FELLOWSHIP TRAINING PROGRAM
in
PEDIATRIC CARDIOLOGY
and
CARDIOVASCULAR RESEARCH

2011 - 2012

Department of Cardiology
Children's Hospital Boston

Department of Pediatrics
Harvard Medical School
Boston, MA
USA

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MISSION STATEMENT

DEPARTMENT OF CARDIOLOGY, CHILDREN'S HOSPITAL BOSTON

1. We use a relentless, data-driven and self-critical approach to provide outstanding clinical care to all patients.

2. We expect altruism and generosity to characterize our relationships with patients, students, colleagues and society as a whole.

3. We are committed to foster innovation and discovery at all levels of the Department.

4. We strive to select and train fellows who are committed to clinical excellence, altruism, innovation and the scientific practice of pediatric cardiology.

FELLOWSHIP TRAINING PROGRAM
IN
PEDIATRIC CARDIOLOGY & CARDIOVASCULAR RESEARCH

Cardiologist-in-Chief
James E. Lock, M.D.

Co-Directors
David W. Brown, M.D.
Jane W. Newburger, M.D., M.P.H.
David E. Clapham, M.D., Ph.D.

Fellowship Selection
Michael D. Freed, M.D.

The Fellowship Program of the Department of Cardiology has as its main goal the training of academically oriented leaders in the clinical care and laboratory and clinical investigation of cardiovascular disease in the young. One of the central tenets of the Department philosophy is the exposure of trainees to the approaches and techniques that represent the current state of the art. The Program aims to prepare trainees to work at the forefront of the field. In order to build on the recent dramatic advances in pediatric cardiology, it is fundamental to gain a better understanding of cardiovascular structure and function at the molecular, cellular and organ system levels with respect to development, morphogenesis, physiology, pathology and pharmacology. These approaches are expected to have a significant impact on the most pressing issues in pediatric cardiology including: the "natural history" of surgically corrected complex cardiac malformations, antenatal diagnosis and therapy of congenital defects, the cellular basis of cardiac development and the cellular response to abnormal physiology; and, ultimately the effective prevention of both congenital and degenerative cardiovascular disease. With these expectations, the Cardiology Department maintains that thorough training in research will be essential for all pediatric cardiologists who are to assume positions of leadership. It is the goal of this Program to participate in the education of such individuals and to graduate exceptionally trained clinically oriented fellows with particular expertise in focused areas that match their interests and aptitude.

To meet these goals the Training Program combines the unique resources of the Cardiovascular Program with the clinical and research opportunities of both Children's Hospital Boston, Harvard Medical School and the Longwood medical community to give an unparalleled opportunity to explore virtually any area of clinical or basic research. With well developed divisions of interventional cardiology, cardiac imaging, electrophysiology, preventive cardiology, prospective clinical research, intensive care cardiology, transplant cardiology and adult congenital heart disease, along with the unparalleled resource of the Cardiac Registry, the Program offers trainees a range of approaches within each clinical subspecialty that allows an introduction to the core problems and frontiers of clinical pediatric cardiology. The patient population reflects the Program's long history of leadership in caring for congenital and acquired heart disease in the young, and includes large local, regional, national, and international referral sources. This patient base, combined with a highly-evolved interdisciplinary approach among cardiology, cardiac surgery, and cardiac anesthesia, represents the greatest strength of the Fellowship Training Program. The research

opportunities are even more diverse, combining intramural expertise in molecular genetics, cardiac morphogenesis and cellular adhesion with an exceptionally wide range of laboratory investigation occurring throughout the Boston medical community.

The core fellowship involves three years in training, comprising twenty-four months of clinical rotations and twelve of elective and research experience. Fellows may reverse the usual sequence and start their training in the laboratory, deferring clinical training for one or more years. An increasing proportion of trainees spend one or more additional year of training as "senior clinical fellows" in the subspecialty areas of pediatric cardiology. There is a reasonable amount of flexibility in scheduling and individualized programs may be possible, particularly for those with prior training in pediatric cardiology. New fellows are assigned a faculty advisor who helps with initial orientation and provides ongoing guidance in the form of performance review, selection of clinical electives, and identification of a research mentor (see below).

CORE CLINICAL ROTATIONS

The first eighteen months of training constitute an intensive immersion in clinical cardiology with a focus on caring for a large number of patients in the inpatient and outpatient settings and on learning what information is important in making clinical decisions. Fellows rotate through five clinical services and a night float position at approximately monthly intervals. Three core rotation fellows are on call in the hospital every night: two to cover the cardiac intensive care unit as his or her sole responsibility, and a night float to supervise cardiac medical and surgical patients on the cardiology floor, and to respond to urgent consults from other services. At present, fellows are expected to take coverage every fourth night in the ICU for approximately three months and perform night float coverage for two months (divided time) during the first eighteen months of training. Ample back-up support is available from more senior fellows on call and from staff cardiologists covering the subspecialty services within the Department.

Cardiac Medicine/Surgery: The fellow leads a team of three or four pediatric residents in the care of cardiac medical patients on 8 East, the cardiac inpatient floor. The fellow also assists the surgical team (which includes nurse practitioners) in the postoperative care of cardiac patients convalescing on the floor, assuming the role of consulting cardiologist and pediatrician. The fellow runs morning rounds, manages patient care in tandem with attending cardiologists, and teaches the residents on an informal basis during the day. More formal teaching and supervision of patient care is provided by the attending cardiologist assigned each month. Additional daily teaching sessions are conducted by the cardiology faculty.

Cardiac Intensive Care: Two or three core rotation cardiology fellows are scheduled each month on the Cardiac Intensive Care Unit along with advanced training fellows and fellows rotating from the General Pediatric Intensive Care Unit and the Neonatal Intensive Care Unit. Over the first eighteen months of training, each fellow will have three clinical months on the CICU. The clinical commitment is less than 80 hours/week including call. The fellows in the CICU are responsible for the intensive care management of the cardiac surgery, cardiac medical, and select patients with cardiac disease undergoing non-cardiac surgery. Three attending intensive care staff are responsible for providing direct supervision of patient care and teaching during daily rounds. Fellows receive training in cardiac pathophysiology, intensive care management, and critical care monitoring and procedures.

Electrophysiology: In conjunction with an electrophysiology staff physician, the core rotation fellow functions as a consultant for all inpatients and selected outpatients with arrhythmias. The fellow is responsible for coordinating patient management, helping to plan and execute drug trials, esophageal electrophysiology studies, cardioversions and exercise studies, as well as review of all Holter studies. Although the more senior fellows on this service are primarily responsible for intracardiac electrophysiology studies, ablations and intraoperative procedures, the core fellow participates in these procedures as well. One month of electrophysiology occurs during the first eighteen months which includes training in exercise physiology of fellowship; an additional one and a half months rotation occurs during the second eighteen months.

Echocardiography: Core rotation fellows are introduced to cardiac ultrasound through hands-on experience guided by the echocardiography staff, senior fellows and experienced technologists. Additionally, a comprehensive tape library and didactic sessions are provided for the fellows. The fellow is expected to take an active role in the laboratory performing echocardiographic scanning, spending several half day sessions each week to gain experience in the interpretation of anatomic, Doppler and ventricular function studies. Four of the initial eighteen months of training are devoted to echocardiography.

Catheterization Laboratory: Two to three days a week are spent performing catheterizations under staff guidance. Responsibilities of the core rotation fellow include: preparation of the case and review of informed consent with the patient's family the day prior to the procedure, presentation of the case at morning conference, performance of the catheterization with a staff physician, and analysis and review of the data at the end of the day. The fellow participates in two or three catheterizations per day. As the rotation progresses, the fellow learns to obtain a complete set of hemodynamic, saturation and angiographic data in a safe and expedient manner. Training in catheterization of the newborn infant and interventional procedures begins during the core rotation. There are four months of catheterization during the core clinical rotations.

Night Float: A first year fellow is available in the hospital from 7 P.M. to 7 A.M. to assume patient care responsibilities for the cardiac medical, surgical, and consult services, as well as handling referrals or questions from outside physicians. Extensive clinical backup is available from a more senior fellow on call, staff cardiologists on service and the cardiac ICU. A staff physician regularly reviews any outstanding patient management issues with the fellow.

Cardiology Clinic: Each fellow is assigned to a weekly half day clinic session, which is supervised by two attending cardiologists. Fellows evaluate and plan the care of patients referred to the clinic for outpatient evaluation, and also provide long-term continuity care for patients with more serious lesions whose care they have assumed while on their various clinical rotations.

THE SECOND EIGHTEEN MONTHS

Midway through the second year of training, fellows have been exposed to each of the main sub-specialties of pediatric cardiology and generally have a good sense of how cardiology is practiced at a single institution. The goal of the next eighteen months is to build on the technical and cognitive skills to allow increasing independence, expand the fellows' knowledge to allow a broader

understanding of the controversies and challenges of the field, and most importantly to identify a specific initial career path that allows for the focusing of research and clinical energies. To this end, this period is flexible in combining clinical requirements and protected time for research and study.

During CICU rotations, fellows take in-house call. The remainder of the time the fellows share "back-up" call from home on nights and weekends, acting as a resource for the core rotation fellows in the hospital. The primary responsibility of this fellow is to perform night and weekend echocardiograms under supervision of the appropriate staff cardiologist. The cath senior fellows or general fellows interested in cath are always on call for the cath lab.

Scheduling of clinical responsibilities is generally decided by the fellows themselves. There is always a second or third year fellow, or a senior clinical fellow with comparable experience, assigned to the cardiac catheterization laboratory and the CICU. In the cardiac catheterization laboratory, the fellows take increasing responsibility for organizing the daily laboratory schedule with a goal of performing hemodynamic cases independently and becoming more involved in interventional procedures.

There is always an experienced fellow on the consult service, providing cardiology consultation to Children's Hospital Boston patients and infants at the affiliated neonatal units at Brigham and Women's Hospital and the Beth Israel/Deaconess Medical Center. This fellow sees all new referrals and provides continuing cardiology coverage on the floors and outpatient clinics as appropriate. Rounds are conducted with the supervision of a staff cardiologist.

During the second eighteen months of training there are opportunities for advanced rotations in echocardiography, electrophysiology, cardiac transplant medicine, intensive care medicine, adult congenital heart disease, and pathology. During these rotations the fellows assume broader responsibilities based on their interest and abilities.

	First 18 Months	**Second 18 Months**	**Total**
Echocardiography	3.5	2	**5.5**
Cardiac Intensive Care Unit	3	2	**5**
Catheterization	3	1	**4**
Inpatient and Night Float	4.5	0	**4.5**
Electrophysiology	1	1.5	**2.5**
Consults	0.5	0.5	**1**
Subspecialty Clinics & Adult Congenital	1	0	**1**
Research & Elective	0	9.5	**9.5**
Vacation	1.5	1.5	**3**
Total:	**18**	**18**	**36**

RESEARCH TRAINING

The Department maintains that experience in cardiovascular research is an essential component of fellowship training in cardiology. In addition to their patient care responsibilities, fellows are expected to become involved in a clinical research project during the core rotations, under the guidance of the faculty. Such projects, either new or ongoing, are often of the chart review type, and may form the basis for a future prospective study for those fellows interested in clinical research. Fellows should identify a clinical or basic science research mentor from among the faculty by the end of the first year. Each fellow has a Scholarship Oversight Committee which assists the fellow in identifying projects, resources, and monitors progress throughout fellowship training.

Approximately half of the second eighteen months of fellowship are dedicated to ongoing research training. It is expected that each fellow will, with appropriate guidance, write and submit a proposal for a research project which: (1) addresses an important question; (2) applies available state-of-the-art techniques to answering that question; and (3) is practical within the time and other constraints of the fellowship. The project may be either basic science or clinical.

Fellowship training in the Department beyond the third year is predicated on the identification of a suitable mentor and appropriate research project(s). The Department has an institutional NIH training grant, which permits selected fellows to train in basic research laboratories throughout the Harvard Medical Area, as well as in clinical research. Fellows are also encouraged to write individual grant applications, but fellowship funding is not dependent upon such grants being funded. Fellows interested in higher-level training in clinical research may be considered for participation in the Program in Clinical Effectiveness at the Harvard School of Public Health or the Scholars in Clinical Science Program at Harvard Medical School.

SENIOR CLINICAL FELLOWSHIP TRAINING

The Department offers advanced clinical training in the major subspecialty disciplines of pediatric cardiology. This program is open to individuals who have completed much or all basic pediatric cardiology training at other institutions. In general, these trainees are funded by a sponsoring institution or grants, although some departmental resources are available. The period of training varies from six months to two years, based on individual needs.

Senior clinical fellowships are available in cardiac catheterization, echocardiography, MRI, electrophysiology, cardiac intensive care, adults with congenital heart disease, and heart failure and transplantation.

INFORMATION FOR FELLOWSHIP APPLICANTS

Physicians seeking subspecialty training in pediatric cardiology are eligible to enter the program following a minimum of three (rarely two) years of internship and residency in pediatrics. Fellowship applicants are evaluated on the basis of (1) performance during medical school, residency and other postgraduate training, (2) letters of recommendation, and (3) clinical or basic

science research experience, where applicable. Candidates are also asked to visit the Department for a series of interviews. Applications are submitted at least 18 months prior to the anticipated start date, although positions may be available on shorter notice from time to time. The Department participates in ERAS. Detailed information about the application process is available at http://www.aamc.org/programs/eras/. Applicants for Senior Clinical Fellowships positions should contact Dr. David W. Bown, Department of Cardiology, Children's Hospital, 300 Longwood Avenue, Boston, MA 02115.

The Fellowship Training Program in Pediatric Cardiology and Cardiovascular Research at the Children's Hospital participates in the Specialties Matching Services of the National Resident Matching Program. For 2012 appointments, applicant agreements will be available in November, 2010. A schedule of dates and other information can be obtained from:

Specialties Matching Services
National Resident Matching Program
2501 M Street, NW, Suite 1
Washington, DC 20037-1307
(202) 862-6077
www.nrmp.org

HISTORY OF CARDIOLOGY AT CHILDREN'S HOSPITAL

The cardiology fellowship program at Children's Hospital Boston, among the oldest in the country, was founded in 1949 by Dr. Alexander S. Nadas. Just eleven years earlier, a major milestone had been achieved at Children's when Dr. Robert E. Gross ligated a patent ductus arteriosus in a young girl, the world's first successful surgery for congenital heart disease. Faced with the increasing numbers of patients with congenital heart disease who were being drawn to the Hospital as a result of Dr. Gross' achievement, Dr. Nadas began in earnest to build the rigorous program in pediatric cardiology that he was to head for 33 years.

Dr. Nadas' program attracted a growing body of fellows, both pediatricians and internists, seeking experience in pediatric cardiology. The learning curve was steep for students and teachers alike. The training program was based on the strength of the clinical service and its contributions to the diagnosis, classification, and management of pediatric cardiovascular disease. The knowledge and experience accumulated at that time formed much of the infrastructure of modern pediatric cardiology, culminating in Dr. Nadas' first textbook, published in 1957. The cardiology program at Children's grew rapidly during the next decade. This period was marked by the return of one of Dr. Nadas' first fellows, Dr. Donald C. Fyler, who initiated the New England Regional Infant Cardiac Program, the first study of its kind to prospectively document the incidence, natural history, and treatment outcome of structural heart disease. Indeed, with this and other work, the emphasis of the cardiology program expanded on its base of outstanding patient care to include substantial clinical and whole organ physiology research efforts. By the mid-1960s, Children's Hospital had become the largest center for pediatric cardiology in the United States, with fifteen staff physicians and as many fellows, and achieved national recognition for its cardiac research.

In 1972, Dr. Gross was succeeded as chief of cardiac surgery by Dr. Aldo R. Castaneda, who pioneered neonatal and infant heart surgery for the early correction of congenital defects. Successes in the operating room were paralleled by rapidly advancing diagnostic and technical skills in cardiology that permitted earlier and more detailed diagnosis and improved survival. Through the efforts of Drs. Castaneda and Nadas, an extraordinarily cooperative working relationship was forged between the Cardiac Surgery and Cardiology Departments at Children's Hospital, a rapport that flourishes today.

Following the retirement of Dr. Nadas in 1982, Dr. Bernardo Nadal-Ginard was appointed chairman of the Department of Cardiology. Dr. Nadal-Ginard's commitment to a strong basic science research effort in pediatric cardiology resulted in the development of an outstanding research group focusing on the most fundamental problems of cardiovascular biology. The Laboratory of Molecular and Cellular Cardiology established an international reputation in the vanguard of basic cardiovascular research. During Dr. Nadal-Ginard's tenure, the research division of the Department grew to include nearly forty investigators, comprising M.D. and Ph.D. faculty, postdoctoral fellows, and graduate students. The clinical service of the Department, including both patient care and clinical investigation, was also strengthened and expanded during this time. Critical to this process was the work of several well-qualified young cardiologists, including Dr. James E. Lock, who together have spearheaded highly productive efforts in experimental physiology, therapeutic innovation, and patient-based research.

The first six decades of cardiology at Children's Hospital, have witnessed enormous progress in both clinical and research activities. The Department has remained a fertile training ground, having graduated more than 200 fellows. Many have become leaders in pediatric cardiology worldwide. With Dr. Lock's appointment as Cardiologist-in-Chief in 1993, the Department retains an unwavering commitment to patient care and clinical and basic research in pediatric cardiology. These efforts, and the training of outstanding young academic pediatric cardiologists, are fundamental to the mission of the Department.

DEPARTMENT OF CARDIOLOGY TODAY

The Department of Cardiology has over seventy staff physicians and scientists with faculty appointments at Harvard Medical School, over fifty clinical and research fellows, and a full complement of administrative and technical personnel. The faculty and fellows regularly attract major research support from granting agencies including the National Institutes of Health and the American Heart Association. They have also been the recipients of prestigious training and research awards and have been recognized with a number of named lectureships and visiting professorships.

Children's Hospital Boston is a cardiac center of international stature, in the forefront of patient care, clinical innovation and research, and basic cardiovascular science. Approximately 1000 cardiac operations and over 1800 cardiac catheterizations are performed annually, including the greatest number of pediatric interventional catheterizations in the world. In addition, there has been substantial growth of the physical plant. A new clinical building was dedicated in the spring of 2005. A cardiac imaging floor includes four new catheterization laboratories, a dedicated Magnetic Resonance Imaging suite, an inpatient echocardiography area as well as procedure rooms, and a ten bed recovery area. The cardiac intensive care unit moved to a new 30 bed floor. Three new operating suites are dedicated to the cardiovascular program.

CARDIOLOGY INPATIENT SERVICE – 8 EAST

Cardiac patients not requiring critical care are admitted to the 30 bed cardiac inpatient unit, 8 East. The unit is contiguous with the Cardiac Intensive Care Unit and includes ECG telemetry with central monitoring, fully equipped procedure rooms, physician and nursing conference rooms, interview rooms, play space for young children and a well appointed resource room for adolescent and adult patients and parents. The division is staffed by nurses dedicated to the care of children with heart disease. More than 2000 patients were admitted to 8 East in FY2010; the average daily census was 26.9 patients.

The management of the cardiac medical patients is coordinated by the rotating first year cardiology fellow, who leads a team of three to four pediatric residents on the service. Teaching and supervision are provided by the attending faculty cardiologist. A team of highly skilled pediatric cardiac nurse practitioners manages the post-operative surgical patients in conjunction with attending cardiac surgeons and cardiologists.

CARDIAC INTENSIVE CARE UNIT—8 SOUTH

The 30-bed Cardiac Intensive Care Unit treats approximately 1,200 patients with congenital and acquired cardiac disease each year. Full-time critical care cardiologists and intensivists work in close collaboration with cardiovascular surgeons, anesthesiologists, and nurses. Supervision and teaching is provided by three attending staff each day. The CICU staff are directly responsible for the perioperative care of all cardiac surgery patients in close collaboration with the cardiac surgery staff. In addition to the usual intensive care management, fellows develop an understanding of the variable pathophysiology and postoperative course for patients undergoing complex cardiac procedures. All forms of pharmacologic support, mechanical ventilation, mechanical support of the circulation (ECMO and VAD) and renal replacement therapies are used in the CICU. A wide spectrum of patients are managed in the CICU, including newborns to adults with congenital heart disease, patients with acquired heart disease and heart failure, acute and chronic pulmonary hypertension and following cardiac transplantation. Dr. Peter Laussen is the Chief of the Division and on staff are Drs. Catherine Allan, Melvin Almodovar, Joshua Blinder, James DiNardo, John Kheir, Thomas Kulik, Peter Lang, Mary Mullen, Satish Rajagopal, H. David Rosen, Joshua Salvin, Sarah Teele, Ravi Thiagarajan and Vamsi Yarlagadda.

CARDIOLOGY OUTPATIENT SERVICE

The outpatient service provides evaluation and follow-up care for more than 21,000 clinic visits yearly in multiple locations. The clinic at Children's Hospital Boston, located adjacent to the echocardiography and EKG laboratories on Farley 2 is the central site for the majority of these encounters. The outpatient program has expanded its focus with the establishment of satellite cardiology clinics throughout eastern Massachusetts. All clinic sites are staffed by teams composed of a staff cardiologist, nurse, nurse practitioner and sonographer and meet at least once a month. Participation in these clinics provides an excellent opportunity for fellows to spend uninterrupted time with a senior cardiologist, evaluating a variety of cardiac problems.

All fellows are assigned a half day continuity clinic session per week, most typically alternating between Boston and a satellite. This includes the assessment of new patients with cardiovascular complaints as well as follow-up visits. Several staff cardiologists supervise these sessions and serve as resources for discussion related to these patients when clinics are not meeting. Fellows work with two different staff cardiologists on an alternating basis weekly.

Sub-specialty clinics including lipid, transplant, myopathy, adult congenital, arrhythmia, pacemaker and genetics are held on a weekly basis. First year fellows have an outpatient rotation dedicated solely to these clinics. Arrangements may be made to participate in sub-specialty clinics during elective time.

The director of the outpatient services is David R. Fulton, M.D. with coordination supplied by Cheryl O'Connell, R.N., and Betty Brown, R.N.

CARDIOLOGY INPATIENT CONSULTATION SERVICE

The Cardiology Consult Service performs approximately 1000 initial inpatient consults annually. Consults are requested from three active nurseries (Children's 7 North, Brigham & Woman's Hospital, and Beth Israel/Deaconess Medical Ceneter) as well as from the emergency room, preoperative clinic, and the various in-patient services at Children's Hospital Boston. This rotation provides excellent exposure to cardiac issues associated with general medical conditions.

Consults are evaluated by a fellow (second, third, or fourth year level) and an attending staff cardiologist. Consults are seen on the day of the request. The consult fellow staffs the service from 7:00 AM to 7:00 PM Monday through Friday. The night float assumes responsibilities for consults after 7:00 PM on weeknights. The fellow on 8 East performs consults on weekends. Appropriate cardiac testing (electrocardiography, echocardiography, magnetic resonance imaging, and cardiac catheterization) is performed by the divisions of the Department of Cardiology. Patient encounters that will be instructive for colleagues are reviewed at the monthly 8E/Consult conference.

HEART FAILURE/TRANSPLANTATION

The Heart Failure/Transplantation Program at Children's Hospital, Boston, is a jointly administered program of the Cardiology and Cardiac Surgery Departments, under the direction of Dr. Francis Fynn-Thompson (Surgical Director), Dr. Elizabeth D. Blume (Medical Director) and Transplant Coordinator Heather Bastardi, RN, MSN, PNP. The Program is staffed by an additional nurse, nurse practitioner and transplant cardiologists, T.P. Singh, M.D., Leslie Smoot, M.D., Christopher Almond, M.D. and Kevin Daly, M.D. All the cardiac surgical staff participates in patient evaluation and transplant surgery. The Program consists of a multidisciplinary team of consultants from nursing, social work, infectious disease, and psychiatry as well as other allied health professionals. This busy clinical service manages patients with end-stage heart failure secondary to cardiomyopathy or congenital heart disease, as well as evaluates potential candidates for mechanical support and heart transplantation. In addition, the team follows all patients following heart transplantation. Since its inception in 1986, 190 patients have been transplanted. Multidisciplinary transplant conference occurs weekly as does Pediatric Transplant Council, made up of all solid organ programs. Fellows participate in the care of these patients on all of their first year rotations including pre-operative management on the medical floor, post-operative care in the cardiac intensive care unit, routine endomyocardial biopsies in the cardiac catheterization laboratory, and function surveillance by echocardiography. Second and third year fellows are encouraged to rotate on the heart failure/transplant service as an elective. A fourth year senior fellowship in Cardiomyopathy/Heart Failure/VAD/Transplant is available.

