

INTERVENTIONAL CARDIOLOGY FELLOWSHIP CURRICULUM

PROGRAM DIRECTOR : SRIHARI S. NAIDU, MD

TABLE OF CONTENTS

- 1. PROGRAM'S STATEMENT OF COMMITMENT**
- 2. OVERVIEW OF GOALS AND OBJECTIVES**
- 3. PROGRAM FACULTY**
- 4. STRUCTURE OF PROGRAM**
- 5. FACILITIES AND RESOURCES**
- 6. CONFERENCES**
- 7. PROCEDURES**
- 8. QUALITY IMPROVEMENT**
- 9. SYLLABUS BY TOPIC**
- 10. SUGGESTED READING**
- 11. EVALUATION PROCESS: FELLOWS, FACULTY, AND PROGRAM**
- 12. SAMPLE EVALUATION INSTRUMENTS**

1. PROGRAM'S STATEMENT OF COMMITMENT

The Interventional Cardiology Fellowship at Winthrop University Hospital operates within the Division of Cardiology and the General Cardiology Fellowship Program, fully integrating two interventional fellows (PGY7) into the structured teaching, educational, research and clinical care missions of the Division. The goal is to educate and train two interventional fellows per year so they may develop into highly skilled and capable physician leaders in education, research and clinical care.

The program provides abundant clinical opportunities, including a comprehensive depth and breadth of procedures (over 6000 procedures performed per year), under the direct supervision of both voluntary and full-time interventional cardiologists, so that fellows become proficient in all requisite devices and techniques by the end of the year-long training. Moreover, fellow involvement in both pre-procedure and post-procedure care, including the inpatient consultative and outpatient ambulatory services, respectively, completes the comprehensive training.

The program also develops a strong sense of scientific inquiry and teaching, with regularly-scheduled didactics and journal clubs led by faculty, interventional fellows and general fellows, placing significant emphasis on formal learning and education by and to the interventional fellows. Focus is placed on allowing the fellow to develop the skills necessary for life-long learning and scholarship. In addition to local conferences, regional Long Island Cardiology Fellows Forums and national conferences aimed at the interventional fellows supplement this training. In addition, fellows participate actively in clinical research, including large-scale clinical trials and investigator-initiated case reports, case series, and original research.

The program is committed to providing extremely close mentorship, focusing both on personal and professional growth and well-being of the interventional fellows, and assisting in career choices and placement at the end of the year.

At the conclusion of training, fellows will be competent to practice as independent operators in the field of interventional cardiology, and will have achieved competency in the six domains of Medical Knowledge, Patient Care, Professionalism, Interpersonal and Communications Skill, Practice-Based Learning and Improvement, and System-Based Practice.

2. OVERVIEW OF GOALS AND OBJECTIVES

GOALS

1. To develop competence in the performance of basic and advanced coronary angiography.
2. To develop competence in the performance of basic and advanced hemodynamic assessment, including right and left heart catheterization for complex disease states.
3. To develop the clinical knowledge necessary to diagnose and manage the breadth of cardiovascular conditions seen in invasive cardiology practice, including valvular, myocardial, coronary, vascular, electrophysiologic, and pericardial conditions.
4. To develop and acquire technical skills in interventional techniques including angioplasty, stent placement, atherectomy, intravascular ultrasound, fractional flow reserve, valvuloplasty, biopsy, trans-septal catheterization, peripheral and structural intervention.
5. To understand normal and abnormal physiology as it pertains to cardiac catheterizations.
6. To advance the science and practice of cardiovascular medicine through the conduct and participation in clinical research.
7. To develop effective interpersonal and communication skills to include procedure-related discussion with patients and families as well as physician colleagues.
8. To develop effective communication skills regarding formal teaching through preparation of teaching material, and speaking formally to small and large groups of medical personnel, including physician colleagues.
9. To develop interpersonal skills as they relate to working within a multi-disciplinary team toward comprehensive and compassionate patient care.
10. To acquire clinical and technical skills in a progressive fashion, with increasing responsibility under appropriate supervision, in order to ultimately function as an independent operator trained in all aspects of interventional cardiology, with a commitment and ability to provide compassionate, professional and comprehensive care.

OBJECTIVE #1

Acquire and demonstrate medical knowledge about cardiovascular pathophysiology and catheter-based interventions.

Competency Domains Addressed: Medical Knowledge, Interpersonal and Communication Skill, Professionalism, Patient Care, Practice-Based Learning and Improvement

- Organize, attend and lead the weekly Cardiac Catheterization Conference on Wednesday mornings.
- Prepare and present 4-6 reviews of an interventional cardiology topic.
- Prepare and present 2-3 case presentations and clinical reviews at the Quarterly Long Island Fellows Forum.
- Prepare and present 1-2 case presentations and reviews at national cardiology society meetings, including American College of Cardiology, Society for Cardiac Angiography and Intervention, Transcatheter Cardiovascular Therapeutics, CRF Fellows Course, SCAI Fellows Course, and/or American Heart Association.
- Prepare and present cases and clinical reviews at the biweekly combined cardiac catheterization and cardiothoracic surgery conference (Cardiac Cath / TCV Conference).
- Organize and present literature review surrounding interventional-cardiology related articles as part of interventional and general cardiology Journal Club.
- Participate in case reviews and discussions at weekly Case Based Learning clinical case sessions.

OBJECTIVE #2

Acquire and demonstrate knowledge about clinical diagnosis and management of cardiovascular disease related to the field of interventional cardiology.

Competency Domains Addressed: Medical Knowledge, Interpersonal and Communication Skill, Professionalism, Patient Care, Practice-Based Learning and Improvement and Systems-Based Practice

- Perform a directed history and physical examination, such as in patients presenting with acute myocardial infarction, as it pertains to the patient undergoing an invasive catheterization procedure.
- Manage pre-procedure clinical situations, including consenting of patients, dye allergy, medication compliance, and indications/contraindications to the planned procedure.
- Understand the role of invasive testing and techniques within the larger health care system, as well as alternatives to invasive management, and the comparative effectiveness and cost effectiveness of various approaches to clinical care.
- Diagnose and manage post-procedure complications, including access site complications.
- Follow patients after angioplasty and other intervention, including structural heart intervention, until discharge, to understand post-procedure medical management.
- Maintain a weekly outpatient clinic to evaluate patients who have undergone procedures, or who are being referred and worked up for invasive procedures.

- Present patients in clinic to the supervising interventional cardiology attending, and discussing individual case-based diagnosis and management.
- Provide inpatient consultation on patients being considered for advanced interventional procedures, such as ASD/PFO closure and alcohol septal ablation.

OBJECTIVE #3

Acquire and demonstrate technical proficiency and knowledge in the performance of catheter-based procedures, including coronary, peripheral and/or structural intervention.

Competency Domains Addressed: Patient Care, Medical Knowledge, Practice-Based Learning and Improvement.

