years of funding are enormous.”
“It’s extremely desirable to have a drug treatment that reduces or prevents the ventricular tachycardias, and therefore prevents the ICD shocks.”

high doses, and calcium channel blockers — to control the arrhythmias. Implantable cardioverter defibrillators (ICDs) are placed in patients at high risk for sudden death, but ongoing arrhythmias can result in frequent stressful shocks.

The Dutch patient, for example, experienced ventricular tachycardia — and ICD shocks— whenever he got out of bed, Knollmann said. Defibrillator therapy also can be problematic for pediatric patients (CPVT is usually diagnosed in children), who require multiple surgical revisions of their systems.

“For this particular disease, the ICD is a suboptimal treatment,” he said. “It’s extremely desirable to have a drug treatment that reduces or prevents the ventricular tachycardias, and therefore prevents the ICD shocks.”

Knollmann and his team have been studying the molecular defects that trigger arrhythmias. They knew that mutations in two genes that encode calcium-handling proteins, the ryanodine receptor and calsequestrin, cause the disorder.

In 200_, the group discovered how these mutations cause arrhythmias at the cellular level — by allowing calcium to “leak” out of its storage containers inside heart cells. Knollmann’s team developed a mouse model for CPVT (by eliminating the calsequestrin gene) and proposed using the model to study medications and interventions for the disorder.

They tried flecainide, a clinically available anti-arrhythmic that is used to treat atrial fibrillation. It worked.

In isolated heart cells, flecainide blocked the ryanodine receptor and the calcium “leak” (the underlying molecular defect in CPVT), and it completely prevented ventricular arrhythmias in the mouse model of CPVT.

“So we knew that this established drug specifically targets the disease mechanism in CPVT,” Knollmann said.
Vanderbilt Heart physicians are using a relatively new protocol to help limit the extent of brain damage caused by sudden cardiac arrest by lowering the patient’s body temperature.

“Patients whose brains are deprived of oxygen for more than four minutes have a high-risk of developing anoxic brain injury. The risk of survival with meaningful neurologic outcome is statistically less than 10 percent in cases like this,” said John McPherson, M.D., medical director of the Cardiovascular Intensive Care Unit.

The therapeutic hypothermia protocol is the process of rapidly cooling the body temperature to 86 degrees Fahrenheit. It is implemented as soon as a patient arrives on the cardiovascular intensive care unit.

“It’s a very complicated thing to do because it causes a lot of changes in the metabolic status of a patient,” McPherson said.

Once a good pulse is established in the patient, the cardiologist, in consult with the intensivist, begins the cooling process. They medically paralyze and completely sedate the patient. Paralysis prevents shivering, which is the body’s way of raising its temperature.

Covers containing circulating cold water are placed over the patient’s body and around the head. A machine slowly and carefully lowers the body temperature and maintains it for 24 hours from the onset of the initial injury.

“We think 86 degrees is low enough to attenuate any brain injury, but not too low to be excessively dangerous,” McPherson said.

Returning the patient to normal body temperature is also a very slow, controlled process that occurs at 1 degree Celsius every hour.

“This process is very intensive for nurses and physicians who must look for changes in blood pressure and metabolic status,” McPherson said.

How the cooling process actually limits brain damage is not fully understood. It appears to attenuate cell death and inflammation that occurs after anoxic brain injury, and prevents ongoing injury.

“What we’re learning is that not all brain injury is irreversible, and a lot of permanent injury occurs in the first 24 hours, when cells at risk of dying may be prevented from dying if we can cool them down.”
Thousands of patients with high blood pressure could benefit from changing their drug treatment regimen to reduce their risk of cardiac death.

The current U.S. hypertension treatment guidelines recommend using a thiazide diuretic — a drug that increases the volume of urine — alone as the initial drug therapy for high blood pressure. But a failure of diuretic drugs to decrease deaths from heart attacks, an important consequence of hypertension, prompted Vanderbilt University Medical Center researchers to analyze data from existing clinical trials of diuretic drugs.

They found that combining a thiazide diuretic with a "potassium-sparing" drug to treat hypertension reduced both sudden cardiac death and total coronary mortality by 40 percent. The findings call into question the current treatment guidelines.

Thiazide diuretics successfully reduce blood pressure for many patients, but they are also known to deplete potassium, said John Oates, M.D., a professor of Medicine and hypertension specialist. This potassium "wasting" has sparked concern over the years with studies suggesting a link between potassium loss and sudden cardiac death.

Oates and colleagues examined data from controlled clinical trials that compared a thiazide diuretic/potassium-sparing (ENaC inhibitor) drug combination to placebo.