BOSTON ADULT CONGENITAL HEART (BACH) AND PULMONARY HYPERTENSION SERVICE

The Boston Adult Congenital Heart Service is a multi-institutional (Children's Hospital/Brigham and Women's Hospital) inpatient and outpatient program designed to provide for the long-term care

of patients with congenital heart disease or pulmonary hypertension as they reach and progress through adulthood. On a monthly basis, Drs. Michael Landzberg, Michelle Gurvitz, Mary Mullen, Alexander Opotowsky, Michael Singh, Anne Marie Valente or Fred Wu with the assistance of an expert staff of mid-level practitioners are responsible for the inpatient BACH service (cardiovascular service admissions and consultations on all adult patients with congenital heart disease) and acts in concert with the medical teams. Drs. John Mayer, Pedro Del Nido, Prem Shekar, as well as Drs. Peter Lang and Edward Walsh participate in weekly patient care oriented conferences. Outpatient care is provided in both AM and PM specialty clinics at both participating institutions, as well as a satellite in Waltham. Standard program Cardiology fellows participate during medical inpatient and cardiac ICU rotations. Senior clinical electives are encouraged. A separate detailed description of responsibilities is provided to all Senior Fellows and visitors.

CARDIAC CATHETERIZATION

The Cardiac Catheterization Laboratory comprises four state-of-the-art angiographic suites, installed in 2005. The laboratory is staffed by Drs. James E. Lock, Michael J. Landzberg, Peter Lang, Audrey C. Marshall, Lisa T. Bergersen, Doff B. McElhinney and Diego Porras. In addition, Drs. Edward P. Walsh, John K. Triedman, Mark E. Alexander, Laura M. Bevilacqua and Frank Cecchin staff electrophysiologic studies and ablations.

Approximately 1800 cardiac catheterizations were performed last year, at least 50% of which were interventional. Interventional procedures performed include balloon valvotomy of mitral pulmonary and aortic valves, including infants with critical pulmonary and aortic valvar stenoses; balloon angioplasty of coarctation of the aorta and pulmonary artery stenosis; transcatheter closure of PDAs, PFOs, ASDs, VSDs, Fontan fenestrations and aortopulmonary collaterals; stent placement in pulmonary arteries, aortic coarctations and venous obstructions; endocardial biopsies; and radiofrequency ablation of bypass tracts. Children's Hospital Boston participates in many multi-institutional interventional trials including trans-catheter valve inplantations.

A cardiology fellow is assigned to each catheterization procedure, under the guidance of one of the staff cardiologists. In addition to participating fully in all aspects of the procedure itself, the fellow evaluates the patients prior to catheterization, obtains consent, reviews the previous data and angiograms at the morning pre-catheterization conference, interprets the hemodynamic data and angiograms from the study, and summarizes the results in a formal report for the patient record.

ELECTROPHYSIOLOGY

The electrophysiology service includes Drs. Edward P. Walsh (Chief), Dominic J.R. Abrams, John K. Triedman, Mark E. Alexander, Laura M. Bevilacqua, Frank Cecchin and Douglas Y Mah. The team is further supported by two full-time nurse specialists and a nurse practitioner experienced in the care of young patients with arrhythmia and pacemaker issues. Cardiology fellows rotate through the service during both the first and second year, and there are positions for senior clinical fellows to obtain more intense electrophysiology training during their third and/or fourth years.

The division is directly involved in the care of all inpatients and outpatients with cardiac

arrhythmias, including those in the Cardiac Intensive Care Unit. There is a dedicated electrophysiology catheterization suite with state-of-the-art recording and ablation equipment where over 600 procedures are performed annually. Non-invasive rhythm evaluation by Holter monitor monitoring, event recording, signal averaged ECG, T-wave alternans analysis, tilt-table testing, and esophageal EP testing are included in the division's activities. Outpatient care is delivered in specialized arrhythmia and pacemaker clinics which meet five days per week.

The division's research activities span a broad range of interests, including the molecular genetics of arrhythmias, autonomic physiology, computer modeling of reentry circuits, whole-animal mapping and ablation studies, as well as human clinical protocols for the development and testing of catheters, drugs, and anti-tachycardia devices. Fellows at all levels of training are invited to participate in these ongoing projects.

NONINVASIVE CARDIAC IMAGING

Training in noninvasive cardiac imaging includes echocardiography and cardiac magnetic resonance imaging (MRI). All fellows are trained to achieve a core level of expertise in both modalities as part of the three year Pediatric Cardiology Fellowship Program. Advanced training is required to prepare fellows for a career in noninvasive cardiac imaging and typically involves an additional year of training.

ECHOCARDIOGRAPHY

The Echocardiography Laboratory provides imaging services throughout Children’s Hospital, at newborn nurseries in neighboring hospitals, at numerous satellite locations in eastern Massachusetts, and also provides interpretive services to numerous institutions and physicians. The laboratory utilizes state-of-the-art technology for 2- and 3-dimensional imaging (e.g., pulsed, continuous wave, and color Doppler, tissue Doppler, speckle tracking, vascular ultrasound), and sophisticated off-line image manipulation and analysis capabilities. The Laboratory is staffed by Drs. Tal Geva (Director), Puja Banka, David W. Brown, Ming Hui Chen, Steven D. Colan, David M. Harrild, Ronald V. Lacro, Jami C. Levine, Renee E. Margossian, Gerald R. Marx, Sharon E. O'Brien, Andrew J. Powell, Ashwin Prakash, Rahul H. Rathod, Sepehr Sekhavat, and Wayne Tworetzky. The laboratory operates multiple cardiac ultrasound scanners, a computer-based off line analysis system developed in-house for quantitative image and Doppler analysis, a commercial 3-D image reconstruction workstation, and a sophisticated video editing and image processing system for creating and editing still and video images. The laboratory utilizes a digital image capture and archiving system to digitally record full-length echocardiographic exams and make them available via intranet throughout the institution. Laboratory personnel include 22 full time pediatric ultrasound technicians.

Approximately 20,000 echocardiograms (including over 1600 fetal and 900 transesophageal echocardiograms) are performed annually. In addition to clinical evaluations, the laboratory participates in numerous research protocols, including evaluation of ventricular function parameters in a variety of congenital and acquired heart diseases, evaluation of the utility and reliability of noninvasive imaging and Doppler in diagnosis and outcome determination, and evaluation of new

and emerging technology such as 3-dimensional echocardiography and tissue Doppler. Cardiology fellows take an active role in performing and interpreting the full range of studies in the Echocardiography Laboratory (including transesophageal and fetal exams for the senior clinical fellows), initially under the supervision of experienced technologists, senior clinical fellows, and staff echocardiographers. Over time, fellows are incorporated into the emergency echocardiography process and eventually also participate in teaching and training the junior fellows.

CARDIOVASCULAR MAGNETIC RESONANCE IMAGING

The cardiovascular magnetic resonance imaging (MRI) program was established in 1995 and has experienced rapid growth in its clinical activities. In 2005, the program moved to the new clinical expansion building (Main South) where it operates a dedicated state-of-the-art 1.5T cardiac MRI scanner. Cardiac MRI examinations are performed in patients ranging in age from newborns to adults and include evaluation of cardiovascular anatomy, ventricular function, flow quantification, and myocardial perfusion and viability. The clinical volume has increased over the years with 1335 cardiac MRI studies performed in 2010.

Training in cardiovascular MRI is an integral part of the training curriculum of the Noninvasive Division. Fellows participate in the clinical activities of the Cardiac MRI program and attend a weekly conference. Advanced training (senior fellowship) is available. Research activities in Cardiac MRI include clinical and laboratory projects. Fellow's participation in MRI research is encouraged.

EXERCISE PHYSIOLOGY

The exercise laboratory performs more than 1,900 treadmill and bicycle tests annually, supervised by Drs. Jonathan Rhodes and Mark Alexander. The three laboratories are equipped with a treadmill, a bicycle ergometer, ability to measure microvolt t-wave alternans, transcutaneous oxygen saturation monitor, blood pressure recording devices and a state-of-the-art computer-based, breath-by-breath expired gas analysis system for the measurement of oxygen consumption, carbon dioxide production, and anaerobic threshold. There are four graduate exercise physiologists on staff who perform the studies. The exercise lab supports stress echo examinations as well as nuclear cardiac perfusion studies. Cardiac fellows participate in the exercise laboratory's activities during their electrophysiology rotation and are called to supervise high risk studies. During this time, they learn about the physiology of exercise, the methodology of exercise testing, and the potential uses of this technology. Research activities are available and encouraged.

COMPUTING FACILITY

The Cardiology Department operates a local area network (LAN) of over 400 personal computers and printers, connected by network to cardiology servers as well as the central Oracle servers on which the hospital ISD is based. Personal computers provide desktop services such as word processing, spread sheets, graphics, statistics, literature searches, and e-mail as well as high

speed internet access. Diagnostic digital images including x-rays, echocardiograms, and catheterizations are available on PCs and workstations throughout the hospital. Secure access to the network may be obtained from outside the Hospital. Four network administration computer support personnel are dedicated to Cardiovascular Program. Computer training is available through both the Department and the hospital. An extensive historical electronic database, supported by approximately 10 applications development personnel, with diagnostic and procedural codes has been accumulated to assist with clinical care and research.

CLINICAL RESEARCH

A considerable clinical research infrastructure in the Department of Cardiology supports the following functions: (1) to educate fellows and faculty with respect to study design, data analysis, and computer usage; (2) to facilitate implementation of protocols for research projects that require extensive data entry and coordination of patients or services; (3) to function as a resource for fellows who need information on grant applications; and (4) to maintain an active list of clinical projects that are ongoing or planned in the Department. Administrative staff includes coordinators of grants and patient follow-up, study nurses, computer programmers, statisticians, and data entry personnel.

Faculty members from all divisions in the Department of Cardiology lead or participate in prospective, multi-disciplinary and/or multi-center studies. A few examples of such studies include:

- Safety and Efficacy of Fetal Aortic Valve Dilation to Promote Ascending Aortic Growth in Utero (PI: James Lock)
- Trial of Beta Blocker Therapy (Atenolol) vs. Angiotensin II Receptor Blocker Therapy (Losartan) in Individuals with Marfan Syndrome (PI: Ronald Lacro)
- Neurologic and Developmental Outcome in Adolescents after the Fontan operations (PI: Jane W. Newburger)
- Methods for Evaluating and Improving Outcomes in Pediatric Cardiac Catheterizations (PI: Lisa Bergersen)
- Safety and Efficacy of the Cutting Balloon to Treat Resistant Pulmonary Artery Stenosis (PI: Kathy Jenkins)
- Progressive Pulmonary Vein Stenosis in Children with Congenital Heart Disease (PI: Kathy Jenkins)
- Implantation of the Medtronic transcatheter pulmonary valve in patients with dysfunctional right ventricular outflow tract (rvot) conduits (PI: McElhinney)
- Berlin Heart excor pediatric VAD trial (PI: Almond).
- Coarctation of the Aorta Stent Trial – COAST (PI: McElhinney)

The Cardiovascular Program participates in many multi-center trial networks and registries. A few

examples include:

- Pediatric Heart Network (NHLBI)
- Pediatric Cardiac Genomics Consortium (Bench-to-Bedside) (NHLBI)
- Pediatric Cardiomyopathy Registry (NHLBI)
- Congenital Heart Surgeon's Society (Department of Cardiac Surgery Institutional Resources)
- Society for Thoracic Surgeons Database (Department of Cardiac Surgery Institutional Resources)
- Interagency registry of mechanically assisted circulatory support -INTERMACS (NIH).
- REACH: Research Empowerment for Adult Congenital Hearts (NHLBI)
- HEART-ACHD: Health Education and Access to Research Trial in Adults with Congenital Heart Disease (NHLBI)
- National collaborative to improve care of children with complex congenital heart disease: a project of the Joint Council of Congenital Heart Disease
- Congenital cardiac catheterization outcomes project (ACC)
- Pediatric Cardiac Intensive Care Research Consortium and Data Standards Repository (NIH)

DEPARTMENT OF CARDIAC SURGERY

Six cardiovascular surgeons, Drs. Pedro J. del Nido (Chairman), John E. Mayer, Jr., Frank A. Pigula, Christopher W. Baird, Francis Fynn-Thompson and Sitaram Emani perform more than 1,100 operations a year. The complexity of the cases covers a broad range and represents the state-of-the-art congenital heart surgery. A chief resident and four to five senior residents and fellows train in the Department.

The Department of Cardiac Surgery also has an active research laboratory conducting both basic and bench to bed-side research including projects in the area of tissue engineering of heart valves and conduction tissue, myocardial metabolism in hypertrophy and heart failure, and image-guided intervention including surgical robotics. The Department has several post-doctoral research fellows, including M.D.s and Ph.D.s and participates in the National Research Service Training Program of the Department of Cardiology.

The Departments of Cardiology and Cardiac Surgery enjoy a cooperative, constructive working relationship at Children's Hospital Boston. Joined efforts are an integral part of patient care, teaching and research. Several weekly combined conferences are held. The Cardiology Fellows are encouraged to spend time in the operating room where they are given every opportunity to view surgical anatomy and reconstructive procedures.

DIVISION OF CARDIAC ANESTHESIA

Thirteen attending cardiac anesthesiologists and five or six anesthesia fellows provide coverage each day for the cardiac operating rooms, cardiac catheterization laboratory, and procedures in the CICU and cardiac MRI facility, as well as a consult service to evaluate and manage patients with cardiac disease undergoing non-cardiac surgery.

The active areas of clinical investigation within the Division of Cardiac Anesthesia include control of cerebral blood flow and oxygenation in patients with congenital heart disease and during cardiopulmonary bypass, CNS monitoring and brain injury and protection during CPB, etiology and the pathophysiology of coagulation abnormalities in CHD patients and during CPB.

The Division also maintains an active basic science and translational laboratory research program. Current areas of focus include bioengineering of cardiac conduction tissue, effects of hypoxia and abnormal flow upon endothelial function, myocardial inflammatory signaling, functional and energetic consequences of abnormal pressure loading of the infant right and left ventricle and the genetic basis, mechanisms, and sequelae of the infant inflammatory response to CPB.

Many of these projects are conducted in collaboration with attending and fellow staff in the Department of Cardiology and Cardiac Surgery. Cardiology fellows are also welcome to spend an elective clinical month as a fellow in pediatric cardiac anesthesiology.

CARDIAC REGISTRY

The Cardiac Registry, directed by Dr. Stephen Sanders, is an internationally renowned resource for training and research in the pathologic anatomy of congenital heart disease. The Cardiac Registry collection consists of more than 3600 cases of congenital heart disease and 190 cases of acquired heart disease. In addition to the formalin-fixed cases of heart disease, there are 75 waxed heart specimens that are unparalleled for three-dimensional representation of the anatomy. There is also a collection of normal hearts, important for quantitation, from prematurity to adulthood. A series of teaching videotapes entitled *Diagnostic and Surgical Pathology of Congenital Heart Disease* (directed by Richard Van Praagh, M.D. and Stella Van Praagh, M.D.) is available for review. The Registry also has a library of relevant journals, textbooks, and theses.

The Cardiac Registry is a unique, fully integrated teaching and research resource for congenital heart disease. The Heart Collection is now non-renewable and irreplaceable because large unoperated examples of virtually all forms of congenital heart disease are no longer seen at autopsy in this country. The specimens of the Heart Collection have been saved over the past half-century and represent all eras of pediatric cardiology and cardiac surgery - from presurgical, to closed heart, to open heart. Clinical summaries are available for most cases, which allows for an appreciation of the evolution of management strategies for congenital heart malformations.

Fellows are encouraged to make full use of the Cardiac Registry throughout their training. An intensive anatomy overview course is offered each July. Formal teaching conferences are given each week that focus on specific malformations in depth. Additional conferences correlating

anatomy in the clinical settings of the ICU and echo lab are also held weekly. Individual sessions on topics of interest and concern can be arranged. Fellows may also spend elective time in the Registry. The Cardiac Registry is an ideal correlation center between cardiac pathology and all imaging modalities.

CARDIAC PHYSIOLOGY RESEARCH FACILITY

The Cardiac Physiology Research Laboratory is the large animal laboratory for the Departments of Cardiology and Cardiac Surgery. This laboratory occupies more than 3,000 square feet of space, comprising three fully equipped surgical suites with cardiopulmonary bypass capability, two recording laboratories, and the Kresge Laboratory, a state of the art research imaging facility with digital monoplane fluoroscopy, and electrophysiologic and ultrasonic graphic recording equipment. An extensive array of computer interfaced instrumentation is available for recording and analysis of physiological data. There is adjacent to this space the facilities of ARCH (Animal Resources at Children's Hospital), a veterinarian supervised facility for the care and boarding of experimental animals.

Topics currently under investigation include the effects of different cardioplegia solutions and perfusion pressures on myocardial preservation, mechanisms of cerebral damage during bypass in neonatal animals, studies on the role of calcium and other second messengers and the affects of ischemia on immature myocardium, development of tissue engineered prosthetic cardiac valves and robotic techniques in cardiovascular surgery, and design and evaluation of electrophysiologic mapping techniques.

LABORATORY OF MOLECULAR AND CELLULAR CARDIOLOGY: http://clapham.tch.harvard.edu/

The Laboratory of Molecular and Cellular Cardiology occupies more than 8,000 square feet on the 13th floor, and 5,000 square feet on the 12th floor of the Enders Research Building, including centrally organized core facilities. Dedicated equipment supports state-of-the-art techniques in molecular biology, protein biochemistry, microscopy and imaging, and basic electrophysiology, genetics, and regeneration.

The molecular biology facilities are extensive. Other techniques are well supported including the use of transgenic mice, gene chip analysis, the yeast two-hybrid system, expression cloning, cDNA cloning, and site-directed mutagenesis. Basic protein biochemistry is also a major component of work. FPLC, cold rooms, and electrophoresis apparatus are used in these endeavors. The laboratory maintains its own computer network compromising a network linking Mac, PC and Unix machines.

Extensive equipment supporting basic cardiac electrophysiology and imaging includes eight patch-clamp electrophysiology setups, 2 Olympus confocal microscopes, conventional fluorescence microscopes, and evanescent field (TIRF) microscopy.

CARDIOLOGY, CARDIAC SURGERY and CARDIAC ANESTHESIA FACULTY

(Alphabetical Listing)

MARK E. ALEXANDER, M.D.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Alexander is a member of the arrhythmia service with particular interest in the mechanisms and consequences of syncope. Following initial pediatric training and five years of general pediatric practice with the U.S. Army, he completed fellowship in Pediatric Cardiology and Electrophysiology at Children's Hospital. He directs the non-invasive electrophysiology program and co-directs the exercise laboratory. Current research focuses on fetal arrhythmias, risk assessment for ventricular arrhythmias in patients with congenital heart disease, systematic approaches to the evaluation and management of syncope and assisting with evaluation of modern pacemaker and implantable defibrillator use on pediatric and congenital heart patients. Dr. Alexander's recent publications include:

Alexander, ME. *Arrhythmias in Pediatrics: From Cell to Bedside, 5th Edition,* Eds Zipes, D and Jalife, J, 2009 941-950

Radbill AE, Brown DW, Lacro RV, Cecchin F, Berul CI, Triedman JK, Bevilacqua LM, Walsh EP, Alexander ME. Ascending aortic dilation in patients with congenital complete heart block. *Heart Rhythm* 2008 December;5(12):1704-1708

Alexander ME, Cecchin F, Huang KP, Berul CI, T-Wave Alternans in Congenital Heart Disease and Pediatrics *PACE*, Volume 29 Page 733 - July 2006

Alexander, ME, Syncope, in *Current Pediatric Therapy*, Eds Burg, FD, Ingelfinger, JR, Polin, RA, Gershon, AA, Saunders, Philadelphia, 2006, p36-39.

Fortescue EB, Berul CI, Cecchin F, Walsh EP, Triedman, JK, Alexander ME. Patient, Procedural, and Hardware Factors Associated with Pacemaker Lead Failures in Pediatrics and Congenital Heart Disease. *Heart Rhythm*, 2004, Vol 1/2 pp 150-159.

CATHERINE K. ALLAN, M.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Allan is a member of the cardiac critical care division. She completed her pediatric cardiology training and a senior fellowship in cardiac critical care at Children's Hospital, Boston in 2005. Her primary non-clinical interest is in simulation and medical education. Her research and educational endeavors focus on the use of high fidelity patient simulators to teach advanced technical, cognitive, and teamwork skills in the cardiac intensive care unit, with a particular focus on training mutlidisciplinary teams for emergent ECMO cannulation. She also serves as the Associate Program Director for the Children's Hospital Boston Simulator Program, focussing on Simulator Faculty Development and Course Development and support. In addition to her activities in medical education, Dr. Allan also continues to do clinical research in the field of pediatric cardiac intensive care. She has done research on the complex interplay of cytokines and chemokines that contribute to the inflammatory reaction to cardiopulmonary bypass as well as on outcomes of support of the failing circulation with extracorporeal membrane oxygenation. She currently serves as site PI for a

randomized controlled trial of milrinone versus niseritide versus placebo at the time of the Fontan operation. Recent publications include:

Allan CK, Thiagarajan RR, Armsby LR, del Nido PJ, Laussen PC. Emergent use of extracorporeal membrane oxygenation during pediatric cardiac catheterization. Pediatr Crit Care Med. 2006 May;7(3):212-9.

Allan CK, Thiagarajan RR, del Nido PJ, Roth SJ, Almodovar MA, Laussen PC. Indication for initiation of mechanical circulatory support impacts survival for infants with shunted single ventricle physiology supported with extracorporeal membrane oxygenation. J Thorac Cardiovasc Surg. 2007 Mar; 133(3):660-667.

Allan CK, Thiagarajan RR, Beke D, Imprescia A, Kappus L, Garden A, Hayes G, Laussen PC, Bacha E, Weinstock P. Simulation-based training delivered directly to the pediatric cardiac intenisve care unit engenders preparedness, comfort, and decreased anxiety among mutlidisciplinary resuscitation teams. J Thorac Cardiovasc Surg. In Press.

Bautista-Hernandez V, Thiagarajan RR, Fynn-Thompson F, Rajagopal SK, Nento DE, Yarlagadda V, Teele SA, Allan CK, Emani SM, Laussen PC, Pigula FA, Bacha EA. Pre-operative Extracorporeal Membrane Oxygenation as a Bridge to Cardiac Surgery in children with Congenital Heart Disease. Annals of Thoracic Surgery. 2009 Oct; 88(4)1306-11.

Costello JM, Polito A, Brown DW, McElrath TF, Graham DA, Thiagarajan RR, Bacha EM, Allan CK, Cohen JN, Laussen PC. Delivery before 39 weeks is associated with adverse outcomes in neonates with cardiac disease. Pediatrics. In Press.

MELVIN C. ALMODOVAR, M.D.
Medical Director, Cardiac ICU, Assistant Professor of Pediatrics, Harvard Medical School

Dr. Almodovar completed his cardiology fellowship with advanced fellowship training in cardiac intensive care at Children's Hospital, Boston before joining the Cardiac ICU staff in January, 2000. After serving as Director of the Cardiac ICU at The Children's Hospital, Denver he returned to the Department of Cardiology in August, 2006. His primary clinical interest includes the intensive care management of infants, children and adults before and after cardiac surgery. Other clinical interests include optimizing outcome in premature neonates with congenital heart disease, teaching basic mechanisms of single ventricle physiology, applying short and long-term mechanical circulatory support strategies, short and long-term treatment of pulmonary hypertension, and implementing and evaluating information technology in the intensive care environment. Recent publications include:

Allen CK, Thiagarajan RR, del Nido PJ, Roth SJ, ***Almodovar MC***, Wessel DL, Laussen PC. Indication for Cannulation Impacts Survival for Infants with Shunted Single Ventricle Physiology Supported with Extracorporeal Membrane Oxygenation. J Thorac Cardiovasc Surg. 2007 Mar;133(3):660-7.