- Perform right and left heart basic and advanced catheterization (including complex hemodynamic assessment) under direct supervision of interventional cardiology attending.
- Assist and then progress to independent operator in cardiovascular interventions under direct supervision of interventional cardiology attending.
- Perform closure device procedures under the direct supervision of interventional cardiology attending.
- Understand and show proficiency in the indications and use of various ancillary procedures, including intravascular ultrasound and fractional flow reserve.
- Show ability to modify and adapt techniques to suit individual patient and disease characteristics.
- Assist in invasive procedures in the intensive care units, and supervise the general fellows in such procedures to include transvenous pacemaker placement and right heart catheterization, under the supervision of cardiology attending.

OBJECTIVE #4

Acquire and demonstrate understanding of the risks and benefits of individual procedures, and the alternatives to these procedures, including no invasive therapy when appropriate, and demonstrate ability to communicate these effectively.

Competency Domains Addressed: Patient Care, Interpersonal and Communication Skill, Medical Knowledge

- Discuss the risks and benefits of procedures orally to patients and their families under the direct supervision of interventional attending.

- Discuss the risks and benefits of procedures orally and written to physician colleagues, as part of outpatient continuity clinic, under direct supervision of interventional attending.

OBJECTIVE #5

Acquire and demonstrate the ability to critically review, read and incorporate into clinical practice the scientific literature surrounding interventional and general cardiology topics.

Competency Domains Addressed: Medical Knowledge, Patient Care, Systems-Based Practice, Practice-Based Learning and Improvement, and Interpersonal and Communication Skill.

- Attend and participate in monthly general cardiology fellowship Journal Club and additional Interventional Cardiology specific Journal Club
- Prepare Journal articles for presentation and teaching of relevant interventional issues, including integrating new literature and data into current clinical practice.
- Review scientific literature surrounding select research topics, as part of fellow research experience.
- Attend and participate in Quarterly Long Island Cardiology Fellows Forum.
- Prepare cases with adequate scientific literature review, and present findings at Quarterly Long Island Fellows Forum.
- Participate and lead combined Cardiac Cath / TCV conference, including reviewing scientific literature based on individual case presentations.

OBJECTIVE #6

Acquire and demonstrate understanding of the systems and regulatory requirements for adequate medical training, the affordance of board certification and obtaining hospital privileging, and demonstrate proficiency in ability to utilize system of care to provide excellence in patient care.

Competency Domains Addressed: Professionalism, Systems-Based Practice

- Demonstrate understanding of ABIM requirements for board certification in interventional cardiology, and ACGME requirements to interventional cardiology training.
- Demonstrate understanding of basic requirements for hospital privileging in interventional cardiology.

- Demonstrate understanding of procedural and technical requirements, as well as patient care requirements, to certification in peripheral and/or select structural heart interventional procedures.

OBJECTIVE #7

Develop and/or actively participate in a research project in interventional cardiology.

Competency Domains Addressed: Medical Knowledge, Professionalism, Interpersonal and Communication Skill, Systems-Based Learning

- Participate as sub-investigator in large-scale multi-center clinical trials.
- Initiate or assist in an investigator-initiated clinical research project.
- Conduct literature reviews as necessary to achieve research productivity.
- Select a mentor and discuss ideas, develop a project and advance to realization of a manuscript if appropriate.
- Maintain CITI and Human Subjects Protection Training.
- Acquire knowledge of and familiarity with IRB processes and requirements.

OBJECTIVE #8

Acquire and demonstrate the skills required for formal teaching.

Competency Domains Addressed: Medical Knowledge, Systems-Based Learning, Interpersonal and Communication Skill, Professionalism

- Organize, prepare and present teaching conferences to the telemetry nurses 4 times per year, on various topics including post-procedure access site management.
- Organize, prepare and present teaching conferences to colleagues as part of weekly Cardiac Catheterization Conference.
- Organize, prepare and present teaching conferences to colleagues as part of combined cardiothoracic and cardiac cath lab biweekly conference series.
- Organize, prepare and present teaching conferences to colleagues as part of regional Long Island Cardiology Fellows Forum.

3. PROGRAM FACULTY

The interventional cardiology fellowship program is comprised of three key faculty members, as described below. As such, there is ample supervision for all procedures,

clinical care, education, teaching and research requirements. In addition, the experience is strengthened by the relationship with 8-10 voluntary faculty who provide additional expertise, case volume, and teaching in coronary and peripheral vascular intervention.

Srihari S. Naidu, MD

Program Director, Interventional Cardiology Fellowship Program and Director, Cardiac Catheterization Laboratory

Srihari S. Naidu, MD, Director of the Cardiac Catheterization Laboratory, Interventional Cardiology Fellowship Program, and Hypertrophic Cardiomyopathy Center at Winthrop-University Hospital is skilled in all aspects of interventional cardiology including atrial septal defect and patent foramen ovale closure, alcohol septal ablation for hypertrophic cardiomyopathy, aortic and mitral valvuloplasty, and peripheral and coronary intervention.

Prior to joining Winthrop he was Assistant Professor of Medicine in the Division of Cardiology at New York Presbyterian Hospital-Weill Cornell Medical Center, where he was a high volume operator (>350 PCI/year) and developed their Hypertrophic Cardiomyopathy (HCM) Center, performing Cornell's first series of alcohol septal ablations. As such, he is a recognized expert on Hypertrophic Cardiomyopathy, currently performing more alcohol septal ablations than any other physician in New York.

Dr. Naidu is Board Certified in Internal Medicine, Cardiovascular Disease and Interventional Cardiology, and is currently Assistant Professor of Medicine at SUNY – Stony Brook School of Medicine.

His post-graduate training included fellowships in interventional cardiology and general cardiology at the University of Pennsylvania Medical Center in Philadelphia, where he received the 2004 Outstanding Teaching Award. He completed his residency in internal medicine at New York Hospital-Cornell Medical Center, where he received the David B. Skinner award for Administrative Stewardship, and received his medical degree from Brown University, where he remains associated as a Member of their Board of Directors. At Winthrop since 2006, he received the 2010 Attending of the Year Award.

A Fellow of the American College of Cardiology (FACC), the Society of Cardiovascular Angiography and Intervention (FSCAI) and the American Heart Association (FAHA), Dr. Naidu is also one of approximately 10 nationally-appointed members of the prestigious Cardiac Catheterization and Intervention Committee of the American College of Cardiology, sits on the 2010 ACC/AHA Guideline Writing Committee for the Diagnosis and Management of patients with HCM, and regularly serves as invited Abstract Reviewer and Faculty for the American College of Cardiology and American Heart Association Scientific Sessions.

Dr. Naidu has published over 70 original articles, reviews, editorials, and abstracts dealing with angioplasty outcomes, new technology and innovative procedural modifications, and regularly presents his research and experience throughout the United States and Europe.

Kevin P. Marzo, MD
Co-Program Director, Interventional Cardiology Fellowship Program and Chief,
Division of Cardiology

Kevin Marzo, MD, Chief of the Division of Cardiology at Winthrop-University Hospital, is an accomplished interventional cardiologist skilled in all aspects of vascular interventions, including coronary stenting, vascular brachytherapy, intravascular ultrasound, rotational atherectomy, peripheral vascular and renal artery stenting and percutaneous balloon valvuloplasty.