They generated new, previously unpublished data on sudden death in these trials, and then analyzed the results of the trials in a meta-analysis — a statistical evaluation of data combined from multiple trials.

They found a 40 percent reduction in total cardiac mortality and in sudden cardiac death in elderly patients with hypertension taking the drug combination compared with those receiving placebo.

The investigators also performed a new meta-analysis on the clinical trials of thiazides given without a potassium-sparing drug, adding new trials to the mix. They found no benefit in coronary mortality and a 26 percent increase in sudden death.

Even though the increase was not statistically significant, it was "going in the direction in which you didn't want to go," Oates said.

Observational studies previously had found an increase in sudden cardiac death in patients taking a thiazide diuretic alone, and one showed that sudden death was greater at higher doses of thiazides, he said.

Do thiazide diuretics given alone have an adverse effect of increasing the risk of sudden cardiac death in patients with high blood pressure? It's possible.

"If it's true, it's probably the largest adverse effect in the history of modern pharmacology. The number of individuals affected over the last 50 years would be staggering," Oates said.

And since the current U.S. clinical practice guidelines for hypertension recommend a thiazide diuretic without a potassium-sparing drug, millions of patients may be at increased risk of coronary death, Oates pointed out.

As studies proceed to determine how these drugs reduce death risk, he said, it's time to add them to thiazides as recommended first-line treatment for high blood pressure in the elderly.

Patricia Hebert, Ph.D., Christopher Coffey, Ph.D., Daniel Byrne, Theresa Scott, Rogert Fagard, M.D., Ph.D., Jeffrey Rottman, M.D., and Katherine Murray, M.D., participated in the current study. The National Institute of General Medical Sciences supported the research.
SELECTED 2008 — 2009 PEER REVIEWED PUBLICATIONS

**CARDIAC SURGERY**


**VASCULAR SURGERY**


CARDIOVASCULAR MEDICINE


Ellis CR and Rottman JN. Increased rate of subacute lead complications with small-caliber implantable cardioverter-defibrillator leads. Heart Rhythm, 2009; 6:619-624.

Hong CC and Yu PB. Applications of small molecule BMP inhibitors in physiology and disease. Cytokine & Growth Factor Reviews, 2009; 20:409-418.


Pentassuglia L and Sawyer DB. The role of neuregulin-1/Erβ signaling in the heart. Experimental Cell Research, 2009; 315:627-637.


Selected research grants for the Division of Cardiovascular Medicine
2008 – 2009

Effectiveness of a Walking Program Modulating Cardioprotective Factors in Heart Failure
Heart Failure Society of America
Carrie A. Geisberg

Optimizing Cardiac Stem Cells for Cardiac Repair
National Heart, Lung, and Blood Institute
Antonios Hatzopoulos

Optimizing Cardiovascular Stem Cells for Cardiac Repair and Regeneration
National Heart, Lung, and Blood Institute
Antonios Hatzopoulos

Proposal to Develop Future Drugs to Treat Fibrodysplasia Ossificans Progressiva
University of Pennsylvania
Charles C. Hong

Fox Transcription Factors in Arterial Cell Determination
American Heart Association/Southeast Affiliate
Tsutomu Kume

COAG: Clarification of Optimal Anticoagulation through Genetics: A Randomized Clinical Trial of Genotype-guided Dosing of Warfarin Therapy
University of Pennsylvania
James A. S. Muldowney III

Mechanisms of Immunoglobulin Light Chains Cardiotoxicity in AL Amyloid: Effects on Myocyte-Endothelial Cells Interaction
Amyloidosis Research Foundation
Xuyang Peng

Novel application of N1177 (Iodinated Nanoparticulate Contract Agent) Computed Tomography (CT) for Structural and Molecular Imaging of Abdominal Aortic Aneurysms
American College of Cardiology
Uchechukwu K. A. Sampson

Role of Inflammation in the Pathobiology of Abdominal Aortic Aneurysms
Robert Wood Johnson Foundation
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Recombinant Neuregulin for the Treatment of Heart Failure
National Heart, Lung, and Blood Institute
Douglas B. Sawyer

Vasculogenesis in the Gut: A Novel Paradigm in Blood Vessel Formation
American Heart Association/Southeast Affiliate
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High Content Assay for Zebrafish Cardiomyocyte Development
National Institute of Neurological Disorders and Stroke
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CAMP Transporter in Left-Right Development
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Bves Function in Cardiac Myogenesis
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Regulation of Cardiac Myocyte Differentiation
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Macrophage Expression of APOAI and Atherosclerosis
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Role of Adenosine Receptors in Homing of Endothelial Progenitors
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The Role of Wnt Modulators in Cardioprotection Following Ischemic Injury
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Chemical Genetics of Vertebrate Vascular Development
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