Kaufman J, ***Almodovar M***, Zuk J, Friesen R. Correlation of Abdominal Site Near Infrared Spectroscopy (NIRS) with Gastric Tonometry in Infants Following Surgery for Congenital Heart Disease. Pediatric Critical Care Medicine. 2008 Jan; 9 (1); 62-8.

Almodovar MC. Principles of Postoperative Care. Chapter 38 in Section F: Clinical Disorders of Cardiac Conditions. In *Pediatric Critical Care Medicine.* Edited by Anthony Slonim & Murray Pollack. 2005.

Costello JM, ***Almodovar MC***. Emergency Care for Infants and Children with Acute Cardiac Disease. Clin Ped Emerg Med 2007, 8:145-155.

Shukla AC, ***Almodovar MC***. Anesthesia Considerations in Children with Pulmonary Hypertension. Pediatric Critical Care Medicine. Pediatric Critical Care Medicine 2010; 11 [Suppl.]: S70-S73.

PUJA BANKA, M.D.
Instructor in Pediatrics, Harvard Medical school

Dr. Banka completed her medical training at Stanford University before joining the Children's Hospital Boston pediatrics residency program. She then completed her cardiology fellowship and a year of subspecialty training in non-invasive imaging before joining the Department of Cardiology as a member of the Non-Invasive Imaging division with interests in both echocardiography and cardiac magnetic resonance imaging. In addition, Dr. Banka spends time attending on the inpatient cardiology service, as well as directing the 4th year medical student pediatric cardiology clerkship and the quality improvement activities of the Non-Invasive Imaging division. Her research interests include clinical cardiology, non-invasive imaging, and quality improvement. Recent publications include:

Banka P, McElhinney DB, Bacha EA, Mayer JE, Gauvreau K, Geva T, Brown DW. What is the clinical utility of routine cardiac catheterization before a Fontan operation? Pediatric Cardiology 2010; 31: 977-985.

Banka P, Bacha EA, Powell AJ, Benavidez OJ, Geva T. Outcomes of inferior sinus venosus defect repair. J Thorac and Cardiovasc Surg 2011; 142: 517-22.

Banka P, Sleeper LA, Atz AM, Cowley CG, Gallagher D, Gillespie MJ, Graham EM, Margossian R, McCrindle BW, Sang CJ, Williams IA, Newburger JW, for the Pediatric Heart Network Investigators. Practice variability and outcomes of coil embolization of aortopulmonary collaterals prior to Fontan completion: a report from the Pediatric Heart Network Fontan Cross-Sectional Study. American Heart Journal 2011; 162: 125-30.

LISA J. BERGERSEN, M.D.
Assistant Professor in Pediatrics, Harvard Medical School

Dr. Bergersen is a member of the interventional catheterization division. She completed her pediatric interventional catheterization training at Children's Hospital Boston in 2004. She is developing outcome and performance assessment tools in congenital cardiac catheterization. Recent publications include:

Bergersen L, Foerster S, Marshall AC, Meadows J. Congenital Heart Disease: The Catheterization Manual. New York : Springer;2009.

Bergersen L, Everett AD, Giroud JM, Martin GR, Franklin RC, Béland MJ, Krogmann ON, Aiello VD, Colan SD, Elliott MJ, Gaynor JW, Kurosawa H, Maruszewski B, Stellin G, Tchervenkov CI, Walters HL, Weinberg P, Jacobs JP. Report from The International Society for Nomenclature of Paediatric and Congenital Heart Disease: Cardiovascular Catheterization for Congenital and Paediatric Cardiac Disease (Part 1 – Procedural Nomenclature). Cardiol Young. 2011;21:252-259.

Bergersen L, Gauvreau K, Marshall A, Kreutzer J, Beekman R, Hirsch R, Foerster S, Balzer D, Vincent J, Hellenbrand W, Holzer R, Cheatham J, Moore J, Lock J, Jenkins K. Procedure Type Risk Category. Circ Intervention. 2011;(2):188-94.

Bergersen L, Justino H, Nugent A, Rome J, Kreutzer J, Rhoades J, Nykanen D, Zahn E, Latson L, Moore P, Gauvreau K, Lock J, Jenkins J. Catheterization for Congenital Heart Disease Adjustment for Risk Method (CHARM). Am J Cardiol. 2011;4(9): 1037-46

Bergersen L, Justino H, Nugent A, Rome J, Kreutzer J, Rhoades J, Nykanen D, Zahn E, Latson L, Moore P, Gauvreau K, Lock J, Jenkins J. A Randomized Trial of Cutting Balloon® Compared to High Pressure Angioplasty

for the Treatment of Resistant Pulmonary Artery Stenosis. Circulation. 2011; Accepted

LAURA M. BEVILACQUA, M.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Bevilacqua is a member of the arrhythmia service. Her pediatric cardiology training was at Babies' and Children's Hospital of New York (Columbia Presbyterian Medical Center), followed by additional training in electrophysiology at Children's Hospital, Boston. During her training, Dr. Bevilacqua conducted basic science laboratory work evaluating electrophysiologic phenotypes in transgenic mice. Her primary research interests include mechanisms of ventricular tachycardia in mouse models of hypertrophic cardiomyopathy. Dr. Bevilacqua's recent publications include:

Bevilacqua LM, Maguire CT, Seidman CE, Seidman JG, Berul CI. QT Dispersion in alpha-MHC familial hypertrophic cardiomyopathy mice. *Pediatr Res* 1999;45:643-647.

Maguire CT, Bevilacqua LM, Wakimoto H, Gehrmann J, Berul CI. Maturational atrioventricular nodal physiology in the mouse. *J Cardiovasc Electrophysiol* 2000;11(5):557-563.

Bevilacqua LM, Rhee EK, Epstein MR, Triedman JK. Focal Ablation of chaotic atrial rhythm in an infant with cardiomyopathy. *J Cardiovasc Electrophysiol* 2000;11(5):577-591.

Bevilacqua LM, Berul CI. Familial Hypertrophic Cardiomyopathy Genetics, in Molecular Genetics of Cardiac Electrophysiology. Eds. Berul CI and Towbin JA. Kluwer Academic Publishers, Norwell, MA, 2000.

Bevilacqua LM, Simon AM, Maguire CT, Gehrmann J, Wakimoto H, Paul DL, Berul CI. A targeted disruption in connexin40 leads to distinct atrioventricular conduction defects. JICE 2000;4:459-467.

ELIZABETH D. BLUME, M.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Blume is Medical Director of the Heart Failure and Transplant Program at Children's Hospital Boston where her clinical time is spent caring for children with end-stage heart disease and heart transplant patients. She has served as the pediatric representative to the Heart Failure/Transplant Committee of the American College of Cardiology, and the Region 1 representative to the UNOS Pediatric Committee. Dr. Blume has contributed to multiple research projects involving children with heart failure, serving as the PI for an initial multi-center trial of carvedilol in children, as a member of the Steering Committee for the first randomized beta blocker trial in children, and as PI on the multicenter ventricular assist device study from the Pediatric Heart Transplant Study, of which she is currently serving as President. As pediatric chair to the NIH contract of Intermacs, Dr. Blume continues to work actively between the FDA, NIH, industry, and clinicians to attempt to coordinate the registry efforts for future device trials for pediatric mechanical circulatory support.
Dr. Blume's recent publications include:

Blume ED, CE Canter, R. Spicer, SD Colan, K Jenkins. Prospective multi-center protocol of adjunct carvedilol in pediatric patients with moderate ventricular dysfunction. Pediatric Cardiology 2006; 27(3):336-42.

Blume ED, Naftel DC, Bastardi HJ, Duncan BW, Kirklin JK, Webber SA for the PHTS Investigators. Outcomes of Children Bridged to Heart Transplant with Ventricular Assist Devices: A Multi-Institutional Study. Circulation 2006; 113(19):2313-2319.

Shaddy RE, Boucek MM, Hsu DT, Boucek RJ, Canter CE, Mahony L, Ross RD, Pahl E, **Blume ED**, Dodd DA,

Rosenthal DN, Burr J, LaSalle B, Holubkov R, Lukas MA, Tani LY. for the Pediatric Carvedilol Study Group. Carvedilol for children and adolescents with heart failure: a randomized controlled trial. JAMA 2007; 298(10):1171-9.

Singh TP, Gauvreau K, Rhodes J, **Blume ED.** Longitudinal changes in Heart Rate Recovery Following Maximal Exercise in Pediatric Heart Transplant Recipients: Evidence of Autonomic Re-innervation. J Heart Lung Transplant 2007; 26(12):1306-12.

ROGER E. BREITBART, M.D.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Breitbart trained in both clinical cardiology and cardiac molecular biology. Prior research focused on mechanisms of cardiac gene regulation, and on the application of genomic strategies for identification of novel molecular pathways in the cardiovascular system. From 1996-2002 he headed the cardiovascular drug target discovery programs at Millennium Pharmaceuticals, Inc., in Cambridge, MA. Current research collaborations focus on the identification of novel disease genes in congenital heart disease, particularly tetralogy of Fallot, and the elucidation of genotype-phenotype correlations. Dr. Breitbart chairs the Publications and Presentations Committee and serves on the Executive Committee of the NHLBI Pediatric Heart Network. He is also a co-investigator in the NHLBI Pediatric Cardiac Genomics Consortium. Dr. Breitbart is the interim chief of the cardiology inpatient service (8 East). His principal clinical activities involve the inpatient management of children referred with complex congenital heart disease. Recent publications include:

Anderson PAW, Sleeper LA, Mahony L, Colan SD, Atz AM, Breitbart RE, Gersony WM, Gallagher D, Geva T, Margossian R, McCrindle BW, Paridon S, Schwartz M, Stylianou M, Williams RV, Clark BJ. Contemporary outcomes after the Fontan procedure: a Pediatric Heart Network Multicenter Study. J Am Coll Cardiol. 2008;52:114-116.

Greenway SC, Pereira AC, Lin JC, DePalma SR, Israel SJ, Mesquita SM, Ergul E, Conta JR, Korn JM, McCarroll SA, Gorham JM, Gabriel S, Altshuler DA, Quintanilla-Dieck ML, Artunduaga MA, Eavey RD, Plenge RM, Shadick NA, Weinblatt ME, DeJager PL, Hafler DA, Breitbart RE, Seidman JG, Seidman CE. *De novo* copy number variants identify new genes and loci in isolated, sporadic tetralogy of Fallot. *Nature Genet.* 2009;41:931-935.

McCrindle BW, Zak V, Sleeper LA, Paridon SM, Colan SD, Geva T, Mahony L, Anderson PAW, Breitbart RE, Margossian R, Williams RV, Gersony WM, Atz AM. Laboratory measures of exercise capacity and ventricular characteristics and function are weakly associated with functional health status after Fontan. *Circulation* 2010;121:34-42.

Anderson PAW, Breitbart RE MD, McCrindle BW, Sleeper LA, Atz AM, Hsu DT, Lu M, Margossian R, Williams RV. The Fontan patient: inconsistencies in medication therapy across seven Pediatric Heart Network centers. Ped Cardiol. 2010;31:1219-1228.

Atz AM, Travison TG, McCrindle BW, Mahony L, Quartermain M, Williams RV, Breitbart RE, Lu M, Radojewski E, Margossian R, Covitz W, Gersony WM. Late status of Fontan patients with persistent surgical fenestration. J Am Coll Cardiol. 2011;57:2437-2443.

DAVID W. BROWN, M.D.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Brown attended Williams College and subsequently Harvard Medical School, and completed

pediatric residency and pediatric cardiology fellowship training at Children's Hospital, including a senior fellowship year in the non-invasive imaging laboratory. As staff in the non-invasive imaging division, his primary interests include transthoracic, transesophageal, and fetal echocardiography in the management of congenital heart disease, with special interest in single ventricle heart disease and aortic stenosis. Dr. Brown has a longstanding interest in teaching, and is Director of the Fellowship Training Program. In addition, he serves as inpatient cardiology ward attending, and is the supervisor of the Harvard Medical School third and fourth year medical student cardiology rotations. He is Co-Chair of the Program in Patient Safety and Quality Education Committee. Dr. Brown serves as the cardiology liaison at Children's Hospital for several pediatric cardiologists throughout New England, directs a quarterly congenital cardiology CME series, and is co-founder of the New England Congenital Cardiology Association, a regional collaborative network of pediatric cardiologists, cardiac surgeons, and allied professionals in New England. Publications include:

Brown DW, Gauvreau K, Powell AJ, Lang P, Colan SD, del Nido PJ, Odegard KC, Geva T. Cardiac Magnetic Resonance Versus Routine Cardiac Catheterization Before Bidirectional Glenn Anastomosis in Infants With Functional Single Ventricle: A Prospective Randomized Trial. Circulation 2007; 116:2718-2725.

Brown DW, Chong EC, Gauvreau K, Keane JF, Lock JE, Marshall AC. Aortic Wall Injury as a Complication of Neonatal Aortic Valvuloplasty: Incidence and Risk Factors. Circ Cardiovasc Intervent 2008:1, 53-59.

Peiris V, Singh TP, Tworetzky WT, Chong EC, Gauvreau K, **Brown DW**. Association of Socioeconomic Position and Medical Insurance With Fetal Diagnosis of Critical Congenital Heart Disease. Circ Cardiovasc Qual Outcomes 2009.

Brown DW, Dipilato AE, Chong EC, Lock JE, McElhinney DB. Aortic Valve Reinterventions After Balloon Aortic Valvuloplasty for Congenital Aortic Stenosis: Intermediate and Late Follow-up. *J Am Coll Cardiol* 2010;56:1740-9.

Brown DW, Dipilato AE, Chong EC, Gauvreau K, McElhinney DB, Colan SD, Lock JE. Sudden Unexpected Death After Balloon Valvuloplasty for Congenital Aortic Stenosis. *J Am Coll Cardiol* 2010;56:1939-46.

ALFONSO CASTA, M.D.
Associate Professor of Anaesthesia, Harvard Med School

Dr. Casta received his undergraduate and medical degrees from the University of Puerto Rico. He completed a fellowship in Pediatric Cardiology at St. Christopher's Hospital for Children. He was an Associate Professor in Pediatrics at the University of Texas Medical Branch at Galveston for eleven years. Later he completed an anesthesia residency at the University of Texas Medical Branch at Galveston. Before joining the Department of Anesthesia at Children's Hospital in Boston, he completed a fellowship in Pediatric Anesthesia at Children's Hospital in Boston. He is a Diplomat of the American Board of Pediatrics, Sub Board of Cardiology and the American Board of Anesthesiology. His clinical focus is to provide anesthesia for children with various congenital cardiac diseases. Selected publications:

Casta A, Gruber EM, Laussen PC, McGowan FX, Odegard KC, Zurakowski D, Hansen DD. Parameters associated with perioperative baffle fenestration closure in the Fontan operation. J Cardiothorac Vasc Anesth. 2000; 14(5):553-6.

Chrysostomou C, Di Filippo S, Manrique AM, Schmitt CG, Orr RA, Casta A, Suchoza E, Janosky J, Davis PJ,

Munoz. Use of dexmedetomidine in children after cardiac and thoracic surgery. Critical Care Medicine (in press).

Sakhai H, Casta A. Use of nitric oxide for treatment of pulmonary hypertensive crisis in a child after protamine administration. J Cardiothorac Vasc Anesth (in press).

FRANK CECCHIN, M. D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Cecchin is a member of the electrophysiology division and has special expertise in the implantation of pacemakers and defibrillators. Educating the fellows in electrophysiology is a top priority. His major research interests are clinical and focused at the utilization of medical devices for improving the health of children with cardiovascular disease. Current work involves the prophylactic use of ICDs for prevention of sudden death in children with hypertrophic cardiomyopathy, resynchronization therapy in pediatrics and congenital heart disease and cardiac resuscitation. Dr. Cecchin's recent publications include:

Van Hare GF, Chiesa NA, Campbell RM, Kanter RJ, Cecchin F, for the Pediatric Electrophysiology Society. Atrioventricular node reentrant tachycardia in children: effect of slow pathway ablation on fast pathway function. *J Cardiovasc Electrophysiol*. 2002;13:203-209.

Cecchin F, Jorgenson D, Berul I, Pery JC, Zimmerman AA, Duncan BW, Lupinetti FM, Snyder D, Lyster TD, Rosenthal GL, Atkins D. Accuracy of Automatic External Defibrillator Arrhythmia Analysis Algorithm in Children. *Circulation*. 2001;103:2483-8.

Davis JA, Cecchin F, Jones TK, Portman MA: Major coronary artery anomalies in a normal pediatric population: Incidence and clinical importance. *Journal of American College of Cardiology*: 2001;37(2):593-7.
Harris JP, Cecchin F, Perry JC. Infantile chaotic atrial tachycardia: Association with viral infections. *Annals of Non-Invasive Electrophysiology*: 2000;5(3):279-83.

Stefanelli CB, Stevenson JG, Jones TK, Lester JR, Cecchin F: A case for routine screening of coronary artery origins during echocardiography: Fortuitous discovery of a life threatening coronary anomaly. *Journal of American Society of Echocardiography*. 1999;12(9):769-72.

Cecchin F, Johnsrude CL, Perry JC, Friedman RA: Effect of age and surgical technique on symptomatic arrhythmias after the Fontan procedure. *The American Journal of Cardiology. 1995;76:386-91.*

MING HUI CHEN, M.D., M.M.Sc., F.A.C.C., F.A.S.E.
Assistant Professor of Medicine, Harvard Medical School

Dr. Chen's clinical and research interests are cardiovascular disease in cancer survivors, stress echocardiography, and echocardiography in congenital heart disease. As childhood cancer survivorship has become increasingly common, cardiovascular disease remains one of the leading causes of long-term mortality in this population. Ongoing research projects involve 1) long-term cardiac follow-up of Hodgkin's lymphoma patients following chest radiation, and 2) cardiac side-effects of new biologic anti-cancer agents, such as tyrosine kinase inhibitors. She is a member of the Cardiovascular Disease Taskforce of the Children's Oncology Group and the Cardiac Effects of Cancer Therapy Guidelines Committee for the Heart Failure Society of America.

In collaboration with the non-invasive laboratory at CHB, she leads the Exercise Stress Echocardiography program for children. Current stress echocardiography projects include use of

stress echocardiography to assess for ischemia, contractility in cardiomyopathy, and exercise gradients in valvular heart disease. Collaborating with the Division of Genetics at Children's Hospital, she studies the effect and mechanisms of FilaminA mutations on the congenital heart abnormalities in humans and in mouse models.

Selected publications:

Exercise Stress Echocardiography:
Chen MH, Abernathey E…Utility of exercise stress echocardiography in pediatric cardiac transplant recipients: A single center experience. (Submitted).

Cardiac Disease in Cancer Survivors:
Chen MH, Colan, SD, Diller, L. Cardiovascular disease: Cause of morbidity and mortality in adult survivors of childhood cancers. Circ Research 2011; 108:619-628.

Chen MH. Cardiac dysfunction induced by novel targeted anti-cancer therapy: an emerging issue. Current Cardiology Reports 2009;11(3): 167-174.

Shankar SM, Marina N,…**Chen MH…**. Monitoring for Cardiovascular Disease in Survivors of Childhood Cancer: Report From the Cardiovascular Disease Task Force of the Children's Oncology Group. Pediatrics 2008;121(2):e387-e396.

Chu TF, Rupnick MA, …**Chen MH**. Cardiotoxicity associated with tyrosine kinase inhibitor sunitinib. Lancet 2007;370(9604):2011-9.

DAVID E. CLAPHAM, M. D., Ph.D.
Aldo R. Castañeda Professor of Cardiovascular Research, Director of Cardiovascular Research, Children's Hospital, Professor of Neurobiology, Harvard Medical School.

David E. Clapham, M.D., Ph.D**.,** is the Aldo R. Castañeda Professor of Cardiovascular Research at Children's Hospital Boston, a Professor of Neurobiology at Harvard Medical School, Investigator of the Howard Hughes Medical Institute, and an elected member of the National Academy of Sciences and the American Academy of Arts and Sciences. He earned his Electrical Engineering degree at the Georgia Institute of Technology and his M.D. and Ph.D. in Anatomy/Cell Biology from Emory University School of Medicine. He completed his residency in Internal Medicine at Brigham and Women's Hospital of Harvard Medical School. Dr. Clapham was a senior Fulbright Fellow during his postdoctoral training with Erwin Neher at the Max Planck Institute for Biophysical Chemistry in Göttingen, Germany. Dr. Clapham established his independent research laboratory in the Department of Medicine at Brigham and Women's Hospital of Harvard Medical School in 1985. He moved to the Mayo Clinic in 1987 and became Distinguished Investigator. He received the American Heart Association Basic Science Prize and the Cole Award from the Biophysical Society. Dr. Clapham's major research interest is the signal transduction control of ion channels. This encompasses identification of genes encoding novel ion channels, proteins interacting with these channels, and elucidation of their roles in cardiac and vascular function. The laboratory's major interest is in understanding calcium-permeant ion channels that regulate intracellular calcium and appear to have important roles in development and cell migration. Recent work also includes the development of knockout mouse models for understanding G protein gated channel control of heart rate and the role they play in atrial arrhythmias.

For a review of research in the Clapham lab, see http://clapham.tch.harvard.edu/.

Riccio A, Li Y, Moon J, Kim KS, Smith KS, Rudolph U, Gapon S, Yao GL, Tsvetkov E, Rodig SJ, Van't Veer A, Meloni EG, Carlezon WA, Jr., Bolshakov VY, and Clapham DE. 2009. Essential role for TRPC5 in amygdala function and fear-related behavior. ***Cell*** 137: 761-772. PMCID: PMC2719954.

Zhou H and Clapham DE. 2009. Mammalian MagT1 and TUSC3 are required for cellular magnesium uptake and vertebrate embryonic development. 2009. ***Proc Natl Acad Sci USA*** 106: 15750-15755. PMCID: PMC2732712.

Cheng, X, Jin, J, Hu, L, Shen, D, Dong, X, Samie, MA, Knoff, J, Eisinger, B, Liu, M, Huang, SM, Caterina, MJ, Dempsey, P, Michael, E, Dlugosz, A, Andrews, NC, Clapham, DE, and Xu, H. 2010. TRP channel regulates EGFR signaling in hair morphogenesis and skin barrier formation. ***Cell***, 141, 331-343.

Febvay, S, Marini, DM, Belcher, AM, and Clapham, DE. 2010. Targeted cytosolic delivery of cell-impermeable compounds by nanoparticle-mediated, light-triggered endosome disruption. ***Nano Letters***, 10.1021/nl101157z online May 5; 10, 2211-2219.

Ramsey, IS, Mokrab, Y, Carvacho, I, Sands, ZA, Sansom, MSP, Clapham, DE. 2010. An aqueous H^+ permeation pathway in the voltage-gated proton channel, Hv1. ***Nature Structural and Molecular Biology***, 17, 869-875.

STEVEN D. COLAN, M.D.
Professor of Pediatrics, Harvard Medical School

Dr. Colan is the Associate Chief for Clinical Operations. In addition to his administrative and research activities, he shares staffing responsibilities in echocardiography. His major interests relate to the assessment and treatment of myocardial diseases, including evaluation of left ventricular systolic and diastolic function, clinical aspects of cardiomyopathies, and myocardial performance in congenital and acquired heart disease. The development and validation of non-invasive diagnostic methodologies and instruments remains an important aspect of his clinical and investigative activities. He has spent considerable effort, as well, on the application and implementation of computer-based computational techniques to the analysis of cardiac physiology. Samples of recent publications include:

Lipshultz SE, Sleeper LA, Towbin JA, Lowe AM, Orav EJ, Cox GF, Lurie PR, Mccoy KL, Mcdonald MA, Messere JE, Colan SD. The incidence of pediatric cardiomyopathy in two geographic regions of the United States: the Prospective Pediatric Cardiomyopathy Registry. *N Engl J Med* 2003; 348: 1647-1655.