At Winthrop since 1992, he has played an integral role in transforming the Hospital's cardiology program into a state-of-the-art cardiac care service. In 2008, he received the Attending of the Year Award.

Dr. Marzo is a Diplomate of the American Board of Internal Medicine, Subspecialty of Cardiovascular Disease and Interventional Cardiology.

His postgraduate clinical training included fellowships in interventional cardiology and clinical cardiology at the Hospital of the University of Pennsylvania and a residency in internal medicine at Columbia-Presbyterian Medical Center. He was accepted from high school into the six-year honors program in medical education at Northwestern University Medical School and received his medical degree in 1985 with "Utmost Distinction." He was also elected to Alpha Omega Alpha, the medical honor society.

Dr. Marzo is an Associate Professor of Clinical Medicine at the State University of New York (SUNY) Stony Brook School of Medicine.

A Fellow of the American College of Cardiology and active in cardiovascular research, he has presented papers at many professional conferences, published numerous articles in medical journals and is presently a principal investigator involved in a host of clinical trials focusing on acute myocardial infarction, unstable angina and new interventional techniques. He has been instrumental in bringing large-scale multi-center clinical trials to Winthrop, primarily dealing with new technology and treatments in interventional cardiology.

Dr. Marzo's clinical expertise has been acknowledged by the Consumers' Research Council of America, which listed him in America's Top Physicians. In addition, he has been recognized multiple times as the interventional cardiologist with the lowest risk-adjusted mortality among all physicians in New York State.

Joshua R. De Leon, MD
Director, General Cardiology Fellowship Program

Joshua De Leon, MD, Director of the Coronary Care Unit and the Cardiovascular Fellowship Training Program at Winthrop-University Hospital, is an experienced

invasive/non-invasive cardiologist. Prior to joining Winthrop in 1999, he was Director of the Cardiac Catheterization Laboratory and Coronary Care Unit at Elmhurst Hospital Center. He has specific skill in the performance of right heart catheterization, evaluation of pulmonary hypertension, and high-risk pericardiocentesis.

Dr. De Leon is certified by the American Board of Internal Medicine and is a Diplomat in Cardiovascular Disease. He is certified by the Board of Nuclear Cardiology.

His postgraduate clinical training included fellowships in clinical and molecular cardiology at Montefiore Medical Center in the Bronx, where he served as Chief Fellow in clinical cardiology. He was a research fellow in the Department of Molecular Genetics at the Albert Einstein College of Medicine, where he also completed a residency in internal medicine. He earned his medical degree with honors and Distinction in Research from the SUNY Health Science Center at Brooklyn.

Dr. De Leon is an Associate Professor of Clinical Medicine at the SUNY Stony Brook School of Medicine.

A member of the American College of Cardiology and the American College of Physicians, Dr. De Leon is also on the editorial board of the Journal of Invasive Cardiology, Cardiovascular Reviews and Reports, Heart Failure, and the American Journal of Geriatric Cardiology. He is active in cardiovascular research, has presented papers at professional meetings and coauthored numerous scientific articles. Recently, he received the 21st Century Achievement Award in Cardiovascular Medicine from the International Biographical Centre.

4. STRUCTURE OF PROGRAM

The Interventional Cardiology Fellowship Program is structured as a 12-month block of training in the procedural and clinical care aspects of interventional cardiology. 4 weeks (1 month) of vacation time is included. Fellows participate in weekly outpatient clinic sessions, and inpatient consultations on unique interventional procedures, throughout the 12-month period. In addition, fellows are expected to participate actively in ongoing clinical research activities throughout the year, integrated into their clinical training, toward the publication and/or presentation of original research. At all times, fellows are under direct supervision of interventional cardiology faculty.

Fellows participate in invasive call on a 1 in 4 schedule, taking call entirely from home (no inpatient call). Call is shared with 6 interventional physician assistants. Interventional fellows also serve as back-up for general cardiology fellows, specifically dealing with invasive procedures, as necessary while on call.

The interventional fellow's major responsibility will include the assessment of patients being referred for cardiac catheterization. This will typically include at least 3-5 patients per day. The interventional fellow will be expected to review the patient's history and physical and make sure all of the appropriate blood work has been obtained and is within the standard values for performing interventional procedures. The history and physical and laboratory data will be reviewed by the attending physician.

The interventional fellow will be expected to participate in at least 3-5 diagnostic angiograms and/or percutaneous interventions per day. They will be asked to assess the appropriate technical instruments used during the procedure. Fellows will provide a preliminary report of angiographic interventional findings. Post-procedural orders will be completed by the interventional fellow with the supervision of the attending physician. Post-procedural management and issues in patient care will also be assessed by the fellow and reviewed again by the attending physician. If the patient is admitted and discharged the following day the fellow will be expected to discharge the patient, write the discharge instructions, and have these instructions reviewed directly with the attending physician. All fellows will be directly supervised by the full-time faculty, including interventional and non-interventional attendings, available 24/7.

Didactics, teaching, and other educational opportunities are provided through dedicated cardiac catheterization, general cardiology, clinical case-based, vascular, and regional and national conferences and lecture series as described in the Conferences section (below).

The interventional fellow will be an important teaching and supervisory resource for the general cardiology fellow. During the time in which a general cardiology fellow rotates through the catheterization laboratory, there is ample opportunity for the interventional fellow to teach cath techniques, hemodynamic assessments, the analysis of cath films, indications and contraindications of cardiac cath and interventional procedures, and history and physical on patients undergoing such procedures, as well as the recognition of potential peri-procedural complications. The interventional fellow also serves as educator for inpatient procedures performed by the general cardiology fellow, such as bedside intra-aortic balloon pump management, Swan-Ganz catheter placement and temporary pacemaker placement. In addition, the interventional fellows run two conferences (Core Curriculum Cath Conference and Cardiac Cath / TCV conference, see below Conferences Section), providing formal teaching to the general cardiology fellows.

As the fellowship is a one-year intensive training in procedural and related clinical skills, there are no separate additional rotations, such as elective or research blocks. Rather, the fellow is immersed in all aspects of interventional cardiology on an ongoing basis throughout the 12-month period, including didactic education, formal teaching, clinical care pre-, intra- and post-procedure, independent research, other scholarship, and procedural skills and proficiency. Individual experiences within the fellowship may be further elucidated as follows:

- a) Cath Lab Experience: Interventional fellows shall perform procedures as first assistant and then primary operator under direct attending supervision,

to fulfill minimum ACGME primary operator procedural requirements for both coronary and peripheral diagnostic and interventional procedures. At all times, fellows will participate in the pre-procedure and post-procedure management, including medical decision-making, indications and contraindications of procedures, in addition to intra-procedural decision-making (techniques, choice of equipment, alternatives). Fellows will also supervise the general cardiology fellows in basic diagnostic angiography and hemodynamic assessment procedures. In general, each fellow will participate in 3-5 cases per day, under the supervision of attending staff. In most instances, the cases will be assigned to the full-time staff, but additionally the fellow will have exposure to the voluntary staff.