Lipshultz SE, Lipsitz SR, Sallan SE, Dalton VM, Mone SM, Gelber RD, Colan SD. Chronic progressive cardiac dysfunction years after doxorubicin therapy for childhood acute lymphoblastic leukemia. J Clin Oncol 2005; 23: 2629-2636.

McElhinney DB, Lock JE, Keane JF, Moran AM, Jonas RA, Colan SD. Left heart growth, function and reintervention after balloon aortic valvuloplasty for neonatal aortic stenosis. Circulation 2005; 111: 451-458

Sluysmans T, Colan SD. Theoretical and empirical derivation of cardiovascular allometric relationships in children. J Appl Physiol 2005; 99: 445-457

Colan SD, Lipshultz SE, Lowe AM, Sleeper LA, Messere J, Cox GF, Lurie PR, Orav EJ, Towbin JA. Hypertrophic cardiomyopathy in children: Findings from the Pediatric Cardiomyopathy Registry. Circulation 2007; 115: 773-781.

SARAH D. DE FERRANTI, M.D., M.P.H.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. de Ferranti directs the Preventive Cardiology Program and participates in the Clinical Cardiology service on an inpatient and outpatient basis. She sees patients with hyperlipidemia, hypertension and other atherosclerotic risk factors both in clinic satellites and Thursday morning in the Boston site Preventive Cardiology Clinic. On Thursday afternoons she sees patients with general pediatric cardiology complaints. Her research interests focus on hyperlipidemia, atherosclerosis - particularly the inflammatory mechanism of disease, hypertension, childhood obesity, the metabolic syndrome and insulin resistance, and the familial aspects of these factors in children and young adults. She runs monthly multidisciplinary rounds on Preventive Cardiology topics and a monthly journal club. Recent publications include:

Selamet Tierney ES, Newburger JW, Gauvreau K, Geva J, Coogan E, Colan SD, **de Ferranti SD**. Endothelial Pulse Amplitude Testing: Feasibility and Reproducibility in Adolescents. ***J Pediatr***. 2009; 154(6):901-5. Epub 2009 Feb 12

de Ferranti SD, Gauvreau K, Ludwig D, Newburger J, Rifai N. Inflammation and Changes in Metabolic Syndrome Abnormalities in US Adolescents: Findings from the 1988-1994 and 1999-2000 National Health and Nutrition Examination Surveys. ***Clinical Chemistry*** 2006 Jul;52(7):1325-30.

de Ferranti SD, Gauvreau K, Ludwig DS, Neufeld EJ, Newburger JW, Rifai N. Prevalence of the Metabolic Syndrome in American Adolescents: Findings from the Third National Health and Nutrition Examination Survey. ***Circulation***. 2004 Oct;110(16):2494-7.

de Ferranti SD, Ludwig DS. Storm over statins - the controversy surrounding pharmacologic treatment of children. **N Engl J Med.** 2008 Sep 25;359(13):1309-12.

de Ferranti SD, Mozaffarian D. The perfect storm: obesity, adipocyte dysfunction, and metabolic consequences. **Clin Chem**. 2008 Jun;54(6):945-55. Epub 2008 Apr 24.

PEDRO J. del NIDO, M.D.
Chairman, Department of Cardiac Surgery, Children's Hospital Boston; William E. Ladd Professor of Child Surgery, Harvard Medical School

Dr. delNido's laboratory research work has focused on the following areas related to cardiac surgery:

"Image-guided Intracardiac Beating Heart Surgery"
This is a Bioengineering Research Partnership to develop novel imaging techniques and instrument modification for performing reconstructive surgery inside the beating heart. The partnership includes two engineering laboratories (Dupont-Children's Hospital Boston; Howe-Harvard DEAS), and industry (Philips Medical Systems) working on modification of ultrasound imaging hardware, image processing, instrument modification, and device development.

"Pediatric Cardiovascular Device Consortium"
The goal of this project is to provide expertise and resources to device developers and manufacturers at each of the steps necessary for novel pediatric cardiac device development in order to accelerate the pace of innovation.This Consortium includes expertise from New England

Research Institute (Sleeper); University of Michigan (Bocks); Georgia Tech (Yoganathan); and Philips Medical Systems, Inc. (Salgo).

"3D MRI-Based Modeling for Computer-Aided Right Ventricle Remodeling Surgery"
This project proposes to develop a mathematical model of the right ventricle in patients late after repair of Tetralogy of Fallot and a tool for planning surgical reconstruction of the right ventricle.

Geva T, Gauvreau K, Powell AJ, Cecchin F, Rhodes J, Geva J, **del Nido P**. Randomized trial of pulmonary valve replacement with and without right ventricular remodeling surgery. Circulation. 2010 Sep 14;122(11 Suppl):S201-8.

Hammer PE, Sacks MS, **del Nido PJ,** Howe RD. Mass-spring model for simulation of heart valve tissue mechanical behavior. Ann Biomed Eng. 2011 Jun;39(6):1668-79.

Walter EM, Vasilyev NV, Sill B, Padala M, Jimenez J, Yoganathan AP, Hetzer R, **del Nido PJ**. Creation of a tricuspid valve regurgitation model from tricuspid annular dilatation using the cardioport video-assisted imaging system. J Heart Valve Dis. 2011 Mar;20(2):184-8.

Tang D, Yang C, Geva T, Gaudette G, **del Nido PJ**. Multi-Physics MRI-Based Two-Layer Fluid-Structure Interaction Anisotropic Models of Human Right and Left Ventricles with Different Patch Materials: Cardiac Function Assessment and Mechanical Stress Analysis. ComputStruct. 2011 Jun;89(11-12):1059-1068.

Vasilyev NV, Kawata M, Dibiasio CM, Durand KV, Hopkins J, Traina ZJ, Slocum AH, **del Nido PJ**. A novel cardioport for beating-heart, image-guided intracardiac surgery. J ThoracCardiovasc Surg. 2011 Aug 18. [Epub ahead of print].

DAVID R. DEMASO, M.D.
Professor of Psychiatry and Pediatrics, Harvard Medical School

Dr. DeMaso is Psychiatrist-in-Chief, Chairman of Psychiatry, and Leon Eisenberg Chair in Psychiatry at Children's Hospital Boston (CHB). He completed a pediatric internship at Massachusetts General Hospital, general psychiatry training at Duke University Medical Center, child psychiatry training at Judge Baker Guidance Center/CHB, and a pediatric psychiatry consultation fellowship at CHB. He is Senior Associate in Psychiatry and Cardiology consulting to the Department for 30 years. Children and families facing the stresses of having pediatric heart disease have been at the center of his clinical and research work.

DeMaso DR, Kelley SD, Bastardi H, O'Brien P, Blume ED. The Longitudinal Impact of Psychological Functioning, Medical Severity, and Family Functioning in Pediatric Heart Transplantation. J Heart Lung Transplant 2004; 23:473-480

Baker A, Baptista-Neto L, Newburger JW, DeMaso DR. Psychosocial Concerns in Children with Kawasaki Disease. Progress in Pediatric Cardiology 2004;19:189-194.

Farley LM, DeMaso DR, D'Angelo, Kinnamon C, Bastardi H, Hill CE, Blume ED. Parenting Stress and Parental Post-Traumatic Stress Disorder in Families Following Pediatric Heart Transplantation. J Heart Lung Transplant 2007; 26: 120-126

Bers MU, Beals LM, Chau C, Satoh K, Blume ED, DeMaso DR, Gonzalez-Heydrich J. Use of a virtual community as a psychosocial support system in pediatric transplantation. Pediatric Transplantation 2010;14:261-267

Bellinger DC, Wypij D, Rivkin MJ, **DeMaso DR**, Robertson RL, Rappaport LA, Wernovsky G, Jonas RA, Newburger JW. Adolescents with d-Transposition of the Great Arteries Corrected with the Arterial Switch Procedure: Neuropsychological Assessment and Structural Brain Imaging. Circulation (In press)

JAMES A. DINARDO, M.D., FAAP

Assistant in Cardiology; Francis X. McGowan, Jr., M.D. Chair in Cardiac Anesthesia; Interim Chief, Division of Cardiac Anesthesi, Children's Hospital Boston; Professor of Anaesthesia, Harvard Medical School

Dr. DiNardo graduated from Dartmouth College and Dartmouth Medical School (with honors). He completed his anesthesia residency, a fellowship in Cardiac Anesthesia, and was Chief Resident in Anesthesia at Beth Israel Hospital in Boston. He has served as Co-Director of Cardiac Anesthesia at Beth Israel Hospital in Boston, as well as Director of Cardiothoracic Anesthesiology, Associate Department Chief, and Clinical Director of Anesthesiology, all at Arizona Health Sciences Center, and Chief of Anesthesiology, Tucson Heart Hospital. He has received numerous teaching awards. Dr. DiNardo has received certification in perioperative transesophageal echocardiography and transthoracic echocardiography by the National Board of Echocardiography and is the outgoing Chair of the Perioperative TEE Exam Committee as well as a member of Board of Directors of the National Board of Echocardiography. He is a senior examiner of the American Board of Anesthesiology and a Member of the Joint Council. His major clinical interests are perioperative echocardiography and abnormalities of coagulation in patients with congenital heart disease particularly during cardiopulmonary bypass. His major research interest is coagulation. Current research involves: 1) pharmacokinetics of tranexamic acid during CPB, 2) kinetics of thrombin formation during CPB and ECMO, and 3) analysis of cerebral blood flow following superior cavopulmonary anastomosis 4) risk factors for procedural sedation failure in children. He is the author of a major textbook "Anesthesia for Cardiac Surgery, 3rd Edition" and has authored or co-authored more than 100 peer-reviewed articles and book chapters. Selected recent publications:

DiNardo JA: Should what we know about neurobehavioral development, complex congenital heart disease and brain maturation affect the timing of corrective cardiac surgery? Paediatr Anaesth 2011; 21:781-6.

Burch TM, McGowan FX, Kussman BD, Powell JA, **DiNardo, JA**: Congenital supravalvular aortic stenosis and sudden death associated with anesthesia: What's the mystery?

DiNardo JA, Andropoulos, DA, Baum VC: A proposal for training in pediatric cardiac anesthesia. Anesth Analg 2010; 110:1121-5.
Anesth Analg 2008; 107:1848-54.

Kussman BD, Wypij D, Laussen PC, Soul JS, Bellinger DC, **DiNardo JA**, Robertson R, Pigula FA, Jonas RA, Newburger JW: Relationship of intraoperative cerebral oxygen saturation to neurodevelopmental outcome and brain magnetic resonance imaging at 1 year of age in infants undergoing biventricular repair. Circulation 2010; 122:245-54.

Meier PM, Goobie SM, **DiNardo JA**, Proctor MR, Zurakowski D, Soriano SG: Endoscopic strip craniectomy in early infancy: The initial five years of anesthesia experience. Anesth Analg 2011; 112:407-14.

MICHAEL D. FREED, M.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Freed is a Senior Associate in Cardiology and past Chair of the Graduate Medical Education Committee of the Hospital. He has held positions of leadership on the Executive Board and Program committee of the American Academy of Pediatrics, American Heart Association, Cardiovascular Disease of the Young, and the Pediatric Cardiology Committee of the American College of Cardiology and the Sub-Board of Pediatric Cardiology of the American Board of Pediatrics where he was chair of its credentials committee. He recently finished a 5 year term as a Trustee of the American College of Cardiology. Starting July 1, 2008 he went to part-time status.

In addition to maintaining a clinical practice, Dr. Freed has written extensively on the variety of topics in pediatric cardiology. Dr. Freed's recent publications include:

Graham TP Jr. Beekman RH 3rd, Allen HD, Bricker JT, Freed MD, et al. ACCF/AHA/AAP recommendation for training in pediatric cardialog a report of the American College of Cardiolgoy Foundation/American Heart Association/American College of Physicians Task Force on Clinical Competence (ACC/AHA/AAP Writing Committee to Develop Training Recommendations for Pediatric Cardiology). *Circulation* 2005;112:255-80

Faxon DP, Freed, MD et al. ACC/AHA 2006 guidelines for management of patients with valvular heart disease: a report of the American College of Cardiology. American Heart Association Task Force on Practice Guidelines (writing committee to revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease). *Circulation* 2006;114:e84-231.

Child JS, Freed MD, Mavroudis C, Moodie DS, Tucker AL. Task Force9: training in the care of adult patients with congenital heart disease. *J AM Coll Cardiol.* 2008 51: 389-93.

Selamet Tierney ES, Graham DA, McElhinney DB, Trevey S. Freed MD, Colan SD, Geva T. Echocardiographic prediators of mitral stenosis-related death or intervention on infants. *AM Heart J.* 2008;156: 384-90.

DAVID R. FULTON, M.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Fulton is Chief of Outpatient Cardiology Services. After completing his fellowship in cardiology at Children's, he was a staff cardiologist at Floating Hospital for Children later serving as Chief of the Division of Pediatric Cardiology and Associate Chairman for Network and Development of the Department of Pediatrics. In addition to a large clinical practice, he has specific interest in Kawasaki disease. His major focus is the establishment of a network of satellite cardiology clinics integrating primary care with the tertiary and quaternary cardiology intervention at the Children's campus. His recent publications include:

Leung DYM, Meissner HC, Fulton DR, Murray DL, Kotzin BL, Schlievert PM. Toxic shock syndrome toxin-secreting Staphylococcus aureus in Kawasaki syndrome. Lancet 1993;342:1385-88.

Fulton DR, Marx GR, Romero BB, Mumm B, Krauss M, Wollschläger H, Ludomirsky A, Pandian NG. Dynamic three-dimensional echocardiographic imaging of congenital heart defects in infants and children by computer controlled tomographic parallel slicing using a single integrated ultrasound instrument. Echocardiography 1994; 11:155-164.

Hijazi ZM, Geggel RG, Marx GR, Rhodes J, Fulton DR. Balloon angioplasty for native coarctation of the aorta:

acute and mid-term results. *J Invas Cardiol* 1997;9:344-348

Hill SL, Evangelista JK, Pizzi AM, Mobassaleh M, Fulton DR, Berul CI. Proarrhythmia associated with cisapride in children. *Pediatr* 1998;101:1053-1056.

FRANCIS E. FYNN-THOMPSON, M.D.
Instructor in Surgery, Harvard Medical School, Surgical Director, Heart and Lung Transplantation and Surgical Director, Mechanical Support Program

Dr. Fynn-Thompson is a member of the Department of Cardiac Surgery. He attended the University of Pennsylvania and subsequently Harvard Medical School and completed general surgery residency and cardiothoracic surgery fellowship at the Massachusetts General Hospital. His clinical work focuses on the surgical treatment of all forms of congenital heart disease with special interest in heart and lung transplantation, pediatric VADs and Cardiac ECMO and arrhythmia surgery.

KIMBERLEE GAUVREAU, Sc.D.
Associate Professor of Pediatrics, Harvard Medical School and Assistant Professor of Biostatistics, Harvard School of Public Health

Dr. Gauvreau provides biostatistical support to members of the Cardiovascular Program. She collaborates on a wide variety of projects focusing on such areas as short- and long-term outcomes following cardiovascular surgery and the effects of patient and hospital characteristics on mortality and resource use for children with congenital heart disease. Her duties also involve consulting on diverse statistical analyses, and providing biostatistical instruction to fellows and staff. Publications include:

Connor JA, **Gauvreau K**, Jenkins KJ. Factors associated with increased resource utilization for congenital heart disease. Pediatrics 2005; 116:689-695.

Benavidez OJ, **Gauvreau K**, Bacha EA, del Nido PJ, Jenkins KJ. Complications and risk factors for mortality during congenital heart surgery admissions. Annals of Thoracic Surgery 2007; 84:147-155.

Brown DW, **Gauvreau K**, Powell AJ, Lang P, Colan SD, del Nido PJ, Odegard KC, Geva T. Cardiac magnetic resonance versus routine cardiac catheterization prior to bidirectional Glenn anastamosis in infants with functional single ventricle: a prospective randomized trial. Circulation 2007; 116:2718-2725.

Bergersen L, **Gauvreau K**, Lock JE, Jenkins KJ. A risk adjusted method for comparing adverse outcomes among practitioners in pediatric and congenital cardiac catheterization. Congenital Heart Disease 2008; 3:230-240.

Singh TP, **Gauvreau K**, Bastardi HJ, Blume ED, Mayer JE. Socioeconomic position and graft failure in pediatric heart transplant recipients. Circulation Heart Failure 2009; 2:160-165.

ROBERT L. GEGGEL, M.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Geggel is an active participant in the Outpatient Cardiology Program, Director of the Cardiology Consult Service, and Attending Physician on 8E. He was the former Associate Chief of

Pediatric Cardiology at the New England Medical Center and former attending in the catheterization laboratory. He has a large clinical practice and evaluates outpatients at Children's Hospital as well as in satellite sites including Lexington, Norwood, Brockton, and Waltham. For the past 12 years, he has participated on a pediatric cardiology team providing care to children in Quito, Ecuador. He created and edited the Multimedia Library of Congenital Heart Disease which is available on the Department's website and to the general public (www.childrenshospital.org/mml/cvp). This site contains more than 1200 files on 27 lesions including still-frames (electrocardiograms, chest radiographs, diagrams, gross pathology), wave-files (phonocardiograms), and video (echocardiography, angiocardiography, magnetic resonance imaging, cardiac surgery). His research interests include medical education and outcomes of intervention for congenital heart disease. Dr. Geggel's recent publications include:

Geggel RL. Conditions leading to pediatric cardiology consultation in a tertiary academic hospital. Pediatrics 2004;114-1071-2 (abstract), e409-417 (text)

Sutton N, Lock J E, Geggel RL. Cardiac catheterization in infants weighing less 1500 grams. Cathet Cardicasc Intervent 2006 68:248-956.

Tzifa A. Marshall AC, McElhinney DB, Lock JE, Geggel RL, Endovascular treatment for superior vena cava occlusion or obstruction in a pediatric and young adult population- a 22-year experience. J Am Coll Cardiol 2007; 49:1003-9

Robinson JD, del Nido PJ, Geggel RL, Perez-Atayde AR, Lock JE, Powell AJ. Left ventricular diastolic heart failure in teenagers who underwent balloon aortic valvuloplasty in early infancy. Am J Cardiol 2010;106:426-9.

Kane DA, Fulton DR, Saleeb S, Zhou J, Lock JE, Geggel RL. Needles in hay: chest pain as the presenting symptom in children with serious underlying cardiac pathology. Congenit Heart Dis 2010;5:366-73.

TAL GEVA, M.D.
Professor of Pediatrics, Harvard Medical School

Dr. Geva heads the Division of Noninvasive Cardiac Imaging and shares staffing responsibilities in the echocardiography laboratory and in cardiac MRI. His major clinical interest is diagnostic imaging of congenital heart disease, including anatomic and functional assessment of complex malformations using echocardiography and magnetic resonance imaging. His research has focused on the use of echocardiography and magnetic resonance imaging to define quantitative morphometric predictors of course and outcome of either native or postoperative congenital cardiac lesions. Recent publications include:

Geva A, McMahon CJ, Gauvreau, K, Mohammed L, del Nido PJ, Geva T. Risk factors for reoperation after repair of discrete subaortic stenosis in children. J Am Coll Cardiol 2007;50:1498-1504.

Knauth AL, Gauvreau K, Powell AJ, Landzberg MJ, Walsh EP, Lock JE, del Nido PJ, Geva T. Ventricular size and function assessed by cardiac MRI predict major adverse clinical outcomes late after tetralogy of Fallot repair. Heart 2008; 94:211-216.

Benavidez OJ, Gauvreau K, Jenkins KJ, Geva T. Diagnostic errors in pediatric echocardiography: development of taxonomy and identification of risk factors. Circulation 2008:117:2995-3001.

Wald RM, Haber I, Wald R, Valente AM, Powell AJ, Geva T. Effects of regional dysfunction and late gadolinium enhancement on global right ventricular function and exercise capacity in patients with repaired tetralogy of Fallot. Circulation 2009;119:1370-1377.

Geva T, Gauvreau K, Powell AJ, Cecchin F, Rhodes J, Geva J, del Nido P. Randomized trial of pulmonary valve replacement with and without right ventricular remodeling surgery. Circulation 2010;122:S201-S208.

DOUGLAS S. GOULD, C.R.N.A, M.S.
Staff Nurse Anesthetist

Mr. Gould earned a B.A. in American Studies, a B.S. in Nursing and an M.S. in Biology/Anesthesia. Since becoming a nurse anesthetist in 1999, his clinical work has been limited to the anesthetic care of infants, children and adults with acquired and congenital heart disease. He is a member of the American Association of Nurse Anesthetists and has been involved in the clinical and didactic training of nurse anesthesia students.

Gould DS, Montenegro LM, Gaynor JW, et al. A comparison of on-site and off-site patent ductus arteriosus ligation in premature infants. Pediatrics 2003; 112:1298-1301.

DAVID M. HARRILD, M.D., Ph.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Harrild obtained his M.D./Ph.D. (in Biomedical Engineering) at Duke University, before heading west for residency training at the University of California at San Francisco. Here at Children's, he is a faculty member in the division of non-invasive imaging. Specific interests include fetal echocardiography, the impact of pulmonary regurgitation and pulmonary valve replacement, and the development of novel techniques for the assessment of regional strain. Selected publications include:

Harrild DM, Henriquez CS. A finite volume model of cardiac propagation. *Ann Biomed Eng.* 1997;25:315-334.

Harrild DM, Penland RC, Henriquez CS. A flexible method for simulating cardiac conduction in three-dimensional complex geometries. *J Electrocardiol.* 2000;33:241-251.

Harrild DM, Henriquez CS. A computer model of normal conduction in the human atria. *Circ Res.* 2000;87:E25-36.

Harrild DM, Berul CI, Cecchin F, Geva T, Gauvreau K, Pigula F, Walsh EP. Pulmonary valve replacement in tetralogy of Fallot: impact on survival and ventricular tachycardia. *Circulation.* 2009;119:445-451.

Harrild DM, Powell AJ, Trang TX, Geva T, Lock JE, Rhodes J, and McElhinney DB. Long-Term Pulmonary Regurgitation Following Balloon Valvuloplasty for Pulmonary Stenosis: Risk Factors and Relationship to Exercise Capacity and Ventricular Volume and Function. *JACC.* 2010; 55: 1041-7.

JAMES S. HARRINGTON, M.D.
Instructor in Anaesthesia (Cardiac), Harvard Medical School

Dr. Harrington completed his medical training at the University of Washington, Seattle and his anesthesiology training at Oregon Health Sciences University in Portland, Oregon. He then completed a Fellowship in Pediatric Anesthesia and Fellowship in Pediatric Cardiac Anesthesia at Children's Hospital Boston and is a Diplomate of the American Board of Anesthesiology. Dr. Harrington's primary clinical focus is the perioperative care of patients of all ages with congenital

heart disease. He has a special interest in quality assurance issues regarding perioperative care of the pediatric cardiac patient, maintaining the Division's incident database and monthly morbidity and mortality presentations to the Department of Anesthesia.

PAUL R. HICKEY, M.D.
Anesthesiologist-in-Chief, Children's Hospital Boston, Professor of Anaesthesia, Harvard Medical School

Dr. Hickey received his BA degree from Yale University and his MD degree from Columbia University. He trained in surgery at Columbia-Presbyterian Medical Center, New York, and in cardiac surgery at the National Heart and Lung Institute, National Institutes of Health, Bethesda, Maryland. He then trained in anesthesia and cardiac anesthesia at the Massachusetts General Hospital in Boston before joining the faculty in the Department of Anesthesia at Children's Hospital Boston in 1981. Dr. Hickey assumed his present position in 1992. His clinical work is concentrated in pediatric cardiac anesthesia as a member of the Division of Cardiac Anesthesia at Children's. He has authored over one hundred papers, chapters and reviews, particularly in the area of cardiac anesthesia. His research interests include brain injury with cardiac surgery in children, pain and stress responses in children, and the pathophysiology and modulation of inflammatory responses to surgery and cardiopulmonary bypass involving leukocyte and endothelial adhesion. He is a past Editor of the journals of Anesthesia and Analgesia and the Journal of Cardiothoracic Anesthesia. Selected recent publications:

Schermerhorn ML, Tofukuji M, Khoury PR, Phillips L, Hickey PR, Sellke FW, Mayer JE, Jr., Nelson DP: Sialyl lewis oligosaccharide preserves cardiopulmonary and endothelial function after hypothermic circulatory arrest in lambs. J Thorac Cardiovasc Surg 2000; 120: 230-7.

Gruber EM, Laussen PC, Casta A, Zimmerman AA, Zurakowski D, Reid R, Odegard KC, Chakravorti S, Davis PJ, McGowan FX, Jr., Hickey PR, Hansen DD: Stress response in infants undergoing cardiac surgery: a randomized study of fentanyl bolus, fentanyl infusion, and fentanyl-midazolam infusion. Anesth Analg 2001; 92: 882-90.

Tabbutt S, Newburger JW, Hickey PR, Mayer JE, Neufeld EJ: Time course of early induction of intracellular adhesion molecule-1 messenger RNA during reperfusion, following cardiopulmonary bypass with hypothermic circulatory arrest in lambs. Pediatr Crit Care Med 2003; 4: 83-8.

de Ferranti S, Gauvreau K, Hickey PR, Jonas RA, Wypij D, du Plessis A, Bellinger DC, Kuban K, Newburger JW, Laussen PC: Intraoperative hyperglycemia during infant cardiac surgery is not associated with adverse neurodevelopmental outcomes at 1, 4, and 8 years. Anesthesiology 2004; 100: 1345-52.

Hansen DD, Hickey, PR. History of Pediatric Cardiac Anesthesia. In: Andropoulus D, ed. Pediatric Cardiac Anesthesia. Blackwell Publishing 2005.

KATHY J. JENKINS, M.D., M.P.H.
Professor of Pediatrics, Harvard Medical School

Dr. Jenkins is a senior member of the Department of Cardiology and is also the Chief Safety and Quality Officer for Children's Hospital. She has special expertise in the design and implementation of regulatory trials, evaluating the safety and usefulness of devices prior to FDA approval. She also studies variation in outcomes for cardiac surgical procedures and has more recently expanded this to include other types of pediatric procedures. She has created the

RACHS-1 (Risk Adjustment for Congenital Heart Surgery) which is a method to adjust for case mix when evaluating mortality for pediatric heart surgery. She has identified myofibroblastic proliferation as the putative cause for progressive pulmonary vein stenosis, and is running a novel treatment protocol with chemotherapeutic agents. She is actively involved in teaching clinical research methods within the department and teaches a longitudinal methods course in conjunction with her biostatistical colleague, Dr. Kim Gauvreau, to fellows or nurses each year. She is a national leader in the field of pediatric cardiology, and is the Chair of the American College of Cardiology Adult Congenital and Pediatric Cardiology Council, in addition to other national roles. In addition, she is an active member of the clinical department with a variety of patient care and teaching responsibilities.

Jenkins KJ, Gauvreau K, Newburger JW, Spray T. Moller JH, Iezzoni LI Consensus-based method for risk adjustment for congenital heart surgery. *J Thorac Cardiovasc Surg* 2002;123:110-118.

Brown, DW, Connor, JA, Pigula, FA, Usmani K, Klitzner, TS, Beekman, RH, Kugler, JD, Martin GR, Neish, SR, Rosenthal, GL, Lannon, C, **Jenkins, KJ**,. Variation in Preoperative and Intraoperative Care for the First-stage Palliation of Single-ventricle Heart Disease: A Report from the Joint Council on Congenital Heart Disease National Quality Improvement Collaborative. Congenit Heart Dis. 2011;6:108-115

Bergersen, L, Gauvreau, K, Foerster, SR, Marshall, AC, McElhinney, DB, Beekman, RH, Hirsh, R, Kreutzer, J, Balzer, D, Vincent, J, Hellenbrand, WE, Holzer, R, Cheatham, JP, Moore, JW, Burch, G, Armsby, L, Lock, JE, **Jenkins, KJ.** Catheterization for Congenital Heart Disease Adjustment for Risk Method (CHARM). JACC: Cardiovascular Interventions. 2011 Sept; 4:1037-1046

JOHN F. KEANE, M.D.
Professor of Pediatrics, Harvard Medical School

Dr. Keane has retired from patient care. However, he still continues to participate in teaching and committee assignments (Cardiology scientific review and Children's Hospital Boston credentialing committees) has considerable interest in the natural history of congenital heart defects. Recent publications include:

Martins JD, Sherwood MC, Mayer JE, Keane JF. Aortico-Left Ventricular Tunnel: 35-Year Experience. *J Am Coll Cardiol* 2004; 44:446-50.

Nadas' Pediatric Cardiology. Keane JF, Lock JE, Fyler, DC: *Elsevier* 2006

Brown DW, Chong EC, Gauvreau K, Keane JF, Lock JE, Marshall AC. Aortic Wall Injury as a Complication of Neonatal Aortic Valvuloplasty: Incidence and Risk Factors. Circ Cardiovasc Intervent 2008:1, 53-59.

Hasan B, Keane JF, Tworetzky W, Lock JE, Marshall AC: Postnatal angiographic appearance of left ventricular myocardium in fetal patients with aortic stenosis having in-utero aortic valvuloplasty. *Am J Cardiol*. 2009 Nov 1;104(9):1271-5.

Kulik TJ, Clark RL, Hasan BS, Keane JF, Springmuller D, Mullen MP. Pulmonary arterial hypertension: what the large pulmonary arteries tell us. *Pediatr Cardiol* 2011; 32: 759- 65.

GRIGORY B. KRAPIVINSKY, Ph.D.

Assistant Professor of Pediatrics, Harvard Medical School

Dr. Krapivinsky received his Ph.D. from Moscow State University under Professor M.V. Volkenstein. Dr. Krapivinsky is a protein biochemist and molecular biologist interested in cellular signal transduction mechanisms. He was Senior Research Scientist at the Institute of Cell Biophysics in the Russian Academy of Sciences at Pushchino, Russia where he focused on the G signaling protein in the mammalian visual system. In 1992, he joined the Mayo Clinic in Rochester, MN where he studied G- protein regulated potassium channels. At present he is studying molecular organization of native channel signaling complexes mainly focusing on TRP family ionic channels.

Krapivinsky, G., Krapivinsky, L., Manasian, Y., Ivanov, A., Tyzio, R., Pellegrino, C., Ben-Ari, Y., Clapham, D. E., and Medina, I. The NMDA receptor is coupled to the ERK pathway by a direct interaction between NR2B and RasGRF1. *Neuron* (2003) *40*, 775-784.

Kirichok, Y., Krapivinsky, G., and Clapham, D. E.. The mitochondrial calcium uniporter is a highly selective ion channel. *Nature* (2004) *427*, 360-364.

Krapivinsky, G., Medina, I., Krapivinsky, L., Gapon, S., and Clapham, D. E.. SynGAP-MUPP1-CaMKII synaptic complexes regulate p38 MAP kinase activity and NMDA receptor-dependent synaptic AMPA receptor potentiation. *Neuron* (2004) *43*, 563-574.

Krapivinsky, G., Mochida, S., Krapivinsky, L., Cibulsky, S. M., and Clapham, D. E. The TRPM7 ion channel functions in cholinergic synaptic vesicles and affects transmitter release. Neuron (2006) *52*, 485-496.

Chung JJ, Navarro B, Krapivinsky G, Krapivinsky L, Clapham DE. A novel gene required for male fertility and functional CATSPER channel formation in spermatozoa. *Nat Commun*. (2011) *2*, 153.

BERNHARD KÜHN, M.D.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Kühn is a physician-scientist. He directs a research laboratory with a focus on myocardial regeneration. His clinical activities are in the cardiomyopathy group. Dr. Kühn trained in molecular pharmacology and received his M.D. degree from the Freie Universität Berlin in Germany. He completed a residency in pediatrics, a clinical fellowship in pediatric cardiology, and a research fellowship. Dr. Kühn received the Young Investigator Award of the American College of Cardiology in 2007. His laboratory is interested in mechanisms of regulation of cellular proliferation in the heart with the goal of enhancing myocardial regeneration in humans as a new strategy to treat heart failure.

Publications:

Kühn B, Shapiro ED, Walls TA, Friedman AH. Predictors of Outcome of Myocarditis. *Ped. Cardiol*. 2004;25:379-384.

Kühn B, del Monte F, Hajjar RJ, Chang YS, Lebeche D, Arab S, Keating MT. Periostin Induces Proliferation of Differentiated Cardiomyocytes and Promotes Cardiac Repair. *Nat. Med*. 2007;13:962-969.

Kühn B, Peters J, Marx GR, Breitbart RE. Etiology, Management, and Outcome of Pediatric Pericardial Effusions. *Ped. Cardiol*. 2008;29:90-94.

Bersell, K., Arab, S., Haring, B., & **Kühn, B.** Neuregulin1/ErbB4 Signaling Induces Cardiomyocyte Proliferation and Repair of Heart Injury. *Cell* 2009;138:257-270.

THOMAS J. KULIK, M.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Kulik (Tom) graduated from the University of Colorado School of Medicine in 1977 and completed training in general pediatrics and pediatric cardiology at the University of Minnesota in 1983. He was on faculty there for one year before moving to Boston Children's. In 1992 he took a position at the University of Michigan as the Medical Director of the Pediatric Cardiothoracic Intensive Care Unit, and after14 years in Ann Arbor moved to Cincinnati Children's in 2006. After a two year stint in "the Queen (City) of the West", where they actually do have heat and humidity, he found his way back east to Children's Hospital Boston as the Director of the Pulmonary Hypertension Program.

Tom's clinical practice involves pulmonary hypertension, cardiac intensive care, and general outpatient cardiology.

Tom has done basic research regarding control and growth of the pulmonary circulation, and clinical research related to improving postoperative outcomes in patients with congenital heart disease. Current and future research efforts focus on clinical research involving pulmonary arterial hypertension.

Representative Publications:

Hoffman TM, Wernovsky G, Atz AM, Kulik TJ, Nelson DP, Chang AC, Bailey JM, Akbary A, Kocsis JF, Kaczmarek R, Spray T, Wessel DT: The efficacy and safety of milrinone in preventing low cardiac output syndrome in infants and children after corrective surgery for congenital heart disease. Circulation 2003; 107: 996-1002.

Wright G, Crowley DC, Charpie JR, Ohye RG, Bove EL, Kulik TJ: High systemic vascular resistance and sudden cardiovascular collapse in recovering Norwood patients. Ann. Thorac Surgery 2004; 77:48-52.

Goldberg CS, Bove EL, Devanaey EJ, Mollen E, Schwartz E, Tindall S, Nowak C, Charpie, J, Brown MB, Kulik TJ, Ohye RG. A randomized clinical trial of regional cerebral perfusion versus deep hypothermic circulatory arrest: outcomes for infants with functional single ventricle. J Thorac Cardiovascular Surg 2007; 133: 880-7.

Kulik TJ, Rhein LM, Mullen MP. Pulmonary hypertension in infants with chronic lung disease: will we ever understand it? J Pediatr 2010; 157: 186-190.

Kulik TJ, Clark RL, Hasan BS, Keane JF, Springmuller D, Mullen MP. Pulmonary arterial hypertension: what the large pulmonary arteries tell us. Pediatr Cardiol 2011; 32: 759- 65.

BARRY D. KUSSMAN, M.B.Ch., FFA (SA)
Assistant Professor of Anaesthesia, Harvard Medical School

Dr. Kussman received his undergraduate medical degree and anesthesiology training in South Africa. He subsequently completed a Fellowship in Pediatric Anesthesia at Children's Hospital Boston and a Fellowship in Cardiac Anesthesia at the Beth Israel Hospital, Boston and is a Diplomate of the American Board of Anesthesiology. His major clinical focus is the

perioperative care of infants, children and adults with congenital heart disease. His major research interest is central nervous system monitoring during pediatric cardiac surgery. Selected Publications:

Kussman BD, Gauvreau K, DiNardo JA, Newburger W, Mackie AS, Booth KL, del Nido PJ, Roth SJ, Laussen PC. Cerebral perfusion and oxygenation after the Norwood procedure: comparison of right ventricle-to-pulmonary artery conduit with modified Blalock-Taussig shunt. J Thorac Cardiovasc Surg 2007;133(3):648-55.

Odegard KC, DiNardo JA, *Kussman BD*, Shukla A, Harrington J, Casta A, McGowan FX, Hickey PR, Bacha EA, Thiagarajan RR, Laussen PC. The Frequency of Anesthesia-Related Cardiac Arrests in Patients with Congenital Heart Disease Undergoing Cardiac Surgery. Anesth Analg 2007;105:335-43.

Newburger JW, Jonas RA, Soul J, *Kussman BD*, Bellinger DC, Laussen PC, Robertson R, Mayer JE Jr., del Nido PJ, Bacha EA, Forbess JM, Pigula F, Roth SJ, Visconti KJ, du Plessis AJ, Farrell DM, McGrath E, Rappaport LA, Wypij D. Randomized Trial of Hematocrit 25% versus 35% during Hypothermic Cardiopulmonary Bypass in Infant Heart Surgery. J Thorac Cardiovasc Surg 2008;135(2):347-54.

Burch TM, McGowan FX Jr, *Kussman BD*, Powell AJ, DiNardo JA. Congenital supravalvular aortic stenosis and sudden death associated with anesthesia: what's the mystery? Anesth Analg 2008;107:1848-54.

Kussman BD, Wypij D, Dinardo JA, Newburger JW, Mayer, Jr. JE, del Nido PJ, Bacha EA, Pigula F, McGrath E, Laussen PC. Cerebral oximetry during infant cardiac surgery: evaluation and relationship to early postoperative outcome. Anesth Analg 2009;108:1122-31.

RONALD V. LACRO, M.D.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Lacro is clinically trained in dysmorphology/clinical genetics as well as pediatric cardiology. He directs the Cardiovascular Genetics Clinic and Marfan Syndrome Program, which provide cardiac and genetic services to patients and families with a variety of genetic conditions including Marfan syndrome, other connective tissue disorders, and Williams syndrome. Dr. Lacro is on the staff of the Echocardiography Laboratory, which provides a full range of imaging studies including transesophageal and fetal examinations. He was a Schwartz Center Fellow in Pastoral Care in 2002 and has an interest in spiritual assessment and spiritual care. Research interests include pathogenesis of congenital cardiovascular malformations and management of patients with multiple malformation syndromes such as Marfan syndrome, other connective tissue disorders, and Williams syndrome. Dr. Lacro is principal investigator for a multicenter, randomized clinical trial sponsored by the Pediatric Heart Network and the National Heart, Lung, and Blood Institute of the NIH, comparing beta blocker therapy (atenolol) and angiotensin II receptor blocker therapy (losartan) in individuals with Marfan syndrome.

Dr. Lacro's publications include:

Anttila V, Piaszczynski M, Mora B, Hagino I, **Lacro RV**, Zurakowski D, Jonas RA. Improved outcome with composite graft versus homograft root replacement for children with aortic root aneurysms. Eur J Cardiothorac Surg 2005;27:420-424.

Lacro RV. Dysmorphology and genetics. In: Keane JF, Lock JE, Fyler DC, editors. Nadas' Pediatric Cardiology. Philadelphia: Elsevier Inc; 2006. p. 49-72.

Lacro RV, Dietz HC, Wruck LM, Bradley TJ, Colan SD, Devereux RB, Klein GL, Li JS, Minich LL, Paridon SM, Pearson GD, Printz BF, Pyeritz RE, Radojewski E, Roman MJ, Saul JP, Stylianou MP, Mahony L. Rationale and

design of a randomized clinical trial of beta blocker therapy (atenolol) vs. angiotensin II receptor blocker therapy (losartan) in individuals with Marfan syndrome. Am Heart J 2007; 154:624-631.

Morris SA, Orbach DB, Geva T, Singh MN, Gauvreau K, **Lacro RV.** Increased vertebral artery tortuosity index is associated with adverse outcomes in children and young adults with connective tissue disorders. Circulation. 2011; 124:388-96.

Prakash A, **Lacro RV**, Sleeper LA, Minich LL, Colan SD, McCrindle B, Covitz W, Golding F, Hlavacek AM, Levine JC, Coehn MS. Challenges in echocardiographic assessment of mitral regurgitation in children after repair of atrioventricular septal defect. Pediatr Cardiol 2011.

MICHAEL J. LANDZBERG, M.D.
Associate Physician, Cardiovascular Division, Brigham and Women's Hospital and Assistant Professor of Medicine, Harvard Medical School

Dr. Landzberg is Director of the Boston Adult Congenital (BACH) and Adult Pulmonary Hypertension (BACH-PHT) services. He shares attending responsibilities in the catheterization laboratories at Children's Hospital and Brigham and Women's Hospital. Dr. Landzberg's major research interests relate to understanding congenital heart disease as it displays itself in the adult patient, with particular focus on (1) multi-center clinical trials, (2) care guidelines and training accreditation, (3) pulmonary hypertension and vascular disease, (4) heart failure/mechanics and (5) interventional catheterization. Dr. Landzberg's recent publications include:

Ouyang DW, Khairy P, Fernandes SM, Lee-Parritz A, Landzberg MJ, Economy KE. Pregnancy outcomes in women (POW II) with congenital heart disease: maternal, fetal and neonatal outcomes. Int J Cardiol 2009 May 1

Berger RMF, Beghetti M, Galiè N, Gatzoulis MA, Granton J, Lauer A, Chiossi E Landzberg M. Atrial septal defects versus ventricular septal defects in BREATHE-5, a placebo-controlled study of pulmonary arterial hypertension related to Eisenmenger's syndrome: a subgroup analysis. Int J Cardiol 2009 May 20

Opotowsky AR, Landzberg MJ, Kimmel SE, Webb GD. Percutaneous closure of patent foramen ovale and atrial septal defect in adults: the impact of clinical variables and hospital procedure volume on in-hospital adverse events. Am Heart J 2009; 157: 867-874.

Fernandes SM, McElhinney DB, Khairy P, Graham DA, Landzberg MJ, Rhodes J. Serial cardiopulmonary exercise testing in patients with previous Fontan surgery. Pediatr Cardiol. 2010; 31:175-80

Valente AM, Lock JE, Gauvreau K, Rodriguez-Huertas E, Joyce C, Armsby L, Bacha EA, Landzberg MJ. Predictors of Long-Term Adverse Outcomes in Patients With Congenital Coronary Artery Fistulae. Circ Cardiovasc Interv 2010; March 23 (epub ahead of print)

PETER LANG, M.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Lang is Co-Director *Emeritus* of the Fellowship Training Program in Pediatric Cardiology. He is the former director of the Cardiac Intensive Care Unit at Children's Hospital and was the Chief of Pediatric Cardiology at Massachusetts General Hospital. He has a large clinical practice and interest in interventional catheterization and the care of congenital heart disease in the adult. He has participated in the introduction of innovative medical and surgical treatment protocols. Dr. Lang's publications include:

Norwood WI, Lang P, Hansen DD. Physiologic repair of aortic atresia-hypoplastic left heart syndrome. *N Engl J Med* 1983;308:23.

Roberts JD, Lang P, Bigatillo L, Vlahakes,GJ, Zapol WM. Inhaled nitric oxide in congenital heart disease. *Circulation* 1993 87:447-453.

Hung J, Landzberg MJ, Jenkins KJ, King MEE, Lock JE, Palacios IF, Lang P. Transcather closure of patent foramen ovale for paraodixical emboli: incidence of recurrent neurologic events at intermediate-term follow-up. *J Am Coll Cardiol* 2000;35:1311-6.

PETER C. LAUSSEN, M.B.B.S.
Chief, Division Cardiac Intensive Care, Department of Cardiology; D.D. Hansen Chair of Pediatric Anesthesia, Children's Hospital Boston; Professor of Anaesthesia, Harvard Medical School

Dr. Laussen graduated from Melbourne University Medical School, Australia in 1981 and completed fellowships in Anesthesia and Critical Care Medicine at the Austin Hospital and Royal Children's Hospital Melbourne. He joined the Cardiac Anesthesia faculty at Children's Hospital Boston in 1992 and the Division of Cardiac Intensive Care in 1993. He is the Chief of the Division of Cardiovascular Critical Care and Senior Associate in the Department of Cardiology, and holds the D.D. Hansen Chair of Pediatric Anesthesia at Children's Hospital in the Department of Anesthesia. He is a Professor of Anaesthesia at Harvard Medical School. Dr. Laussen's clinical research interests include the mechanical support of the circulation in children with heart disease, pediatric resuscitation, the stress response to cardiac surgery and cardiopulmonary bypass in neonates and infants, and patient safety and quality insurance in pediatric critical care.

Polito A, Thiagarajan RR, *Laussen PC*, Gauvreau K, Agus MSD, Scheurer MA, Pigula FA, Costello JM. Association between intra-operative and early postoperative glucose levels and adverse outcomes following complex congenital heart surgery. Circulation 2008;118:2235-42.

Kussman BD, Wypij D, DiNardo JA, Newburger J, Mayer JE Jr, delNido PJ, Bacha EA, Pigula F, McGrath E, *Laussen PC*. Cerebral oximetry during infant cardiac surgery: Evaluation and relationship to early postoperative outcomes. Anesth Analg 2009 Apr;108(4):1122-31

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Costello JM, Alexander ME, Greco KM, Perez-Atayde AR, *Laussen PC*. Lyme carditis in children: presentation, risk factors and clinical course. Pediatrics 2009;1223:e835-41

JAMI C. LEVINE, M.D.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Levine's primary clinical responsibility is as an echocardiographer. In addition, she sees patients in the faculty practice clinic at Children's Hospital. Her research interests have focused on non-

invasive cardiac imaging including transthoracic, transesophageal and fetal imaging. Recent publications include:

Levine, J and Tworetzky, W. Intervention for Severe Aortic Stenosis in the Fetus: Altering the progression of left sided heart disease. Progress in Pediatric Cardiology. 2006; 22(1): 71-78.

Recombinant human acid alpha-glucosidase: Major clinical benefits in Infantile-Onset Pompe disease. Kishnani PS, Corzo D, Nicolino M, Byrne B., Mandel H, Hwu W, Leslie N, Levine J, Spencer C, McDonald M, Li J, DuMontier J, Michael H, ChienYH, Hopkin R, Vijayaraghavan S, Gruskin D, Bartholomew D, van der Ploeg A, Clancy JP, Parini R. Morin G, Beck M, Delagastine G, Jokic M, Thurberg G, Richards S, Bali D, Davison M, Worden M, Chen YT, Wraith JE. Neurology. 2007;68 (2):99-109.

Levine J, Kishnani P, Chen YT, Herlong R, Li J. Cardiac remodeling following enzyme replacement therapy with Acid Alpha-Glucosidase in infants with Pompe disease. Pediatr Cardiology. Pediatric Cardiology 2008 29(6):1033-1042.

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Sekhavat S, Kishore N, Levine JC Screening fetal echocardiography in diabetic mothers with normal level II ultrasound. Ultrasound in Obstetr Gyn. 2009.

JAMES E. LOCK, M.D.
Chairman, Department of Cardiology and Alexander S. Nadas Professor of Pediatrics, Harvard Medical School

Dr. Lock has developed and provided the initial descriptions of more than a dozen new techniques in interventional cardiology, including angioplasty of pulmonary arteries, percutaneous dilation of mitral valves in children, transcatheter closure of ventricular septal defects and transcatheter correction of paravalvar leaks. He holds nine U.S. patents for new device ideas, and has several patents pending. He performs over 300 interventional procedures per year, and continues to explore new approaches to catheter therapy. Dr. Lock's recent publications include:

Nugent A, Britt A, Gauvreau K, Piercy G, Lock JE, Jenkins KJ. Device closure rates of simple atrial septal defects optimized by STARFlex device. J Am Coll Cardiol. 2007;48:538-544.

Qureshi AM, McElhinney DB, Lock JE, Landzberg MJ, Lang P, Marshall AC. Acute and intermediate outcomes, and evaluation of injury to the aortic wall, as based on 15 years experience of implanting stents to treat aortic coarctation. Cardiol in the Young. 2007;17:307-318.