- b) Research Experience: In this one-year subspecialty program, research will be integrated throughout the rotations. There will be protected time for research conferences, research design and data analysis, and presentations. A specific faculty member will be assigned as research mentor. Examples of prior research experiences have included writing case reports for publication, interpreting and compiling registry data for original abstracts, serving as Sub-Investigator for large scale clinical trials, and/or preparing original manuscripts for publication. In several cases, fellows have prepared posters for the Annual Research Day at Winthrop. The hospital has a full-time Biostatistical Service which is an important resource to house staff in designing and interpreting data and studies. In addition, the Division has numerous clinical trials which supplement the fellow's experience in areas such as Informed Consent and the IRB process. CITI training is a requirement for all fellows. The Division is currently involved in several interventional trials including NHLBI Dynamic Registry, PROTECT 2, FREEDOM, Xience Registry, USPella Registry, and the HCRI-DAPT trial, providing additional research opportunities for the interventional fellow.
- c) Outpatient Continuity Experience: Fellows are required to attend a Continuity/Consult ambulatory session one half day per week throughout their training. The fellow should be able to see an average of 1-3 new patients and 3-6 return patients. The fellow will be integrated into the practice, seeing most new patients under the direct supervision of attending staff. There will be consultative practice in the outpatient office, for assessment of coronary, peripheral and structural heart disease amenable to interventional procedures. In addition, there will be follow-up of patients who have had diagnostic or interventional procedures, as well as coronary artery bypass surgery. 25-50% of the time, fellows will follow the same patients through the pre-procedure, intra-procedure and post-procedure visits, ensuring continuity of care. This experience takes place in Winthrop Cardiology Associates with ample exam rooms, conference space, and state-of-the-art information technology, educational and diagnostic equipment.
- d) Inpatient Consultation Experience: Fellows will perform initial consultations within the hospital-setting for unique interventional procedures. After the initial consultation by the fellow, there will be

teaching rounds with the attending interventional faculty at the bedside, where a plan of treatment will be decided. Fellows will learn pre-procedure management of these procedures, and the art of inpatient specialized procedural consultations, under direct supervision of attending staff. Fellows will follow these patients throughout their hospital course post-procedure, to assure understanding of how interventional procedures integrate into the inpatient care of hospitalized patients, and to understand late complications of such procedures.

5. FACILITIES AND RESOURCES

The Interventional Fellows perform procedures in four dedicated state-of-the-art cardiac catheterization laboratories, fully integrated with the latest technologic advancements including intravascular ultrasound, intracardiac echocardiography, and fractional flow reserve, among others. The catheterization laboratories also have a state-of-the-art reporting system, which enhances communication between colleagues at the point-of-care (integrates with hospital-wide data management systems and outpatient practices). All technologies affiliated with interventional cardiology are available, allowing the fellow to learn in an open environment where different and unique approaches to interventional techniques can be fostered, serving the education mission.

The catheterization laboratory has the full complement of devices to support peripheral and structural intervention, in addition to coronary intervention, typically allowing the interventional fellow to sufficiently train in these aspects of procedural and clinical care within the scope of one fellowship training year. These include laser atherectomy, DSI atherectomy, and other techniques including valvuloplasty, endomyocardial biopsy and alcohol septal ablation.

A dedicated 18 bed recovery unit is state-of-the-art and modern, with completely electronic data, order entry, and patient management systems, and is staffed with 20 dedicated invasive cardiology nurses. The catheterization laboratory is staffed by 12 technicians fully trained in invasive cardiology.

A physician assistant (PA) service dedicated to the cardiac catheterization laboratory includes 6 PA's who share call with the interventional fellows, and assist with procedural teaching as well as pre- and post-care management of patients. Winthrop does not train physician assistants in interventional procedures, and therefore this PA service does not compete with the interventional fellows for learning opportunity; that is, all dedicated interventional teaching is focused on the interventional fellows.

The interventional fellows have dedicated personal lockers and an Invasive Lounge attached to the catheterization laboratory, equipped with two telephones and two computers. The computers have full internet access in order to perform literature reviews

of interventional topics and assist in research requirements of the fellows. In addition, the fellows have complete access to the Hoag 2 cardiology conference room (with an additional two computers, and full audio-visual setup for presentations), and the Hospital Library, with ready access to all available literature, both hard copy and digital formats. Literature not available at Winthrop is available at the Stony Brook School of Medicine Campus through internet access, supplied to the fellows.

Housing is provided to interventional fellows and located within 2-3 blocks of the hospital for quick and easy access while on call. Fellows also receive standard benefits, including health insurance, meal vouchers and free parking privileges.

Administrative support is provided by the Academic Coordinator, who facilitates all aspects of the interventional fellowship program, including the integration of the various clinical rotations, evaluation process, arrangement of benefits, and other relevant issues. In addition, cath lab administrative support is provided by the Cath Lab Operations Manager, including the purchase of lead aprons, scrubs and other needs.

6. CONFERENCES

The Interventional Cardiology Fellowship Program provides its trainees with a series of didactic and interactive teaching conferences that, throughout the year, enhance and complete the learning experience. These include the following conferences.

- Core Curriculum Cath Conference, Wednesdays at 7:45 AM (mandatory)
 - Includes didactic lectures by faculty (voluntary, full-time and guest), fellows and physician assistants, as well as angiogram and interventional procedural case reviews (see attached schedule)
 - Role of Fellow: Run each conference, assures attendance of fellows and voluntary faculty, and provide didactic teaching and supervision of general cardiology fellows.
- Interventional Clinical Case Conference, Fridays at 7:45 AM (mandatory)
 - Includes intervention specific case-based teaching, with review of angiograms, pathology, non-invasive imaging, and autopsy information as available, in order to improve interventional procedural skills and peri-procedural management.
 - Role of Fellow: Selection of cases to review, gathering of relevant data, and participation in discussion of interventional patient care.
- Cardiac Cath / TCV Conference, Biweekly Thursdays at 7:30 AM (mandatory)
 - Includes discussion of risks, benefits and alternatives to percutaneous vs. open surgical procedures, and enables interpersonal skills and communication through interaction with colleagues from surgery as well as cardiology
 - Role of Fellow: Run each conference, decide on and present cases to faculty for discussion.
- Case-Based Learning Mondays at 7:45 AM (mandatory)

- Case based learning, including literature review and debates on management techniques for various cardiovascular disease states
 - Role of Fellow: Participate in interventional case reviews, indications and contraindications to procedures, and discussion of relevant scientific literature.
- General Cardiology Journal Club, Monthly (mandatory)
 - Critical review and presentation, as well as literature review, of recent articles of import to general cardiology
 - Role of Fellow: Read and interpret literature, participate in discussion, present articles as assigned.
- Interventional Cardiology Journal Club, Quarterly (mandatory)
 - Critical review and presentation, as well as literature review, of recent articles of import to interventional cardiology
 - Role of Fellow: Choose, read and interpret interventional literature, participate in discussion and clinical consensus development.
- Research Conference, Quarterly (mandatory)
 - Discussion of recent ongoing clinical trails in the Division and in the catheterization laboratory, and assignment of responsibilities for patient recruitment and follow-up. Ensure CITI training and proficiency in IRB policies and procedures.
 - Role of Fellow: Participate in research trials, procedures and policies, IRB process, and CITI training.
- Long Island Cardiology Fellows Forum, Quarterly (mandatory)
 - Case based presentations by fellows from the various regional teaching hospitals, organized by Winthrop University Hospital and Long Island Jewish Medical Center Divisions of Cardiology
 - Role of Fellow: Case presentations and formal teaching.
- Vascular, IR and Interventional Cardiology Combined Conference, Mondays 8:30 AM (optional first half of year, mandatory second half of year)
 - Multi-disciplinary rounds based on cases that present and are treated between these three services, in order to discuss indications, contraindications, and management techniques
 - Role of Fellow: Case presentations and formal teaching.

7. PROCEDURES

Interventional cardiology fellows are taught the full range of interventional procedures, achieving over 250 percutaneous coronary interventions and 50 peripheral interventions as per ACGME requirements and guidelines. All procedures are documented in the catheterization laboratory reporting system (HeartLab) for easy retrieval of numbers for each individual fellow. Accrued numbers for each fellow are reviewed by the Program Director at the 6 month fellow evaluation visit and again at year's end.

Emphasis is placed on learning as secondary/assistant operator and then primary operator, and ultimately as an independent operator, all under direct attending supervision.

Interventional fellows typically graduate with proficiency in both coronary and peripheral intervention, with select structural heart interventions based on availability within the given year. Proficiency is determined by successful completion of the requisite number of procedures as primary operator with documented technical success, and demonstration of pre-procedural, intra-procedural, and post-procedural cognitive abilities in managing interventional patients.

The interventional procedures taught in the cardiac catheterization laboratory include the following:

Coronary Procedures/Interventions

- Angioplasty
- Stent placement
- Intravascular Ultrasound
- Angiojet thrombectomy
- Mechanical Thrombectomy
- Rotational atherectomy
- Laser atherectomy
- Chronic Total Occlusion intervention
- Bifurcation stenting
- Fractional Flow Reserve

Peripheral Procedures/Interventions

- Diamond-back rotational atherectomy
- Pioneer / Outback re-entry technique
- SFA intervention
- Iliac intervention
- Renal intervention
- Infrapopliteal intervention
- Subclavian intervention

Structural Procedures/Interventions

- Transvenous pacemaker
- Intracardiac echo
- Impella ventricular assist device
- Valvuloplasty (aortic and/or mitral)
- Endomyocardial biopsy
- Alcohol Septal Ablation
- ASD/PFO closure

8. QUALITY IMPROVEMENT

Interventional fellows participate throughout the year in case reviews and conferences focused on quality improvement within the Division and the cardiac catheterization

laboratory. They are active members of this process, and attendance and participation in these conferences are mandatory.

- Acute MI 911 Program (Monthly)
 - Monthly meeting of physicians, administration, nurses, technicians, physician assistants, fellows (general and interventional cardiology) and emergency room physicians and staff to discuss ongoing AMI door-to-balloon program. All cases are reviewed for compliance with national initiatives, and areas for improvement are noted and addressed. Goal is to evaluate cases for avoidable delays in door-to-balloon time, in order achieve 100% of MI patients successfully treated within 90 minutes.
 - Role of Fellow: Analyze cases, participate in discussion regarding delays in treatment, help track patient times and monitor for improvement over the year.
- Cardiology Peer Review (Monthly)
 - Fellows are assigned cases and interventional complications to review and present at the next meeting, with recommendations discussed within the Division of Cardiology. Results from these reviews form the basis for revised and/or new policies to improve quality of patient care within the Division.
 - Role of Fellow: Prepare interventional cases for discussion, determines areas for improvement, determines compliance with standards of care and current interventional guidelines, assists in policy revisions within the Division and the Cath Lab.
- Interventional Cardiology Curriculum Review Meeting (Quarterly)
 - Quarterly meeting of voluntary and full-time faculty, technicians, physician assistants, nurses, administration and fellows in order to discuss policies and procedures that affect patient care and quality within the Interventional Cardiology Fellowship Program. The curriculum and fellow evaluations are also discussed during this meeting, and areas that require improvement are determined and addressed. Fellows have opportunity to discuss concerns regarding the program, and opportunity to improve the Curriculum and learning experience. This meeting occurs as the second half of the Quarterly Interventional Quality Improvement Meeting.

9. SYLLABUS BY TOPIC

• **Role of Platelet Inhibitor Agents in CAD**

The role of platelets in acute coronary syndromes has been appreciated for several decades, yet the last 5 to 10 years have seen a dramatic increase in the understanding, development, clinical evaluation, and therapeutic application of platelet inhibitor therapy. This has been coupled with a swing away from antithrombotic therapies that overwhelmingly focus on control of thrombin generation and activity, toward a greater appreciation of the importance of control of platelet thrombus formation. The wide-

ranging benefits of antiplatelet therapy in cardiovascular disorders are strong testimony to the central role of platelet thrombus and the need for effective means for its control. The choice of agents has now expanded well beyond aspirin. Alternatives such as ticlopidine, clopidogrel, and cangrelor have mechanisms of action that are less well characterized than aspirin, but have still earned a place as important adjunctive treatments in cardiovascular disease. Potent intravenous agents such as the glycoprotein (GP) IIb/IIIa receptor inhibitors have also become available. In recent years, these latter agents have become less utilized than during their introductory years; nonetheless, their importance in acute coronary syndrome including myocardial infarction is undeniable.

The fellowship year will focus lectures and "in lab" didactics on the role of platelets in cardiovascular disease and provides an in-depth appraisal of the currently available antiplatelet agents, with a particular focus on the GP IIb/IIIa and ADP receptor inhibitors, which have emerged as key agents in the control of arterial thrombosis in high-risk patients.

- **Anticoagulants in Acute Coronary Syndromes and Coronary Intervention**

The acute coronary syndromes (ACS) ranging from unstable angina to ST-elevation myocardial infarction (MI), share many features regarding pathophysiology and treatment. In industrialized nations, ACS is the leading cause for hospitalization among adults as well as the leading cause of death. The etiology of acute myocardial ischemia is most often coronary arterial thrombus formation at the site of plaque rupture. Anticoagulants can prevent thrombus formation, halt progression of an established coronary arterial thrombus, and prevent future ischemic events. Considering these principal points, the importance of antithrombotic therapies for unstable angina and MI is easily understood.

The background, rationale, and outcome for the use of anticoagulant therapies in ACS and in patients with these syndromes undergoing percutaneous coronary revascularization will be discussed during cases as well as during morning lectures. Primary attention is given to agents targeting thrombin because it shares a critical and central role in thrombus formation. To this end, we will discuss newer direct thrombin inhibitors, such as bivalirudin which has emerged as a noninferior antithrombotic compared to heparin, with a significantly lower bleeding risk.