Mizrahi-Arnaud A, Tworetzky W, Bulich LA, Wilkins-Haug LE, Marshall AC, Benson CB, Lock JE, McElhinney DB. Pathophysiology, management, and outcomes of fetal hemodynamic instability during prenatal cardiac intervention. Pediatric Research. 2007;62:325-330.

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JOHN D. MABLY, Ph.D.
Assistant Professor of Pediatrics and Genetics, Harvard Medical School

Dr. Mably received his Ph.D. from the University of Toronto and then trained at the Toronto General Hospital in Human Genetics. He then joined the laboratory of Dr. Mark C. Fishman at Massachusetts General Hospital to begin his studies of cardiovascular development using zebrafish as an animal model. He became a principal investigator in the Center for Cardiovascular Research at MGH in 2003.

In 2007, Dr. Mably moved to the Children's Hospital Boston where he is currently a principal investigator in the Cardiovascular Research program in the Department of Cardiology. He continues to employ zebrafish since it is a vertebrate model system uniquely amenable to both high throughput genetics and physiological studies. His current research is focused on the characterization of developmental defects affecting the morphology and function of heart muscle and the cardiovascular system. Dr. Mably's publications include:

Mably JD, Mohideen M-APK, Burns CG, Chen J-N, Fishman MC. heart of glass regulates the concentric growth of the heart in zebrafish. Curr Biol 2003; 13:2138-47.

Mably JD, Chuang LP, Serluca FC, Mohideen MA, Chen JN, Fishman MC.
santa and valentine pattern concentric growth of cardiac myocardium in the zebrafish. Development 2006; 133:3139-46.

Xiong JW, Yu Q, Zhang J, Mably JD. An acyltransferase controls the generation of hematopoietic and endothelial lineages in zebrafish.
Circ Res 2008; 102:1057-64.

Sogah VM, Serluca FC, Fishman MC, Yelon DL, Macrae CA, Mably JD.
Distinct troponin C isoform requirements in cardiac and skeletal muscle. Dev Dyn. 2010; 239:3115-23.

Chan J, Mably JD. Dissection of cardiovascular development and disease pathways in zebrafish. Prog Mol Biol Transl Sci. 2011;100:111-53.

RENEE E. MARGOSSIAN, M.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Margossian's primary clinical and research interest is in echocardiography, including fetal and transesophageal echocardiography in the assessment of congenital heart disease. She completed her pediatric training at Southwestern Medical Center in Dallas, and her cardiology fellowship at Columbia-Presbyterian in New York as well as a senior fellowship in echocardiography at Children's Hospital, Boston. In addition to echocardiography, her primary clinical interests include the evaluation and treatment of cardiomyopathies with a particular focus in the cardiac care of children and young adults following cancer therapy. Her research focuses on cardiomyopathies and clinical trials in Pediatric Cardiology through the NHLBI sponsored Pediatric Heart Network. Publications include:

Margossian R. Contemporary management of pediatric heart failure. Expert Rev Cardiovasc Ther. 2008;6:187-97.

Margossian R, Schwartz ML, Prakash A, Wruck L, Colan SD, Atz AM, Bradley TJ, Fogel MA, Hurqitz

LM, Marcus E, Powell AJ, Printz BF, Puchalski MD, Rychik J, Shirali G, Wiliams R, Yoo SJ, Geva T. Comparison of Echocardiographic and Cardiac Magnetic Resonance Imaging Measurements of Functional Single Ventricular Volumes, Mass, and Ejection Fraction (From the Pediatric Heart Network Multicenter Fontan Cross-Sectional Study) Am J Cardiol 2009;104:419–428.

Foerster SR, Canter CE, Sleeper LA, Alvarez JA, Cinar A, Jefferies JL, Kantor PF, Lamour JM, Margossian R, Messere JE, Pahl E, Rusconi PG, Shaddy RE, Webber SA, Wilkinson JD, Colan SD, Towbin JA, Lipshultz SE, for the Pediatric Cardiomyopathy Registry (PCMR)Ventricular Remodeling and Survival are More Favorable for Myocarditis Than For Idiopathic Dilated Cardiomyopathy in Childhood: An Outcomes Study from the Pediatric Cardiomyopathy Registry. Circ Heart Fail 2010 Nov 1;3(6):689-97.

Guinan EC, Hewett EK, Domaney NM, Margossian R. Outcome of hematopoietic stem cell transplant in children with congenital heart disease. Pediatr Transplant. 2011 Feb;15(1):75-80.

Margossian R, Lu M, Minich LL, Bradley TJ, Cohen MS, Li JS, Printz BF, Shirali GS, Sleeper LA, Newburger JW, Colan SD for the Pediatric Heart Network Investigators. Predictors of Coronary Artery Visualization in Kawasaki Disease. J Am Soc Echocardiogr. 2011 Jan;24(1):53-9.

AUDREY C. MARSHALL, M.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Marshall is Chief of the Division of Invasive Cardiology, and Director of the Cardiac Catheterization Laboratory. She completed her Pediatric Cardiology fellowship and interventional training at Children's Hospital Boston. She serves as one of the attendings in the pediatric interventional catheterization program, and has helped to build the fetal cardiac interventional program. CURRENT INTERESTS include management of hypoplastic left heart syndrome Recent publications include:

Vida VL, Bacha EA, Thiagaragan R, Gauvreau K, Larrazabal LA, Fynn-Thompson F, Pigula FA, Mayer JE, del Nido PJ, Tworetzky W, Lock JE, Marshall AC. Hypoplastic left heart syndrome and intact or highly restrictive atrial septum: surgical experience from a single center, Ann Thorac Surg, 2007; 84: 581-5.

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*McElhinney DB, **Marshall AC**, Wilkins-Haug L, Brown DW, Benson C, Silva V, Marx GR, Mizrahi-Arnaud A, Lock JE, Tworetzky W. Predictors of technical success and postnatal biventricular outcome after in utero aortic valvuloplasty for aortic stenosis with evolving hypoplastic left heart syndrome, Circulation, 2009, 120: 1482-90.*

*Robinson J, McElhinney DB, Bacha E, **Marshall AC**. The evolving role of intraoperative balloon pulmonary valvuloplasty in valve-sparing repair of tetralogy of Fallot, J Thorac Cardiovasc Surg, JTCVS, 2011*

GERALD R. MARX, M.D.
Director of Ultrasound Imaging Research, Children's Hospital and Associate Professor of Pediatrics, Harvard Medical School

Dr. Marx has a clinical practice at Boston Children's Hospital and at St. Anne's Hospital in Fall River, MA. Additionally, he is a member of the echocardiography staff. He has been part of the development and clinical application of two-dimensional and Doppler echocardiography in the care of patients with congenital heart disease. Presently, he is the director of the three- dimensional echocardiography laboratory which is integrally involved in aortic and mitral valvuloplasties, reconstruction of color flow jets in three-dimensional formats, and currently in the development of real-time three-dimensional echocardiography. Dr. Marx's recent publications include:

Acar P, Laskari C, Rhodes J, Pandian N, Warner K, Marx G. Three-dimensional echocardiographic analysis of valve anatomy as a determinant of mitral regurgitation after surgery for atrioventricular septal defects. *Amer J of Card.* 1999;83:745-749.

Bacha EA, Satou GM, Moran AM, Zureakowski D, Marx GR, Keane JF, Jonas RA. Valve-sparing surgery for balloon-induced aortic regurgitation in congenital aortic stenosis. *J Thoracic and Cardiovascular Surgery.* 122(1):1628, 2001.

Acar P, Marx GR, Saliba Z, Sidi D, Kachaner. Three-dimensional echocardiographic measurement of left ventricular stroke volume in children: comparison with Doppler method. *Pediatr Cardiol* 2001; 22:116-120.

Marx GR, Sherwood MC, Fleishman C, Van Praagh, R. Three-dimensional echocardiography of the atrial septum. *Echocardiography* 2001; 18(5):433-443.

Marx GR, Sherwood MC. Three-dimensional echocardiography in congenital heart disease. A continuum of unfulfilled promises? No! A current technology with clinical applications and an important future. Yes! *Pediatric Cardiology.* 23(3):266-85, 2002.

JOHN E. MAYER, JR., M.D.
Professor of Surgery, Harvard Medical School

Dr. Mayer's primary clinical responsibilities involve surgery for complex forms of congenital heart defects. He was previously Surgical Director of the Cardiac Transplantation Service. Dr. Mayer serves on the Physician Organization's Contracting Committee, and Physicians' Organization Congress. He also serves on the Joint Network and Payor Relations Committee for Children's Hospital Boston and the Children's Hospital Physicians Organization. In 2010, he initiated the cardiac surgical program at Connecticut Children's Medical Center which continues to grow. Dr. Mayer's major research interests include (1) the short and long-term outcomes of congenital heart surgery procedures (2) tissue engineering of cardiovascular structures, and (3) health policy issues affecting cardiovascular medicine and surgery. Recent publications include:

Wu FM, Ukomadu C, Odze RD, Valente AM, Mayer JE Jr, Earing MG. Liver disease in the patient with Fontan circulation. Congenit Heart Dis 2011:190-201.

Emani S, Mayer JE, Emani SM. Gene Regulation of Extracellular Matrix Remodeling in Human Bone Marrow Stem Cell-Seeded Tissue-Engineered Grafts. Tissue Eng Part A 2011. Epub June ahead of print.

DiBardino DJ, Mayer JE Jr. Continued controversy regarding adverse events after Amplatzer septal device closure: mass hysteria or tip of the iceberg? J Thorac Cardiovasc Surg 2011, 142:222-3.

Karamichalis JM, del Nido PJ, Thiagarajan RR, Jenkins KJ, Liu H, Gauvreau K, Pigula FA, Fynn-Thompson FE, Emani SM, Mayer JE Jr, Bacha EA. Early postoperative severity of illness predicts outcomes after the stage 1 Norwood procedure. Ann Thorac Surg 2011, 92:660-5.

Jacobs ML, Daniel M, Mavroudis C, Morales DL, Jacobs JP, Fraser CD Jr, Turek JW, Mayer JE, Tchervenkov C, Conte J. Report of the 2010 Society of Thoracic Surgeons congenital heart surgery practice and manpower survey. Ann Thorac Surg 2011,
92(2):762-9.

MARY P. MULLEN, M.D., Ph.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Mary Mullen is a staff member of the Cardiac Intensive Care Unit and the Boston Adult Congenital Heart Service and specializes in the care of patients with pulmonary hypertension. She is board certified in Pediatrics, Internal Medicine and Pediatric Cardiology. Her research interests include clinical trials in pulmonary hypertension, critical care of adults with congenital heart disease, coronary artery anomalies and the molecular basis of cardiovascular disease. Publications include:

Mullen, MP (2000). Adult Congenital Heart Disease, *Scientific American Medicine,* March 2000, 1-10.

Kamisago M., Sharma, SD, DePalm, SR, Solomon S, Sharma P, McDonough B, Smoot L, Mullen MP, Woolf PK, Wigle ED, Seidman JG, Seidman CE (2000). Mutations in sarcomere protein genes as a cause of dilated cardiomyopathy. N Eng J Med 343:1688-1695.

Mullen, MP, Landzberg, MJ. Care for Adults with Congenital Heart Disease. In Antman E. et al, eds., *Cardiovascular Therapeutics,* W.B. Saunders, 2002;1048-1074.

Mullen, MP, VanPraagh R, Walsh EP Development and anatomy of the cardiac conducting system. In Walsh EP et al, eds., *Cardiac Arrhythmias in Children and Young Adults with Congenital Heart Disease,* New York: Lippincott, Williams &Wilkins, 2001;3-22.

JANE W. NEWBURGER, M.D., M.P.H.
Associate Chief for Academic Affairs, Department of Cardiology, Children's Hospital and Commonwealth Professor of Pediatrics, Harvard Medical School

Dr. Jane Newburger is Commonwealth Professor of Pediatrics at Harvard Medical School, Associate Chief for Academic Affairs in the Department of Cardiology, and Co-Director of the Pediatric Cardiology Fellowship Training Program. A graduate of Harvard Medical School and the Harvard School of Public Health, she completed her training in Pediatrics and Cardiology at Children's Hospital, Boston. She maintains an active clinical practice comprised of patients with congenital and acquired heart disease.
Dr. Newburger's research has focused on prospective clinical studies, including multi-disciplinary prospective randomized clinical trials and prospective cohort studies. Research interests include outcomes of congenital heart disease, including inflammatory, neurological, and developmental effects of open-heart surgery, and the pathogenesis, treatment, and long-term sequelae of Kawasaki disease.

Dr. Newburger's recent, representative manuscripts include:

Newburger JW, Sleeper LA, McCrindle BW, Minich LL, Gersony W, Vetter VL, Atz AM, Li JS, Takahashi M, Baker AL, Colan SD, Mitchell PD, Klein GL, Sundel RP, for the Pediatric Heart Network Investigators. Randomized trial of pulse steroid therapy for primary treatment of Kawasaki disease. N Eng J Med. 2007 Feb 15;356(7):663-75.

Day MD, Gauvreau K, Shulman S, Newburger JW. Characteristics of children hospitalized with infective endocarditis. Circulation. 2009; 119 (6): 865-70.

Ohye RG, Sleeper LA, Mahony L, Newburger JW, Pearson GD, Lu M, Goldberg CS, Tabbutt S, Frommelt PC, Ghanayem NS, Laussen PC, Rhodes JF, Lewis AB, Mital S, Ravishankar C, Williams IA, Dunbar-Masterson C, Atz AM, Colan S, Minich LL, Pizarro C, Kanter KR, Jaggers J, Jacobs JP, Krawczeski CD, Pike N, McCrindle BW, Virzi L, Gaynor JW, for the Pediatric Heart Network Investigators. Comparison of shunt types in the Norwood procedure for single-ventricle lesions. N Engl J Med. 2010;362(21):1980-92. PMID: 20505177; PMCID: PMC2891109

Kussman BD, Wypij D, Laussen PC, Soul JS, Bellinger DC, DiNardo JA, Robertson R, Pigula FA, Jonas RA, Newburger JW. Relationship of Intraoperative cerebral oxygen saturatio neurodevelopmental outcome and brain MRI at one year of age in infants undergoing biventricular repair. Circulation 2010 Jul 20;122(3):245-54. Epub 2010 Jul 6. PMID: 20606124

Bellinger DC, Wypij D, Rivkin MJ, Demaso DR, Robertson RL Jr, Dunbar-MastersonC, Rappaport LA, Wernovsky G, Jonas RA, Newburger JW. Adolescents With d-Transposition of the Great Arteries Corrected With the Arterial Switch Procedure: Neuropsychological Assessment and Structural Brain Imaging. Circulation. 2011 Aug 29. [Epub ahead of print]

SHARON E. O'BRIEN, M.D.

Chief of Pediatric Cardiology, Boston Medical Center, Assistant Professor of Pediatrics, Boston University Medical School

Dr. O'Brien's clinical responsibilities are divided between directing the division of Pediatric Cardiology at Boston Medical Center and attending in the echocardiographic laboratory at Children's Hospital. She completed her pediatric training at Tufts University and her cardiology fellowship at Yale University. Her primary interest is in clinical patient care with a focus on echocardiography including fetal and transesophageal assessment of congenital heart disease. Her research interests include the cardiovascular effects of HIV and its therapies. Selected publications include:

Rhodes, J., O'Brien, S., Banerjee, A., Patel, H., Hijazi, Z: Palliative Balloon Pulmonary Valvuloplasty in Tetralogy of Fallot: Echocardiographic Predictors of Successful Outcome. Journal of Invasive Cardiology, vol 12, no 9, September 2000.

O'Brien, S.E., Apkon, M., Berul, C.I., Patel, H.T., Saupe, K., Spindler, M., Ingwall, J.S., Zahler, R: Phenotypical features of long Q-T syndrome in transgenic mice expressing human Na-K-ATPase α3-Isoform in hearts. Am J Physiology, vol 279, issue 5, H2133-2142, Nov, 2000.

Fujii, A., Brown, E., Mirochnick, M., O'Brien, S., Kaufman, G: Neonatal necrotizing enterocolitis with intestinal perforation in extremely premature infants receiving early indomethacin treatment for patent ductus arteriosus. Journal of Perinatology, 2002; 22:535-540

Feltes, Timothy F. MD et al, Palivizumab prophylaxis reduces hospitalization due to respiratory syncytial virus in young children with hemodynamically significant congenital heart disease: The Journal of Pediatrics Volume 143(4) October 2003 pp 532-540

KIRSTEN C. ODEGARD, M.D.

Director, Division of Cardiac Anesthesia,Children's Hospital Boston and Associate Professor of Anaesthesia, Harvard Medical School

Dr. Odegard completed a residency in internal medicine at Lenox Hill Hospital in New York, followed by a residency in anesthesiology at NYU Medical Center. She then completed a fellowship in cardiothoracic anesthesia at NYU, including a two-month fellowship in pediatric cardiac anesthesia at Children's Hospital Boston. Her main area of research is the understanding of the coagulation system in patients with congenital heart disease undergoing cardiopulmonary bypass, with special interest in perioperative thromboembolic complications in Fontan patients.

Recent Publications:

Odegard KC, Laussen PC. Approach to the premature and full term infant. In: Andropolous DB, Stayer SA, Russel IA, eds. Anesthesia for congenital heart disease, 2005.

Odegard KC, Laussen PC. Pediatric anesthesia and critical care. Pediatric cardiac surgery. In:Sabiston & Spencer's Surgery of the Chest. 7th ed, 2005.

Odegard KC, Hornykewycz S, Zurakowski D, DiNardo JA, Castro RA, Neufeld EJ, Laussen PC. Evaluation of the coagulation system in children with two-ventricle congenital heart disease. Annals of Thoracic Surg 2007;83:1797-804

Odegard KC, DiNardo JA, Kussman BD, Shukla A, Harrington J, Casta A, McGowan FX, Hickey PR, Bacha,EA, Thiagaranjan,RR, Laussen PC. Frequency of anesthesia and procedure-related cardiac arrest in patients with congenital heart disease undergoing cardiac surgery. Anesth and Analg 2007;105:335-43

Odegard KC, DiNardo JA, Zurakowski D, Castro RA, McGowan FX, Neufeld EJ, Laussen PC Prospective Longitudinal Study of Coagulation Profiles in Children with Hypoplastic Left Heart Syndrome (HLHS) from stage I through Fontan completion (J Thorac Cardiovasc Surg, 2009;137:934-941)

FRANK A. PIGULA, M.D.
Associate Professor of Surgery, Harvard Medical School

Dr. Pigula recently joined the Department of Cardiac Surgery from Children's Hospital of Pittsburgh, where he was Director of Pediatric Cardiac Surgery. His clinical work is devoted to the surgical treatment of all forms of congenital heart disease, with special interest in diseases of the aorta and the aortic valve. Dr. Pigula's major research interests include the cerebrovascular response to cardiopulmonary bypass, and surgical approaches to fetal cardiac intervention.

Karamichalis JM, Del Nido PJ, Thiagarajan RR, Jenkins KJ, Liu H, Gauvreau K, Pigula FA, Fynn-Thompson FE, Emani SM, Mayer JE Jr, Bacha EA. Early Postoperative Severity of Illness Predicts Outcomes After the Stage I Norwood Procedure. Ann Thorac Surg. 2011 Jun 23. [Epub ahead of print]

Cheng HH, Almodovar MC, Laussen PC, Wypij D, Polito A, Brown DW, Emani SM, Pigula FA, Allan CK, Costello JM. Outcomes and Risk Factors for Mortality in Premature Neonates With Critical Congenital Heart Disease. *Pediatr Cardiol.* 2011 Jun 29. [Epub ahead of print]

Lund AM, Vogel M, Marshall AC, Emani SM, Pigula FA, Tworetzky W, McElhinney DB. Early reintervention on the pulmonary arteries and right ventricular outflow tract after neonatal or early infant repair of truncus arteriosus using homograft conduits. Am J Cardiol. 2011 Jul 1;108(1):106-13.

Karamichalis JM, del Nido PJ, Thiagarajan R, Liu H, Jenkins K, Gauvreau K, Pigula FA, Fynn-Thompson F, Emani S, Mayer JE, Jr., Bacha EA. Early post-operative severity of illness predicts outcomes following the stage I Norwood procedure *Ann Thorac Surg* 2011;92:660-665.

Nathan M, Karamichalis JM, Liu H, Del Nido P, Pigula F, Thiagarajan R, Bacha EA. Intraoperative adverse events

can be compensated by technical performance in neonates and infants after cardiac surgery: A prospective study. *J Thorac Cardiovasc Surg. 2011 Aug 12 [epub ahead of print].*

ANDREW J. POWELL, M.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Powell's primary clinical interest is non-invasive anatomic and functional assessment of congenital heart disease using echocardiography, magnetic resonance imaging, and computer tomography. His responsibilities include attending in the echocardiography laboratory, cardiac MRI (Director), outpatient clinic, and consult service. His current research focuses on the application of new MRI techniques to patients with congenital heart disease including quantitation of ventricular function, blood flow, myocardial fibrosis, and iron content. Dr. Powell's recent publications include:

Tsai-Goodman B, Geva T, Odegard KC, Sena LM, Powell AJ. Clinical role, accuracy, and technical aspects of cardiovascular magnetic resonance imaging in infants. American Journal of Cardiology, American Journal of Cardiology 2004;94:69-74.

Geva T, Sandweiss BM, Gauvreau K, Lock JE, Powell AJ. Factors associated with impaired clinical status in long-term survivors of tetralogy of Fallot repair evaluated by magnetic resonance imaging. Journal of the American College of Cardiology 2004;43:1068-74.

Prakash A, Garg R, Marcus EN, Reynolds G, Geva T, **Powell AJ**. Faster flow quantification using sensitivity encoding for velocity encoded cine magnetic resonance imaging: in vitro and in vivo validation. Journal of Magnetic Resonance Imaging 2006;24:676-682.

Leonardi B, Margosian R, Colan SD, **Powell AJ**. Relationship of MRI estimation of myocardial iron to left ventricular systolic and diastolic function in thalassemia. JACC: Cardiovascular Imaging 2008;1:572–8.

Robinson JD, del Nido PJ, Geggel RL, Perez-Atayde AR, Lock JE, **Powell AJ**. Left ventricular diastolic heart failure in teenagers who underwent balloon aortic valvuloplasty in early infancy. American Journal of Cardiology 2010; 106:426-429.

ASHWIN PRAKASH, M.B.B.S.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Prakash's area of interest is non-invasive imaging including magnetic resonance imaging and echocardiography. Dr Prakash trained in pediatric cardiology at Columbia University and in cardiac magnetic resonance imaging at Children's Hospital Boston. He was an attending pediatric cardiologist and co-director of the cardiac MRI program at Columbia University from 2003 to 2008. Currently, Dr Prakash is a staff cardiologist in the echocardiography and magnetic resonance imaging laboratories at Children's Hospital Boston. Publications include:

Prakash A, Torres AJ, Printz BF, Prince MR, Nielsen JC. Usefulness of magnetic resonance angiography in the evaluation of complex congenital heart disease in newborns and infants. Am J Cardiol 2007;100:715-721

Strigl S, Hardy R, Glikstein JS, Hsu DT, Addonizio LA, Lamour JM, **Prakash A**. Tissue doppler derived diastolic myocardial velocities are abnormal in pediatric cardiac transplant recipients in the absence of endomyocardial rejection. Pediatr Cardiol 2008 29:749-754.

Prakash A, Khan MA, Hardy R, Torres AJ, Chen JM, Gersony WM. A New Diagnostic Algorithm for Assessment

of Patients with Single Ventricle Prior to a Fontan Operation. J Thorac Cardiovasc Surg. 2009 138:917-923.

Prakash A, Travison TG, Fogel MA, Hurwitz LM, Powell AJ, Printz BF, Puchalski MD, Shirali G, Yoo SJ, Geva T. Relation of the size of secondary ventricles to exercise performance after a Fontan operation. Am J Cardiol 2010;106:1652-6.