- **Effects of Medical Therapies on Acute MI and Unstable Angina Pectoris**

The efficacy of beta blockers, calcium channel blockers, and nitrates, as well as newer agents such as ranolazine, for relieving pain associated with stable angina pectoris is well established. The mechanisms of these agents differ, but they all reduce myocardial oxygen demand, an effect that is of benefit in those with unstable angina pectoris or acute myocardial infarction (MI). There has also been much interest in the use of magnesium

for acute MI. A number of clinical trials with these agents have been carried out since the mid-1980s, with discrepant results.

Fellows will understand the pharmacology and mechanism of action of each agent and then summarize the effects of treatment on mortality and major morbidity in studies of MI and unstable angina. To avoid selection or systematic biases, we have chosen to examine the data from all randomized trials of these agents, regardless of their results. Conclusions are based on the results from individual trials and an overview of all available trials.

- **ACE Inhibition and Angiotensin Receptor Blockers**

The angiotensin-converting enzyme (ACE) inhibitors share a common mechanism of action: inhibition of the enzyme that converts the biologically inactive decapeptide angiotensin I to the biologically active octapeptide angiotensin II. One of the most potent of the naturally occurring pressor substances, angiotensin II augments the contraction of vascular smooth muscle as well as promotes the renal retention of sodium. The latter action is mediated by alterations of intrarenal hemodynamics, and thereby sodium delivery, as well as by the release of aldosterone. Therefore, inhibition of the conversion of angiotensin I to the active angiotensin II should result in the reduction of vasoconstrictive influences and the promotion of urinary sodium excretion. However, ACE, which cleaves two peptides from angiotensin I, has also been identified as kininase II, the enzyme that converts bradykinin to inactive peptides. The administration of an ACE inhibitor therefore results not only in a reduction of the levels of angiotensin II but also in an accumulation of bradykinin and other prostaglandin vasodilators. These later vasodilators contribute to the vasodepressor action of converting enzyme inhibitors, as demonstrated in the blunting of the hypotensive response of ACE inhibitor therapy by the administration of the prostaglandin inhibitor indomethacin.

The discovery of local tissue ACE activity and angiotensin II generation by chymase independent of ACE expanded the opportunities to develop new pharmacologic approaches to inhibition of the renin-angiotensin system. The development of selective angiotensin II receptor (type I) blockers (ARBs) provides a pharmacologic opportunity to more selectively inhibit some of the actions of angiotensin II without directly altering bradykinin degradation.

The well-described systemic endocrine functions of angiotensin II must now be considered as only a short-term controller of cardiovascular homeostasis. Local autocrine functions of angiotensin II have revealed an important long-term trophic role of this peptide on myocardial and vascular tissue. These latter morphologic influences are believed to be important long-term modulators of cardiovascular function. The consequences of chronic ACE inhibition therapy are attributed to the inhibition of both systemic and local actions of angiotensin II.

The fellowship year will focus lectures and "in lab" didactics on the role the clinical utility of ACE inhibitors and ARBs, with an update on recent trials yielding new indications in patients with myocardial infarction and high-risk vascular disease.

- **Thrombolytic Intervention**

The evidence for the benefit of intravenous thrombolytic therapy in acute myocardial infarction (MI) is incontrovertible. After the demonstration that more than 90% of patients who present with ST segment elevation have coronary thrombotic occlusion, pivotal placebo-controlled randomized trials in the 1980s proved the value of early thrombolytic intervention for reducing mortality by approximately 30%. The acceptance of myocardial reperfusion as standard therapy for appropriate patients has ushered in the current thrombolytic era, a term that bespeaks the revolution in attitude among cardiologists, emergency physicians, internists, and nurses toward this disease. Although this major transformation may be taken for granted, substantial refinement continues in the approach to the patient with MI. This refinement includes the selection of a thrombolytic agent, assessment of endpoints of efficacy and safety, patient selection issues, the limitations of thrombolysis, and adjunctive therapy.

The fellowship year will focus lectures and "in lab" didactics on the role each of these issues of advancement, with particular attention to the results of recent randomized clinical trials, laying the groundwork for a future perspective on the field. In addition, we will acknowledge the recent move towards a primary angioplasty model, in hospitals such as ours which can optimize "door-to-balloon" times of less than 90 minutes. Primary angioplasty can restore normal blood flow in over 95% of patients suffering an ST-elevation MI, compared to 70% for thrombolytic therapy. In addition, we will explore the different "hybrid" or "facilitated" strategies, including full lytic therapy, half-dose lytic therapy with GP IIb/IIIa platelet receptor blocker or GP IIb/IIIa platelet receptor blocker alone given to patients enroute or awaiting angioplasty. Fellows will learn from case examples in "real-time", and from didactic lectures as part of morning interventional conference.

- **Elective Coronary Intervention: Approach, Technique, and Complications**

We are well into the "fourth revolution" and probably on the cusp of the "fifth and sixth revolutions" in percutaneous coronary intervention (PCI), an art whose dawning was brought forth by the pioneering work of Andreas Gruntzig nearly 25 years ago. Although many would consider it a mature art, dramatic changes have occurred even in recent years; and, if anything, the pace of important changes appears to be increasing. For the

practitioner new to the field, it is perhaps worth reviewing these major developments in brief: (1) introduction of the movable guidewire by John Simpson and colleagues (1981) (previously the balloon and wire could not be moved independently); (2) introduction of bailout stenting to treat large dissections, by Ulrich Sigwart, Gary Roubin, and others (1986); (3) introduction of high-pressure stenting (Antonio Colombo, 1994); (4) use of peri-procedural thienopyridine (Marie-Claude Maurice and others, 1994), allowing safer, more effective routine stent use; (4) introduction of glycoprotein IIb/IIIa agents for routine prophylactic treatment of thrombotic complications by Eric Topol and others (1992 to 1995) ; (5) recognition of the importance of coronary emboli in the pathogenesis of "minor myocardial injury" (John Webb and colleagues, 1998) in the context of increased awareness of the long-term adverse consequences of "enzymatic infarcts" and the use of entrapment devices to prevent such emboli (Don Baim, Jay Yadav, and others, 1999); and (6) use of biologic/polymer-coated stents to reduce restenosis after stenting (Eduardo Sousa, Patrick Serruys, and others, 2000).

These advances have allowed the interventionalist to treat patients with advanced coronary atherosclerosis with relative safety, such that the risk of major complications in many experienced laboratories has decreased to less than 1%. On the other hand, these new techniques have brought forth new complications, notably in-stent restenosis, subacute stent thrombosis, occasional profound thrombocytopenia, and a small but increased risk of coronary perforation. Thus although the overall incidence of acute complications has been reduced, the distribution of their causes has been markedly altered: Major dissections can now virtually always be "tacked up" with stents and are no longer the primary cause of urgent bypass surgery or major myocardial infarction. In most laboratories occasional dislodgement of voluminous amounts of atheromatous plaque resulting in obliteration of the distal microvasculature, tamponade due to perforation from ablative device use or sloppy handling of coronary guidewires, the occasional major guide catheter-induced ostial dissection, and massive bleeding from a noncompressible site are now the predominant components of the spectrum of major acute complications of coronary intervention.

Concurrent with advances in technology, this field has seen the completion of many important randomized trials that should shape one's practice of interventional cardiology, conforming to "evidence-based medicine." Nonetheless, some of the best practice of intervention remains an art.

The fellowship year will focus lectures and "in lab" didactics on the role of intervention with the goal of optimizing the technique for the clinical benefit of the patient.

- **Percutaneous Coronary Intervention for Unstable Coronary Artery Disease**

Since the introduction of percutaneous transluminal coronary angioplasty by Gruntzig and associates in 1977, the technique has considerably improved. The introduction of

coronary stent implantation has been a major step forward, and since then further refinements in percutaneous coronary intervention (PCI) techniques have made this intervention a predictable, safe method for treating coronary obstructive lesions. Its use has broadened (1) the clinical indications including not only for stable angina patients but also for patients with acute coronary syndromes (ACSs); and (2) the angiographic indications to a wide variety of single or multiple lesions in small or large vessels, including chronic totally occluded vessels. Over the years the frequency of patients who undergo PCI for ACS, or unstable coronary artery disease (CAD), has steadily increased, and in many institutions today it accounts for more than 50% of all interventional procedures. The primary success rate of PCI for unstable CAD is high, but a major drawback is the high frequency of acute procedural ischemic complications and the high adverse event rate following the procedure when compared to that in stable angina patients undergoing PCI.

Reviews on this topic will include first, recent findings of the pathophysiology underlying the syndrome of unstable angina. Second, in the context of its pathophysiology, review of the data on the effectiveness of PCI for unstable CAD and explain why there is a higher risk of adverse events and how these events can be reduced with adjunctive pharmacologic therapy. Finally, guidelines are proposed for the management of unstable CAD, including the role of intensive medical treatment, bypass surgery, and PCI, which is highlighted.

- **Efficacy of PTCA: Randomized Trials of Myocardial Revascularization**

Percutaneous transluminal coronary angioplasty (PTCA) was introduced in 1979 as a non-surgical technique for the treatment of discrete lesions involving a single coronary artery. PTCA has been applied successfully in a broad set of patient and clinical settings, but it proved unsuitable for treatment of some lesion types and has been hampered by the development of recurrent severe stenoses following successful dilatation in about 35% of treated patients. As the limitations of balloon angioplasty were identified, new percutaneous devices were developed. For many years, the term *PTCA* was used to denote any catheter-based treatment of coronary artery disease (CAD). The term *PTCA* is now restricted to denote percutaneous balloon angioplasty, in order to distinguish it from other forms of percutaneous treatment. This distinction is important because some catheter-based therapies offer significant outcome advantages over conventional balloon angioplasty (especially coronary stent placement), whereas others offer no material advantage and may be associated with increased risks (e.g., most atheroblation procedures).

Over the past decade, use of balloon angioplasty alone has declined as use of alternative devices has increased. However, the use of specific devices has varied greatly from year to year, as the strengths and weaknesses of new devices were clarified. Two decades ago, PTCA was the only noninvestigational device available for catheter-based treatment of CAD, and as recently as 10 years ago balloon angioplasty was still the dominant device used in interventional practice. However, data sampled from American hospitals in the past 2 years suggest that virtually all patients receive coronary stents, less than 10%

receive treatment with a nonstent, nonballoon device (mostly rotational and directional coronary atherectomy), and a small minority are treated with balloon angioplasty alone. Nonetheless, trials that tested a strategy of PCI using whatever device seemed most appropriate against coronary artery bypass graft surgery (CABG) or medical therapies are included.

The fellowship year will focus lectures and "in lab" dictatics on the role of PTCA treatment for *stable* angina pectoris, although randomized trial data comparing medical therapy with revascularization in unstable angina and non-Q-wave myocardial infarction (MI) are reviewed.

- **Periprocedural Myocardial Infarction and Emboli Protection**

The recognition of embolization as a pathologic mechanism during percutaneous coronary intervention (PCI) was one of the major conceptual advances in interventional cardiology in the 1990s. Trials of directional coronary atherectomy (DCA) allowed investigators to understand the linkage of embolization to periprocedural myocardial infarction (MI). The appreciation of the clinical impact of embolization not only on epicardial flow, but also on microvascular function, was due largely to the evaluation of the glycoprotein (GP) IIb/IIIa inhibitors and the observation that they substantially reduce the clinical sequelae of embolization, namely periprocedural MI. Although the prognostic importance of periprocedural MI was initially the source of acrimonious debate, the evidence supporting the clinical relevance of periprocedural MI is now beyond contest. Furthermore, the frequency of periprocedural MI was observed to be much higher in clinical trials with systematic collection and adjudication of data than when assessed by physician self-reporting. With more sophisticated measurements of myocardial necrosis, detection of periprocedural MI becomes even more common. Thus both pharmacologic and mechanical means of reducing embolization and subsequent periprocedural MI are topics of active investigation. Furthermore, the paradigm of preventing embolization has spread to interventional procedures for other vascular territories, such as the carotid arteries.

The fellow will understand the role of distal embolization and coronary vasospasm in the "no-reflow" phenomenon, as well as its role in procedural and long-term mortality. In addition, fellows will understand how to avoid and treat such complications, in order to improve short and long-term patient care.

- **Percutaneous Intervention in Patients with Prior Coronary Bypass Surgery**

Although the efficacy of coronary bypass surgery has been enhanced, in this fourth decade of application, by widespread use of arterial grafts, off-bypass and minimally invasive surgical techniques, and antiplatelet agents, the temporary nature of the palliative effect remains a significant health care problem. Severe myocardial ischemic syndromes occur in 3% to 5% of patients immediately after surgery, and thereafter recurrent ischemic symptoms appear in 4% to 8% of patients annually. Progression of disease in native coronary arteries occurs in approximately 5% of patients annually during the first 10 years. Saphenous vein graft (SVG) attrition is approximately 7% during the first week even with aspirin therapy, 15% to 20% during the first year, 1% to 2% per year from 1 to 6 years, and 4% per year from 6 to 10 years after surgery; at 10 years, only 40% of patent grafts are free of significant stenosis. Although it is clear that arterial grafts are superior, the limited number of arterial anastomoses that are possible mandates continued heavy reliance on venous conduits. Deterioration of native vessel and graft lumina after surgery results in an increasing need for repeated revascularization procedures.