Prakash A, Lacro RV, Sleeper LA, Minich LL, Colan SD, McCrindle B, Covitz W, Golding F, Hlavacek AM, Levine JC, Cohen MS. Challenges in Echocardiographic Assessment of Mitral Regurgitation in Children after Repair of Atrioventricular Septal Defect. Pediatr Cardiol. 2011 (Epub ahead of print)

WILLIAM T. PU, M.D., Ph.D.
Associate Professor in Pediatrics, Harvard Medical School

Dr. Pu's laboratory is interested in the regulation of gene expression in heart development and heart failure. The lab uses conditional gene knockout and overexpression approaches to manipulate gene expression in mice and in primary cultured cells. A particular focus on the lab is transcriptional regulation of cardiac gene expression.

The lab is also investigating progenitor populations in the developing and adult heart. Groundbreaking work in the lab demonstrated that a novel epicardial population differentiates into multiple cardiac lineages, including cardiomyocytes, during normal heart development.

Goals of Dr. Pu's research include:

- to understand the transcriptional network regulating heart development
- to understand post-transcriptional mechansisms regulating heart development and heart function
- to understand the role of epicardial and other native progenitor populations in heart development and in cardiac injury responses

Dr. Pu's recent publications include:

Zhou, B., Ma, Q., Kong, S. W., Hu, Y., Campbell, P. H., McGowan, F. X., Ackerman, K. G., Wu, B., Zhou, B., Tevosian, S. G. and Pu, W. T. (2009) Fog2 is critical for cardiac function and maintenance of coronary vasculature in the adult mouse heart. J Clin Invest 119, 1462-1476

Ikeda, S., He, A., Kong, S. W., Lu, J., Bejar, R., Bodyak, N., Lee, K. H., Ma, Q., Kang, P. M., Golub, T. R. and Pu, W. T. (2009) MicroRNA-1 negatively regulates expression of the hypertrophy-associated calmodulin and Mef2a genes. Mol Cell Biol 29, 2193-2204

Zhou, B., Ma, Q., Rajagopal, S., Wu, S. M., Domian, I., Rivera-Feliciano, J., Jiang, D., von Gise, A., Ikeda, S., Chien, K. R. and Pu, W. T. (2008) Epicardial progenitors contribute to the cardiomyocyte lineage in the developing heart. Nature 454, 109-113

Zhou, B. and Pu, W. T. (2008) More than a cover: epicardium as a novel source of cardiac progenitor cells. Regen Med 3, 633-635

Zhou, B., von Gise, A., Ma, Q., Rivera-Feliciano, J. and Pu, W. T. (2008) Nkx2-5- and Isl1-expressing cardiac progenitors contribute to proepicardium. Biochem Biophys Res Commun 375, 450-453

RAHUL H. RATHOD, M.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Rathod completed his pediatrics residency at Rainbow Babies and Children's Hospital in Cleveland, Ohio where he served for an additional year as Chief Resident. He subsequently completed his cardiology fellowship at Children's Hospital Boston, including serving as Chief Fellow. His cardiology training included a fourth year as senior non-invasive fellow. Dr. Rathod is currently a member of the non-invasive division in the Department of Cardiology at Children's Hospital Boston performing cardiac magnetic resonance imaging (CMR), and fetal, transesophageal, and transthoracic echocardiography. As a staff cardiologist, he maintains a busy clinical practice as well. His research interests focus primarily with CMR, in particular starting and building the invasive CMR program. Dr. Rathod is a key member in the Standard Clinical Assessment and Management Plans (SCAMPs) program in the Department of Cardiology.

JONATHAN RHODES, M.D.
Asociate Professor of Pediatrics, Harvard Medical School

Dr. Rhodes is the co-director of the exercise physiology laboratory. His major clinical interests are ventricular function and the effect of congenital heart disease on the cardiopulmonary response to exercise. Dr. Rhodes is also an active participant in the Outreach Cardiology Program and has a large clinical practice, including several satellite clinics. Prior to arriving at Children's Hospital in November, 2002, Dr. Rhodes was the Chief of Pediatric Cardiology at Tufts Medical Center. Selected recent publications:

Fernandes SM, McElhinney DB, Khairy P, Graham DA, Landzberg MJ, Rhodes J. Serial cardiopulmonary exercise testing in patients with Fontan surgery. *Pediatr Cardiol,* 2010;31:175-80

Kipps AK, McElhinney DB, Janet Kane J, Rhodes J. Exercise function of children with congenital aortic stenosis following aortic valvuloplasty during early infancy. *Cong Heart Dis,* 2009;4:258-64

Sutton NJ, Peng L, Lock JE, Lang P, Marx GR, Curran TJ, O'Neill JA, Picard ST, Rhodes, J.
Effect of pulmonary artery angioplasty on exercise function after repair of tetralogy of Fallot. *AmHeart J,* 2008;155:182-6

Meadows JJ, Lang P, Marx GR, Rhodes J. The effects of Fontan fenestration closure on exercise performance and ventilatory efficiency. *J Amer Coll Cardiol* 2008;52:108-13

AMY E. ROBERTS, M.D.
Clinical Geneticist in Cardiology and the Division of Genetics, Children's Hospital Boston and Assistant Professor of Pediatrics, Harvard Medical School

Dr. Roberts trained in both clinical genetics and pediatrics. Her research focuses on genotype phenotype correlations in Noonan syndrome and Noonan syndrome gene discovery. She also is interested in genetic causes of congenital heart disease. Dr. Roberts is the Director of the Children's Hospital Boston Cardiac Gene Project (CHB CGP), a registry and DNA repository for families affected by congenital heart disease. She is the director of clinical cardiovascular genetic research for the department. Her principal clinical activities involve a cardiovascular genetics clinic and inpatient consultation for children with a potential genetic cause of their

congenital heart disease. Her interests include Noonan syndrome, CFC syndrome, Williams syndrome, hypoplastic left heart syndrome, and cardiomyopathy.

Roberts AE, Araki T, Swanson KD, Montgomery KT, Schiripo TA, Joshi VA, Li L, Yassin Y, Tamburino AM, Neel BG, Kucherlapati RS. Germline gain-of-function mutations in *SOS1* cause Noonan syndrome. Nat Genet 2007, 39(1):70-74.

Morita H, Rehm HL, Menesses AD, McDonough B, Bowles NE, Roberts AE, Kucherlapati R, Towbin JA, Seidman CE, Seidman JG. Gene mutations in childhood-onset cardiac hypertrophy. NEJM. 2008 358(18):1899-908.

Pierpont EI, Pierpont ME, Mendelsohn NJ, Roberts AE, Tworog-Dube E, Seidenberg MS. Genotype differences in cognitive functioning in Noonan syndrome. Genes, Brain, and Behavior Genes, Brain, and Behavior 2009 Apr;8(3):275-82. PMID 19077116.

Cirstea IC, Kutsche K, Dvorsky R, Gremer L, Carta C, Horn D, Roberts AE, Lepri F, Merbitz-Zahradnik T, Konig R, Kratz CP, Pantaleoni F, Dentici ML, Joshi VA, Kucherlapati RS, Massanti L, Mundlos S, Patton MA, Silengo MC, Rossi C, Zampino G, Digilio C, Stuppia L, Seemanova E, Pennacchio LA, Gelb BD, Dallapiccola B, Wittinghofer A, Ahmadian MR, Tartaglia M, Zenker M. A restricted spectrum of NRAS mutations causes Noonan syndrome. Nat Genet. 2010 Jan;42(1):27-9. PMID: 19966803

Pierpont, E.I., Pierpont, M.E., Mendelsohn, N. J., Roberts, A.E., Tworog-Dube, E., Rauen, K.A., & Seidenberg, M.S. (2010). Effects of Germline Mutations in the Ras/MAPK signaling pathway on adaptive behavior: Cardiofaciocutaneous syndrome and Noonan syndrome. *American Journal of Medical Genetics Part A*. 152A: 591-600.

SUSAN F. SALEEB, M.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Saleeb trained in both clinical cardiology and non-invasive imaging. Her interests lie in outpatient and inpatient management of congenital heart disease and fetal echocardiography. Her prior research focused on autoimmune associated congenital heart block, and aortic valve prolapse associated with membranous ventricular septal defects. She completed fellowship in 2007 during which she performed studies on ventricular noncompaction and double inlet-double outlet right ventricle. Her current research focuses on coarctation of the aorta and chest pain. Dr. Saleeb's publications include:

Saleeb S, Copel J Friedman D, Byyon, JP Comparison of treatment with fluorinated glucocorticoids to natural history of autoantibody-associated congenital block: Retrospective Review of the Research Registry fro Neonatal Lupus. Arthritis Rheum 1999; 42:2335-45.

Saleeb S, Solowiejczyk DE, Glickstein JS, Korsin R, Gersony WM, Hsu DT. Frequency of development of aortic cuspal prolapse and aortic regurgitation in patients with subaortic ventricular deptal defects diagnosed at <1 year of age. AM J Cardiol 2007, 99: 1588-1592

Saleeb SF, Juraszek A, Geva T. Anatomic, Imaging, and Clinical Characteristics of Double-Inlet, Double-Outlet Right Ventricle. Submitted for publication.

Kane DA, Fulton DR, **Saleeb S**, Zhou J, Lock JE, Geggel RL. Needles in hay: chest pain as the presenting symptom in children with serious underlying cardiac pathology. Congenit Heart Dis 2010;4:366-73.

Friedman KG, Kane DA, Rathod RH, Renaud A, Farias M, Geggel R, Fulton DR, Lock JE, **Saleeb SF**. Management of pediatric chest pain using a standardized assessment and management plan. Pediatrics 2011;128:239-45.

JOSHUA W. SALVIN, M.D, M.P.H.
Instructor in Pediatrics, Harvard Medical School

Dr. Salvin completed training in Pediatrics at the Children's Hospital of Philadelphia, and fellowships in Cardiology and Critical Care Medicine at Children's Hospital Boston prior to coming on staff in the Cardiac Intensive Care Unit in 2007. His non-clinical interests include outcomes research in children with congenital heart disease. He is actively involved in fellow and resident education within Cardiology and Critical Care. His recent publications include:

Salvin JW, McElhinney DB, Colan SD, Gauvreau K, del Nido PJ, Jenkins KJ, Lock JE, Tworetzky W. Fetal Tricuspid Valve Size and Growth as Predictors of Outcome in Pulmonary Atresia with Intact Ventricular Septum. Pediatrics. 2006 Aug, 118(2):e415-20.

Scheurer, MA, **Salvin JW**, Vida VL, Fynn-Thompson F, Bacha EA, Pigula FA, Mayer JE, del Nido PJ, Laussen PC, Thiagarajan RR. Survival and Clinical Course at Stage One Palliation with either a modified Blalock-Taussig shunt or a right ventricle to pulmonary artery conduit. Journal of the American College of Cardiology. 2008; 52(1):52-59.

Salvin JW, Scheurer MA, Laussen PC, Mayer JE, del Nido PJ, Pigula FA, Bacha EA, Thiagarajan, RR. Factors Associated with Prolonged Recovery Following the Fontan Operation. Circulation. 2008 Sep 30;118(14 Suppl):S171-6.

Salvin JW, Laussen PC, Thiagarajan, RR. Extracorporeal Membrane Oxygenation for Post-Cardiotomy Mechanical Cardiovascular Support in Children with Congenital Heart Disease. Pediatric Anesthesia 2008 Dec; 18(12): 1157–1162.

Barrett CS, Bratton SL, **Salvin JW**, Laussen PC, Rycus PT, Thiagarajan RR S . Neurological Injury after Extracorporeal Membrane Oxygenation use to aid Pediatric Cardiopulmonary Resuscitation. Pediatric Critical Care Medicine. May 15,2009, *in press (Epub ahead of print).*

AVINASH C. SHUKLA, M.B.B.S.
Assistant Professor of Anaesthesia, Harvard Medical School

Dr Shukla received his medical degree from Kings College London and subsequently completed his anesthetic training in London, as well. In addition, he completed a research Fellowship in Intensive Care at University College London and a clinical Fellowship in Pediatric Cardiac Anesthesia at Children's Hospital Boston. Following his training he joined the staff at The London Chest Hospital rapidly becoming Chairman of the Department. In 2001, he returned to join the staff of the Cardiac Anesthesia Division. His interests include robotics, transplantation and perioperative arrhythmias.

Selected Publications:

Hamilton-Davies C, Salmon J, Mythen M, Jacobsen D, Shukla AC, Webb A. A Comparison of commonly used indicators of hypovolemia with gastrointestinal tonometry. Intensive Care Medicine 1997;23(3):276-81.

Barnard MJ, Shukla AC, Lovell AT, Goldstone JC. A comparison of airway and oesophageal triggering of pressure support ventilation. Chest 1999;115(2):482-9.

Gruber EM, Shukla AC, Reid RW, Hansen D. Synthetic antifibrinolytics are not associated with an increased incidence of baffle fenestration closure after the modified Fontan procedure. Journal of Cardiothoracic and Vascular Anesthesia 2000;14:257-9.

Shukla, AC, et al. Anesthesia for Pediatric Organ Transplantation. In: Smith's Anesthesia for Infants and

Children, 7th ed. Mosby 2005.

TAJINDER P. (T.P.) SINGH, M.D., M.Sc.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Singh is a member of the Heart Failure/Transplant Service His pediatric residency and pediatric cardiology fellowship training was at Children's Hospital of Michigan in Detroit where he also served as the Medical Director of Heart Transplant Program during 1998-2005 before joining Children's Hospital Boston in October 2005. His research interests include clinical outcome research in pediatric heart failure and heart transplant population and exercise physiology in children. He is also interested in assessment of myocardial blood flow, metabolism and innervation in children using PET imaging and physiological effects of myocardial autonomic denervation

Dr. Singh's recent publications include:

Almond CS, Thiagarajan RR, Piercy GE, Gauvreau K, Blume ED, Bastardi H**, Singh TP.** Waiting list mortality among children listed for heart transplantation in the United States in the current era. *Circulation* 2009; 119: 717-727.

Almond CS, Gauvreau K, Thiagarajan RR, Piercey GE, Blume ED, Smoot LB, Fynn-Thompson F, **Singh TP.** Impact of ABO-incompatible listing on wait-list outcomes among infants listed for heart transplantation in the United States: A propensity analysis. *Circulation 2010; 121:1926-1933.*

Singh TP, Naftel DC, Addonizio L, Mahle W, Foushee MT, Zangwill S, Blume ED, Kirklin JK, Singh R, Johnston JK, Chinnock R. Association of race and socioeconomic position with outcomes in pediatric heart transplant recipients. *Am J Transplant* 2010;10:2116-2123.

Singh TP, Almond CS, Givertz M, Piercey G, Gauvreau K. Improved survival in heart transplant recipients in the United States: Racial differences in era effect. *Circulation: Heart Failure* 2011; 4: 153-160.
Singh TP, Almond CS, Piercey G, Gauvreau K. Trends in wait-list mortality in children listed for heart transplantation in the United States: Era effect across racial/ethnic groups. In press, *Am J Transplant* 2011.

LAURENCE J. SLOSS, M.D.
Physician, Brigham and Women's Hospital and Assistant Professor of Medicine, Harvard Medical School

Dr. Sloss has been at Children's Hospital for 37 years, first as a fellow and subsequently as a member of the departmental staff. Early in his career at Childrens, he was active in the Pathology Department and established a teaching collection of paraffinized heart specimens, and directed the Holter Monitoring service in the EKG Lab. He founded and remains associate director of the Boston Adult Congenital Heart (BACH) service. He has also been responsible for teaching and interpreting Holter monitor studies in the EKG monitoring service. Dr. Sloss has a long-standing appointment at Brigham and Women's Hospital where he formerly served as chief of the noninvasive cardiac laboratory, and has a freestanding private practice in cardiovascular disease. Dr. Sloss' interests lie primarily in clinical cardiovascular medicine, with special emphasis on noninvasive diagnosis and adult congenital heart disease.

LESLIE B. SMOOT, M.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Smoot has been a member of the cardiology staff since 1994. She received her medical degree from the University of Minnesota, followed by pediatrics residency at Northwestern University and Harbor-UCLA Medical Center. Her pediatric cardiology training began at Royal Children's Hospital (Melbourne, Australia) followed by fellowship at Children's Hospital in 1990.

Dr. Smoot's work focuses on cardiovascular genetics as it relates to both developmental abnormalities and cardiomyopathy. She is the director of the Cardiovascular Genetics Registry at Childrens Hospital and attending physician for Cardiovascular Genetics, Heart Failure and Cardiac Transplantation and general cardiology services. Recent publications include:

> Kamisago M, Sharma SD, DePalma SR, Solomon S, Sharma P, McDonough B, Smoot L, Mullen MP, Woolf PK, Wigle ED, Seidman JG, Seidman CE. Mutations in sarcomere protein genes as a cause of dilated cardiomyopathy. *N Engl J Med* 2000 Dec 7;343(23):1688-96.
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> Metcalfe K, Rucka AK, Smoot L, Hofstadler G, Tuzler G, McKeown P, Siu V, Rauch A, Dean J, Dennis N, Ellis I Reardon W, Cytrynbaum C, Osborne L, Yates JR, Read AP, Donnai D, Tassabehji M Elastin: mutational spectrum in supravalvular aortic stenosis. Eur J Hum Genet 2000 Dec;8(12):955-63

SARAH A. TEELE, M.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Teele is a staff member of the Cardiac Intensive Care Unit. Following medical school at Boston University, the remainder of her training has been at Children's Hospital Boston. This has included pediatric residency, pediatric cardiology fellowship including a year as a chief fellow, and a senior year in cardiac intensive care. She joined the staff in 2008. Her clinical interests include mechanical circulatory support and neurodevelopmental outcomes. Dr. Teele's publications to date:

> Teele, SA. Emani SM, Thiagarajan RR, Teele RL. Catheters, Wires, Tubes and Drains on Postoperative Radiographs of Pediatric Cardiac Patients: The Whys and Wherefores. Pediatr Radiol. 2008 Oct; 38(10): 1041-53; quiz 1151. Epub 2008
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> Bautista-Hernandez V, Thiagarajan RR, Fynn-Thompson F, Rajagopal SK, Nento DE, Yarlagadda V, Teele SA, Allan CK, Emani SM, del Nido PJ, Laussen PC, Pigula FA, Bacha EA. Pre-operative extracorporeal membrane oxygenation as a bridge to cardiac surgery in children with congenital heart disease. Ann Thorac Surg. 2009 Oct;88(4):1306-11.

RAVI R. THIAGARAJAN, M.D., M.P.H.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Thiagarajan is a member of the Cardiac Intensive Care team. He is board certified in Pediatrics, Pediatrics Critical Care and Pediatric Cardiology. His research interests include the study of respiratory mechanics and ventilator weaning in children, severity of illness scoring systems in children, and mechanical circulatory support in children with cardiac failure. His recent publications include:

N.J.Braudis, M.A.Q.Curley, K.Beaupre, K.Thomas, G. Hardiman, P. Laussen, **R.R.Thiagarajan.** Enteral Feeding Algorithm for Infants with Hypoplastic Left Heart Syndrome Post Stage I Palliation. *Pediatric Critical Care Medicine 2009; 10: 460 - 466.*

C.S. Barrett, S.L. Bratton, J.W.Salvin, P.C.Laussen. P.T. Rycus, **R.R.Thiagarajan.** Neurological Injury after Extracorporeal Membrane Oxygenation use to aid Pediatric Cardiopulmonary Resuscitation. *Pediatric Critical Care Medicine 2009; 10: 445 – 451.*

C.S.D. Almond*, **R.R.Thiagarajan***, G. Piercy. K. Gauvereau, T.P.Singh***(Joint first authors)**.Wait list mortality among children listed for cardiac transplantation in the United States. *Circulation 2009; 119(5): 717 - 727.*

R.R. Thiagarajan, T.V. Brogan, M.A. Scheurer, P.C.Laussen, P.T. Rycus, S.L. Bratton. Extracorporeal Membrane Oxygenation to Support Cardiopulmonary Resuscitation in Adults. *Annals of Thoracic Surgery 2009; 87(3): 778 - 785.*

D.C.Yu, **R.R.Thiagarajan,** P.C. Laussen, J.P. Laussen, T. Jaksic, C.B.Weldon. Outcomes after the Ladd procedure in patients with heterotaxy syndrome, congenital heart disease, and intestinal malrotation. *Journal of Pediatric Surgery 2009*; *44: 1089 – 1095.*

JOHN K. TRIEDMAN, M.D.
Professor of Pediatrics, Harvard Medical School

Dr. Triedman is a staff member on the Electrophysiology Service. His research interests are the mechanisms and therapy of atrial reentrant tachycardia and modeling and numerical analysis of cardiovascular electrophysiology. Current projects include development of techniques for the visualization of electrophysiological properties of the right atrium, modeling of cardiac defibrillation therapy and development of nonfluoroscopic techniques for ablation of common arrhythmias. Recent publications include:

Jolley M, Stinstra J, Pieper S, MacLeod R, Brooks DH, Cecchin F, Triedman JK. A computer modeling tool for comparing novel ICD electrode orientations in children and adults. *Heart Rhythm* 2008;5:565-572.

Takahashi K, Fynn-Thompson F, Cecchin F, del Nido P, Triedman JK. Clinical outcomes of Fontan revision surgery with and without associated arrhythmia intervention. *Int J Cardiology* 2009, 137:260-266

Jolley M, Stinstra J, Jess Tate J, Pieper S, MacLeod R, Chu L, Wang P, Triedman JK Finite element modeling of subcutaneous implantable defibrillator electrodes in an adult torso. *Heart Rhythm* 2010, 7:692-698

Miyake CY, Mah DY, Atallah J, Oikle HP, Melgar ML, Alexander ME, Berul CI, Cecchin F, Walsh EP, Triedman JK. Nonfluoroscopic imaging systems reduce radiation exposure in children undergoing ablation of supraventricular tachycardia. *Heart Rhythm* 2011, 8:519-525

WAYNE TWORETZKY, M.B.CH.B.
Assistant Professor of Pediatrics, Harvard Medical School

Dr. Tworetzky is an Attending in the Echo Lab. He also attends on the consult service and has two outpatient clinics per week. His time in the Echo Lab is divided between performing fetal echocardiograms, reading transthoracic echos and performing transesophageal echos in both the Cath lab and operating room. He also performs exercise and Dobutamine stress echocardiograms in children with coronary artery disease and certain forms of cardiomyopathy. Dr. Tworetzky completed both his Pediatric Residency and Cardiology Fellowship training at the University of California, San Francisco where he developed his research interest in fetal cardiology. Dr.

Tworetzky's main research interest is in the impact of fetal diagnosis on the in-utero and perinatal management of congenital heart disease. More recently Dr. Tworetzky has been instrumental in starting up a fetal cardiac intervention program in affiliation with the Advanced Fetal Care Center and the Division of Maternal-Fetal Medicine at Brigham and Women's Hopital. The program is seeking to treat fetuses with severe aortic stenosis and other serious congenital heart defects. He is also working closely with the fetal surgeons in the animal research lab to develop techniques for fetal cardiac access and therapy. Publications include:

Lester SJ, McElhinney DB, Viloria E, Reddy GP, Ryan E, Tworetzky W, Schiller NB, Foster E. Effects of losartan in patients with a systemically functioning morphologic right ventricle after atrial repair of transposition of the great arteries. *Am J Cardiol*. 2001 Dec 1;88(11):1314-6. No abstract available.

Tworetzky W, McElhinney DB, Reddy VM, Brook MM, Hanley FL, Silverman NH. Improved surgical outcome after fetal diagnosis of hypoplastic left heart syndrome. *Circulation*. 2001 Mar 6;103(9):1269-73.

Tworetzky W, Bristow J, Moore P, Brook MM, Segal MR, Brasch RC, Hawgood S, Fineman JR. Inhaled nitric oxide in neonates with persistent pulmonary hypertension. *Lancet*. 2001 Jan 13;357(9250):118-20.

Tworetzky W, McElhinney DB, Burch GH, Teitel DF, Moore P. Balloon arterioplasty of recurrent coarctation after the modified Norwood procedure in infants. *Catheter Cardiovasc Interv*. 2000 May;50(1):54-8.

McElhinney DB, Reddy VM, Tworetzky W, Petrossian E, Hanley FL, Moore P. Incidence and implications of systemic to pulmonary collaterals after bidirectional cavopulmonary anastomosis. *Ann Thorac Surg*. 2000 Apr;69(4):1222-8.

ANNE MARIE VALENTE, M.D.
Assistant in Cardiology, Brigham and Women's Hospital, Children's Hospital Boston and Assistant Professor in Medicine and Pediatrics, Harvard Medical School

Dr. Valente is board-certified in adult cardiovascular disease and pediatric cardiology. She is the Outpatient Director of the Boston Adult Congenital Heart (BACH) and Pulmonary Hypertension Program and a staff member of the Cardiovascular Magnetic Imaging (CMR) Program. Dr. Valente's research interests include the use of imaging to determine mechanisms that contribute to ventricular dysfunction in adults with congenital heart disease and predictors of adverse outcomes in patients with repaired tetralogy of Fallot. Dr. Valente's recent publications include:

Valente AM, Sena L, Powell A, Del Nido P, Geva T. Cardiac MRI Evaluation of Sinus Venosus Defects: Comparison to Surgical Findings. Pediatric Cardiology 2007; 28:51-56.

Wald RM, Haber I, Wald R, Valente AM. Powell AJ, Geva T. The Effect of Regional Dysfunction and Late Gadolinium Enhancement on Global Right Ventricular Function and Exercise Capacity in Patients with Repaired Tetralogy of Fallot. Circulation 2009;119:1370-7.

Valente AM, Lock JE, Gauvreau K, Rodriguez-Huertas E, Joyce C, Armsby L, Bacha EA, Landzberg MJ. Predictors of Long-term Adverse Outcomes in Patients with Congenital Coronary Artery Fistulae. Circulation Cardiovascular Interventions 2010;3(2):134-9.

Valente AM, Bhatt AB, Cook S, Earing MG, Gersony DR, Aboulhosn J, Opotowsky AR, Lui G, Gurvitz M, Graham D, Fernandes SM, Khairy P, Webb G, Gerhard-Herman M, Landzberg MJ for the Alliance for Adult Research in Congenital Cardiology (AARCC) Investigators .Congenital Heart Disease in Adults Lower Extremity Systemic Venous Health in Fontan Patients (CALF) Study . Journal of American College of Cardiology 2010; 56:144-50.

Bhatt AB, Landzberg MJ, Gerhard-Herman M, Rodriguez-Huertas E, Graham D, Valente AM. Pathophysiology of Chronic Venous Insufficiency in Adults with a Fontan Circulation. International Journal of Cardiology 2011; doi:10.1016/j.ijcard.2011.07.053.

RICHARD VAN PRAAGH, M.D.
Director, Emeritus, Cardiac Registry, Children's Hospital and Professor of Pathology, Emeritus, Harvard Medical School

Dr. Richard Van Praagh was the Director of the Cardiac Registry (the cardiac pathology laboratory) at Children's Hospital, Boston until June 30, 2001. Trained in pediatrics, pediatric cardiology, pathology, and embryology, Dr. Van Praagh's main interests involve congenital cardiovascular pathology and its many correlations-diagnostic, therapeutic, developmental, and etiologic. He pioneered the widely used segmental anatomic and developmental approach to the diagnosis and classification of complex congenital heart disease. He has contributed to a better understanding of many different forms of congenital heart disease including single ventricle, double-outlet left ventricle, and anatomically corrected malposition of the great arteries. Dr. Van Praagh has developed two new surgical operations – for totally anomalous pulmonary venous connection to the coronary sinus, and for interrupted aortic arch.

Dr. Van Praagh has held numerous visiting professorships and invited lectureships, and has served on the editorial boards of several major cardiology journals. Dr. Van Praagh's recent publications include:

Van Praagh S, Porras D, Oppido G, Geva T. Van Praash R. Cleft mitral valve without ostium primum defect: anatomic data and surgical considerations bsed on 41 cases. *Ann Thorac Surg* 2003; 75:1752-1762.

Porras D, Kratz C, Loukas M. van Doesburg NH, Davignon A, Van Praagh R. Superoinferior ventricles with superior left ventricle and inferior right ventricle: a newly recognized form of congenital heart disease. *Pediatr Cadriol* 2003; 24:604-607.

Konstantinov IE, Alexi-Meskishvile VV, Williams WG, Freedom RM, Van Praagh R. Atrial switch operation: past, present, and future. *Ann Thorac Surg* 2004; 77:2250-8.

Konstantinov IE, Lai L, Colan SD, Williams WG, Li J, Jonas RA, Van Praagh R. Atrioventricular discordance with ventriculoarterial concordance: A remaining indication for the atrial switch operation. J Thorac Cardiovasc Surg 224;128:944-5.

Van Praagh R. Chapter 101: Segmental Anatomy. *In* Sabiston & Spencer Surgery of the Chest, Selke FW, del Nido PJ, Swanon SJ (eds), Elsevier Saunders, Philadelphia 2005; pp 1763-1772.

EDWARD P. WALSH, M.D.
Professor of Pediatrics, Harvard Medical School

Dr. Walsh is Chief of the Electrophysiology Division. He is principally involved in clinical patient care, particularly transcatheter ablation of arrhythmias, along with fellow training and administration of the electrophysiology service. He has been active in the development of radiofrequency ablation since the inception of the technique, and has helped promote its use in the pediatric age group. His research efforts have concentrated on the development of new catheter

technologies to improve mapping and ablation of complex arrhythmias. In addition, he has special interests in postoperative arrhythmias and the adult with congenital heart disease. Recent publications include:

Walsh EP, Saul JP, Triedman JK (editors), Cardiac Arrhythmias in Children and Young Adults with Congenital Heart Disease. Lippincott Williams & Wilkins, Philadelphia. 2001

Walsh EP. Interventional electrophysiology in patients with congenital heart disease. Circulation 2007;115:3224-34.

Harrild DM, Berul CI, Cecchin F, Geva T, Gauvreau K, Pigula F, Walsh EP. Pulmonary valve replacement in tetralogy of Fallot: impact on survival and ventricular tachycardia. Circulation 2009;119:445-451.

Mah D, Miyake C, Clegg R, Collins KK, Cecchin F, Triedman JK, Mayer J, Walsh EP. Epicardial left atrial appendage and bi-atrial appendage accessory pathways. Heart Rhythm 2010;7:1740-1745.

Miyake CY, Del Nido PJ, Alexander ME, Cecchin F, Berul CI, Triedman JK, Geva T, Walsh EP. Cardiac tumors and associated arrhythmias in pediatric patients, with observations on surgical therapy for ventricular tachycardia. J Am Coll Cardiol 2011;58 (in press).

DA-ZHI WANG, Ph.D.
Associate Professor of Pediatrics, Harvard Medical School

Dr. Wang received his Ph.D. from the Department of Biological Sciences of the University of Iowa. Dr. Wang conducted his postdoctoral training in the laboratory of Prof. Eric Olson at the University of Texas Southwestern Medical Center at Dallas from 1998 to 2000. In 2002, Dr. Wang moved to University of North Carolina at Chapel Hill (UNC) as an Assistant Professor in the Department of Cell and Developmental Biology and a member of the Carolina Cardiovascular Biology Center. He was promoted to Associate Professor with tenure in 2008 at UNC. Dr. Wang joined the Division of Cardiovascular Research of Children's Hospital Boston in July 2009. Dr. Wang was named Basil O'Connor Scholar by the March of Dimes Birth Defects Foundation in 2004, and was awarded the Established Investigator Award from American Heart Association in 2008, a prestigious award conferred to leading investigators in cardiovascular biology.

Dr. Wang is interested in molecular regulation of mammalian cardiac and vascular smooth muscle growth and differentiation, in particular, the molecular control of gene expression by transcription factors and microRNAs. He is interested to understand how these pathways go awry in human cardiovascular disorders such as congenital heart defect and heart failure. Selected publications include:

Wang, D.-Z., Chang, P.S., Wang, Z, Sutherland, L., Small, E., Krieg, P.A. and Olson, E. N., 2001. Activation of cardiac gene expression by Myocardin, a transcriptional cofactor for serum response factor. ***Cell*** 105, 851-862.

Chen JF, Mandel EM, Thomson JM, Wu Q, Callis TE, Hammond SM, Conlon FL, **Wang DZ**. 2006. The role of microRNA-1 and microRNA-133 in skeletal muscle proliferation and differentiation. ***Nat Genet.*** 38: 228-233.

Thomas E. Callis and **Da-Zhi Wang.** 2008. Taking microRNAs to heart. ***Trends in Molecular Medicine*** 14: 254-260.

Jian-Fu Chen, Elizabeth P. Murchison, Mauricio Rojas, Ruhang Tang, Mariko Tatsuguchi, Thomas E. Callis, Scott M. Hammond, Gerhard Meissner, Craig Selzman, Michael Schneider, Gregory J. Hannon, Cam Patterson and **Da-Zhi Wang.** 2008. Targeted Deletion of Dicer in the Heart Leads to Dilated Cardiomyopathy and Heart Failure. ***Proc. Natl. Acad. Sci. U. S. A.*** 105: 2111-2116

Thomas E. Callis, Kumar Pandya, Ruhang Tang, Hee Young Seok, Jian-Fu Chen, Monte S. Willis, Craig H. Selzman, Oliver Smithies, and **Da-Zhi Wang.** 2009 MicroRNA-208a is a key regulator of cardiac remodeling and conduction. ***J Clin Invest*** 119:2772–2786**.**

FRED M. WU, M.D.
Associate Physician, Brigham and Women's Hospital; Instructor in Pediatrics, Harvard Medical School

Dr. Wu is board-certified in adult cardiovascular disease, internal medicine and pediatrics. He is a staff member of the Boston Adult Congenital Heart (BACH) and Pulmonary Hypertension group. Dr. Wu's clinical and research interests include multi-organ dysfunction in adults with congenital heart disease, the physician-patient relationship, and the use of health information technology and web-accessible resources to improve patient care and long-term outcomes.

Recent publications:

Bhatt AB, Landzberg MJ, **Wu FM**. "Atrial Septal Defect", in Crawford MH, DiMarco JP, and Paulus WJ: Cardiology, 3rd edition.

Wu FM, Landzberg MJ. "Congenital Heart Defects in Adults", in Wyszynski DF, Correa-Villasenor A, and Graham TP: Congenital Heart Defects: From Origin to Treatment, 1st edition.

Swan PJ, **Wu FM**, Dahle TG, Duprez DA. Extrapericardial cardiac compression syndrome. International Journal of Cardiology 2006 Nov 10; 113(2): 285-287.

VAMSI V. YARLAGADDA, M.D.
Instructor in Pediatrics, Harvard Medical School

Dr. Yarlagadda is a member of the Cardiac Critical Care Division. He completed his cardiology fellowship in 2006 and his critical care fellowship in 2008, both at Children's Hospital Boston. The majority of his clinical time and responsibility is with the cardiac critical care unit, but he also spends time in the general medical/surgical intensive care unit during the year. His primary interests are ventilator and mechanical support strategies.

JUSTIN P.V. ZACHARIAH, M.D., M.P.H.
Instructor in Pediatrics, Harvard Medical School

Dr. Zachariah is a staff physician in the Division of Preventive Cardiology. He completed his medical training at Baylor College of Medicine in Houston, Texas followed by Pediatric residency at the University of California San Francisco. During his pediatric cardiology fellowship here at Children's Hospital Boston, he obtained a Masters in Public Health from the Harvard School of Public Health. He was also a visiting research fellow at the National Heart, Lung, and Blood Institute's Framingham Heart Study.

Dr. Zachariah's research aims to identify novel biochemical and biophysical markers of repaired

and unrepaired congenital heart disease as well as atherosclerotic cardiovascular disease in children. These pursuits include novel investigations on plasma biomarkers in post repair Tetralogy of Fallot patients, hypertrophic cardiomyopathy patients, and community based population cohorts. ***[Justin Zachariah MD MPH]*** Dr. Zachariah is also spearheading noninvasive arterial tonometry research as a tool for risk stratification in preventive cardiology and congenital heart disease cohorts.

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Appendix I: CARDIOLOGY ROUNDS AND CLINICAL CONFERENCES

- Cardiac Intensive Care Unit Work Rounds (twice daily)
- Cardiology 8E Inpatient Work Rounds (daily)
- Cardiology 8E Core Lecture Series (daily)
- Morning Catheterization Conference (weekly)
- Cardiovascular Basic Science Seminar Series (bi-monthly)
- Fellow's Journal Club – General Cardiology (monthly)
- Journal Club – Outpatient (monthly)
- Journal Club – Exercise (monthly)
- Non-invasive Imaging M&M (monthly)
- Inpatient (8E)/Consult Service M&M Conference (monthly)
- Electrophysiology M&M (monthly)
- Outpatient M&M Conference (monthly)
- Cardiac Intensive Care Unit (8S) M&M Conference (monthly)
- Catheterization Conference and M&M (bi-weekly)
- Cardiac Surgery M&M Conference (weekly)
- Resuscitation Review Committee (monthly)
- Cardiovascular Program Bereavement Council (CBC) Conference (monthly)
- Adult Congenital Heart (BACH) Surgical Conference (bi-weekly)
- Adult Congenital Heart (BACH) Lecture Series (weekley)
- CV Surgical Research in Progress (monthly)
- Cardiac MRI Conference (weekly)
- Fellow's Clinical Case Discussion (weekly)
- Cardiomyopathy Meeting (weekly)
- Multidisciplinary Heart Failure transplant conference (weekly)
- Cardiac Pathology Teaching Sessions (several per week)
- Cardiology/Cardiac Surgery Combined Conference (weekly)
- Fellows' Core Curriculum Lecture Series (weekly)
- Fellow's Echocardiography Teaching Conference (weekly)
- Fellow's Angiography Review Conference (monthly)
- Echocardiography Didactic lecture (bi-weekly)
- Basic MRI Physics Lecture (weekly)

Appendix II: FELLOWSHIP POLICIES

1. FELLOW SELECTION POLICY

PURPOSE

This policy is designed to establish guidelines and standard practices by which the Department of Cardiology will recruit, select, and appoint clinical trainees in a fair and non-discriminatory manner.

FELLOW ELIGIBILITY AND SELECTION CRITERIA

Medical School:

Applicants to Children's Hospital GME Programs must be graduates of an LCME (Liaison Committee on Medical Education), AOA (American Osteopathic Association) accredited medical school, or international medical school. International Medical School Graduates must have a valid certificate from the ECFMG (Educational Commission for Foreign Medical Graduates).

Class standings, grades, Dean's letters/Medical School Performance Evaluatin and USMLE scores will be considered in the selection process.

Medical Science Examinations:

Applicants to Fellowship positions must have passed Step 3 of the USMLE. Exceptions may be made only for International Medical Graduates who are not yet eligible to take Step 3.

Medical Licensure:

Applicants must be eligible for a Massachusetts Limited License, and must submit an application for licensure immediately upon notification of an appointment to a Children's Hospital GME program. All appointments are contingent upon the Fellow obtaining and maintaining a Massachusetts license. Applicants with a Massachusetts Full License must submit a copy of their license and license application upon notification of an appointment.

Prerequisite Training:

Applicants must be in good standing in the required preliminary or prerequisite program. Appointment will be contingent upon satisfactory completion of the prerequisite training requirement.

Visas:

Foreign citizens who are permanent residents (Green Card holders) or who are graduates of a U.S. medical school are eligible for appointment on the same basis as U.S. citizen graduates of U.S. medical schools.

Programs are not obligated, but may agree, to sponsor a successful applicant for a J-1 (exchange visitor) or H-1B visa.

Non-Discrimination:

The Department of Cardiology will not discriminate with regard to race, religion, color, sex, marital status, sexual orientation, age, ancestry, disability or veteran status.

APPLICATION AND SELECTION PROCEDURES

National Matching Programs:
The Department of Cardiology participates in the National Resident Matching Program (NRMP) for the selection of first year fellows. Applicants apply directly to the Department and register with the NRMP.

Initial Application Screening/Interviews:
Completed applications are reviewed by the Department's Fellowship Selection Committee. Selected applicants are invited to visit the Department for interviews and to observe the activities of the Department. There are biweekly meetings of the selection committee to review the process and prepare the rank order list for the NRMP.

Rank Order List/Final Selection:
The Fellowship Selection Committee ranks the applicants on the basis of prior performance, letters of recommendations, personal interviews, and academic promise.

2. FELLOW DUTY HOUR POLICY

PURPOSE
This policy is designed to describe the total number of hours per week and days per week each Fellow may be scheduled for active clinical duty in Children's Hospital and any affiliated training sites, and for all scheduled rotations. These policies apply to scheduled hours, and may be waived in emergency or unusual circumstances.

CONSECUTIVE HOURS
Fellows must not be on active clinical duty for more than 24 consecutive hours. Four additational hours will be alloted for transitional activites. In addition, Fellows should have 10 hours free of duty, and must have 8 hours between scheduled duty periods. Feellows must have at least 14 hours free of duty after 24 hours of in-house duty.

HOURS PER WEEK
The Program Director will ensure assignment of reasonable in-hospital duty hours. Clinical duties must not be so pressing or consuming that they preclude ample time for educational activities, other important phases of the training program, or personal needs.

CALL
When averaged over a four week period, Fellows will not be scheduled for in-hospital call more frequently than every third night. Call from home may not be so frequent as to infringe on a reasonable amount of personal time.

NIGHT FLOAT
During the "night float" rotation, there will be no day time responsibilities and there will be one day per week with no call. Fellows must not be scheduled for more than six consecutive nights of night float.

DAYS OFF/WEEK
When averaged over a four-week period, Fellows must have at least one full day out of every seven free of all clinical responsibilities.

3. FELLOW EVALUATION AND REMEDIATION POLICY

PURPOSE
This policy is designed to provide a uniform, minimum institutional standard regarding the evaluation of Fellows appointed to the Cardiology Program. This policy is intended to conform to and supplement ACGME Institutional and Program Requirements and to serve as a guideline for implementing an effective system for Fellow performance appraisals.

FREQUENCY
Formative or Feedback Evaluations are designed primarily to assist Fellows in achieving educational and professional development goals and must be provided, in writing, within two weeks of the completion of each scheduled rotation. These evaluations will be given to the Program Director and are intended to serve as the primary basis for the Summarative Evaluations.

A Summarative Evaluation of each Fellow's professional growth, progress, and competence, including knowledge, skills, and performance, will be conducted at the end of one of each six-months of training. This evaluation will be in writing, and will be provided to and discussed with the Fellow. The Fellow must sign the evaluation, which will be placed in the fellow's file.

A Written Final Evaluation will be completed for each Fellow who completes the Program. This evaluation will include a review of the Fellow's performance during the final period of training and will verify that the Fellow has demonstrated sufficient professional ability to practice medicine competently and independently. This final evaluation will be part of the Fellow's permanent record that is maintained by the department.

EVALUATION STANDARDS
The faculty evaluates the performance each fellow for each rotation based on competence, using a quintile scale. For clinical rotation, components of the evaluation include:

- Gathering data by history
- Gathering data by physical evaluation
- Technical skills
- Assessing data and arriving at a diagnosis
- Managing problems and monitoring health
- Interpersonal relationships with patients and families
- Interpersonal relationships with other members of the health team
- Work habits and competence

REMEDIATION
It is the Program's responsibility to notify each Fellow in a timely fashion if his/her performance is substandard, and to document in writing the specific issues the Fellow must address in order to raise performance to an acceptable standard. A remedial course of study and training, with a reasonable timetable, will be established for addressing these deficits. Any such remedial course of study and training must be reviewed with the Fellow.

In the event that a Fellow is placed on probation, the Fellow will be so notified in writing. The notice will include a fair summary of the reasons for the action, the areas of performance to be improved, a fair summary of the minimum criteria for adequate improvement, and a date upon which the probationary status will be reviewed.

RECORDS
A Fellow shall have the right to examine the material in his/her personnel file. A copy of any material in the Fellow's file shall be furnished to the Fellow at her/his request. A Fellow has the right to place in his/her file a written response or commentary to his/her evaluations.

4. FELLOW PROMOTION AND NON-RENEWAL POLICY

PURPOSE
This policy is designed to provide a standard regarding the advancement or promotion of clinical trainees to the next higher Post-Graduate Year (PGY) level, and to establish reappointment procedures.

PROMOTION
Fellows will be advanced to the next PGY level on the basis of evidence of satisfactory scholarship and professional growth. Written offers of reappointment for the next academic year (beginning the following July 1st) will be provided to each Fellow on or before March 1st.

CONDITIONAL RENEWAL AND NON-RENEWAL
If the Program Director determines that additional time is required to determine the eligibility of a Fellow for promotion, they may offer the Fellow a written conditional reappointment; this conditional reappointment must include an appropriate remediation plan. If it is determined that a Fellow's appointment will not be renewed, the Fellow must be notified in writing no less than four months prior to the reappointment date (on or before March 1st).

A Fellow may be terminated from his/her training program at any time if the Fellow's evaluations document substandard performance and the Fellow has failed to satisfy the terms of his/her remediation plan. Such notice will be provided as early as possible.

REAPPOINTMENT PROCEDURES:
Each year, Fellows must submit their reappointment profile and limited or full medical license application to the Medical Staff Registrar and have a TB test done with Occupational Health in order to complete their reappointment.

5. PROGRAM AND FACULTY EVALUATION BY FELLOWS POLICY

PURPOSE

This policy is designed to provide a standard regarding the frequency and procedure by which all clinical trainees appointed to Cardiology are provided an opportunity to submit written, confidential evaluations of the program, including evaluation of the faculty and all aspects of the curriculum. This policy is intended to conform to ACGME Program Requirements and to be a guideline for implementing an effective system for appraising the educational effectiveness and outcomes within the Program.

FREQUENCY

A. Rotation Evaluations: Within two weeks following completion of each required rotation, each Fellow should have the opportunity to submit written confidential, evaluations of the faculty and the educational effectiveness of the rotation.

B. Annual Evaluation: An Annual Evaluation of the faculty and of the educational effectiveness of the program should be completed by each Fellow in writing and in a confidential manner.

STANDARDS

The Department of Cardiology uses the confidential "New Innovations" web-based evaluations system.

RESPONSIBILITIES

A. **Program Directors** are responsible for developing confidential-processes and providing forms to facilitate completion of faculty, rotation, and program evaluations by the Fellows. Fellows should be encouraged to participate in the evaluation of their educational program by the Program Director. The Program Director should utilize these evaluations by the Fellows in the review of the educational effectiveness of the program and in the review of each faculty member's effectiveness as a teacher of Fellows.

B. **Fellows** have an individual, professional responsibility to submit written program evaluations and faculty evaluations at least annually and at the end of each rotation.

6. VACATION AND LEAVE OF ABSENCE POLICY

VACATION

Each Fellow will be granted one month of vacation per year. The scheduling of vacation time will be coordinated by the chief fellows.

LEAVE OF ABSENCE

Recognized leaves of absence include Medical, Family Medical and Child Care/Adoption. Trainees employed by the hospital for at least twelve months, and who have worked at least 1250 hours

during the twelve month period preceding the leave, may be granted leave for up to twelve weeks in any rolling twelve month period. A medical or family medical leave may be granted on an intermittent or reduced schedule basis if medically necessary. For trainees who have been employed by the hospital for less than twelve months, or who have worked less than 1250 hours during the twelve month period preceding the leave, but who have been employed for at least three months by the hospital, may be granted up to eight weeks of leave for childbirth, or adoption of a child as provided under Massachusetts law. There may be limitations or guidelines for length of training that are determined by your specialty board and may affect leaves of absence. Please check with the training program director or your specialty board for more information

7. MOONLIGHTING POLICY

ELIGIBILITY

Fellows in the Department of Cardiology may moonlight only with the written approval of the Program Director.

Fellows on a J-1 visa may not moonlight under any circumstances. Fellows on other types of visas generally cannot moonlight; questions should be directed to Gail Robinson, Senior Immigration Specialist.

LETTERS OF APPROVAL

A copy of the signed letter of approval required for each moonlighting activity must be kept in the fellow's file.

LICENSURE

Each Fellow who moonlights must have a current FULL license from the Massachusetts Board of Registration in Medicine.

INSURANCE

Children's Hospital's malpractice insurance carrier will cover only Fellows who are eligible to moonlight as specified above and who possess a full license for their moonlighting activities. It is essential that Fellows check with the Medical Staff Registrar's Office (extension 7793) to confirm their eligibility and insurance coverage.