At Emory University and at the Cleveland Clinic, reoperation was required in 2% to 3% of patients by 5 years, 12% to 15% by 10 years, and 30% by 12 to 15 years after an initial coronary bypass operation. At Emory University, reoperative surgery represented 5.4% of coronary surgical procedures in 1982 through 1984 but 15% in 1991 through 2000. Regrettably, the results of reoperative surgery are not as good as those of the first procedure. Even in the most experienced centers, the risk of in-hospital death and nonfatal ST-elevation myocardial infarction (MI) is triple that of the initial operation. At Emory University, the in-hospital mortality in more than 2000 patients undergoing coronary reoperation was 7.0%; it was 4.6% for those younger than 60 years, 8.2% for patients 60 to 69 years old, and 10% for those 70 years and older. In experience confined to the past decade, in-hospital mortality for reoperative surgery remained over 7% and ST-elevation infarction, costs, and length of stay were higher than for initial operations. In the Netherlands, in-hospital mortality was 7.2%. In New York State, in-hospital mortality was 4.1% for initial operations but 10.6%, 24.5%, and 38.5% for first, second, and third reoperations, respectively; at the Mayo Clinic, it was 12% for second or more reoperations. In addition to being more risky, reoperative surgery was associated with less complete angina relief and a reduced graft patency at 5 years of 65% for SVGs and 88% for internal mammary artery (IMA) grafts in patients undergoing recatheterization. Importantly, reoperation exhausts the limited supply of graft conduits, restricting future surgical options. During combined surgical and interventional conferences, the fellows will explore the indication for CABG vs. multi-vessel angioplasty with stent placement.

The post-bypass patient presents certain unique challenges for the interventionalist. Namely, PCI of venous bypass grafts carry with them a high risk of distal embolization, no-reflow phenomenon, and consequent poorer procedural and long-term outcome. In addition, different techniques are utilized, including different guide catheters, wires, and embolic protection devices.

Fellows will come to understand the various procedural challenges during “in lab” and didactic teaching conferences.

- **Ostial and Bifurcation Lesions**

Despite the availability of third-generation interventional devices and more than two decades of experience, ostial and bifurcation lesions continue to be a challenge to the interventional cardiologist. Elastic recoil of ostial lesions and the combination of longitudinal displacement of plaque and recoil of the ostial branch in bifurcation lesions frequently lead to suboptimal results, both procedurally and long-term, where restenosis rates may be higher.. No single preferred approach to these lesions has emerged despite the predominance of coronary stenting in most lesion subtypes.

The fellowship year will focus lectures and "in lab" didactics on the techniques, complexities, and pitfalls of intervention in both ostial and bifurcation lesions. Specifically, fellows will understand the indications and contraindications the different bifurcation stenting techniques.

- **Long Lesions and Diffuse Disease**

Long lesions and diffuse coronary disease present considerable challenges to the interventional cardiologist. Compared with discrete stenoses, percutaneous revascularization of long lesions is associated with decreased rates of procedural success, greater incidence of acute complications, and higher rates of restenosis. Patients with diffuse coronary disease often possess other clinical features (e.g., diabetes, multivessel disease) that are associated with adverse procedural and long-term outcome. Furthermore, patients with diffuse disease may not be suitable candidates for conventional bypass grafting because the disease involves the distal vascular territories.

In general, despite enthusiastic and favorable observational reports during the preliminary experience with a variety of new-generation devices, the superiority of ablative and debulking techniques over balloon angioplasty in the treatment of long lesions has not been confirmed in more recent randomized trials. Likewise, in spite of the significant improvements in both short- and long-term outcome of coronary stenting of discrete stenoses, recent data suggest that restenosis rates remain substantial when either long or multiple overlapping stents are used to treat long lesions. Newer drug-eluting stents have managed to improve outcome in these patients, however the results remain far from perfect.

The fellowship year will focus lectures and "in lab" dictatics on the role the various potential approaches to long lesions, and emerging concepts regarding treatment of diffuse coronary disease by providing insights through examination of the firsthand experience of treating long lesions. Studies focusing on long and complex lesions will also be reviewed as part of the morning lecture series.

- **Restenosis: The Clinical Issues**

Since the inception of percutaneous transluminal coronary angioplasty (PTC A) almost 25 years ago, percutaneous coronary revascularization has been an increasingly attractive alternative to surgical revascularization and medical therapy for coronary artery disease (CAD). Currently, well over 1 million percutaneous coronary intervention (PCI) procedures are performed each year worldwide, with the majority of cases being performed in North America and Western Europe, and the rate doubles every 5 to 8 years. Despite the steady and continuous advancement in the field of interventional cardiology, restenosis remains an important limitation of percutaneous coronary revascularization. Prior to the advent of drug-eluting stents, about one quarter of procedures were performed in lesions that were previously treated with PCI. Considering that more than 700,000 cases were performed in the United States annually at that time, this translated to a cost of \$3.5 billion/year for the treatment of restenosis. In 2003, drug-eluting stents became available, after studies confirmed their significant reduction in the development of restenosis. There is no question that drug-eluting stents have been a breakthrough, resulting in the treating of more complex lesions and reducing the need for repeat procedures over the ensuing year. However, over the past year, it has become clear that these stents also carry a somewhat higher risk of late thrombosis.

Fellows will understand the pathophysiology of restenosis, the various methods of treating and prevention restenosis, the risks and benefits of drug-eluting stents, and the challenges in developing next generation stents to combat restenosis while preserving a higher safety profile.

- **Endovascular Options for Peripheral Arterial Occlusive and Aneurysmal Disease**

By the first quarter of the twenty-first century, diseases of the vascular tree will surpass infectious pathologies as the number one cause of death worldwide. In the United States alone, cardiovascular disease or stroke was listed as a primary or contributing cause in 1.4 million deaths in 1999, or about 60% of all deaths that year. With demographic trends toward more aged populations, not only quantity, but quality of life issues are coming to the fore as well. The prevalence of intermittent claudication ranges from about 1% for people ages 40 to 44 years up to almost 7% for those 70 years old and above. Worldwide, the burden of lower limb amputations, which is a multifactorial problem, ranges from 120 per million population in Western Finland to 500 per million in the United Kingdom annually. In the United States, there are more than 400,000 hospitalizations for peripheral arterial disease (PAD) and close to 80,000 amputations annually.

In spite of this, PAD is still inadequately understood. There are but a few randomized clinical trials (RCTs) validating contemporary clinical diagnostic or therapeutic strategies for PAD. Factors that have contributed to this lag in scientific information include difficulties in clinical endpoint selection and ascertainment, end-organ heterogeneity, inadequate interdisciplinary communication and collaboration, a belated recognition of the burgeoning prevalence of PAD, and perhaps even an element of therapeutic nihilism.

Peripheral arterial occlusive disease can also be viewed as end-stage atherosclerosis: The average age of patients in the acute coronary syndrome trials is close to 60 years old, but almost a decade older for patients in stroke or abdominal aortic aneurysm (AAA) trials. The 5-year death rates after revascularization for carotid, vertebral artery, or supra-aortic trunk stenosis is as high as 30%, mostly as a consequence of cardiac disease. Hence, the presence of competing comorbidities in these cohorts introduces another level of complexity in analyzing the true benefits and risks of interventions, sequential procedures and multiple hospitalizations.

Although the rapid advances in coronary artery disease (CAD) research and therapy shed some light on PAD, there are fundamental differences that render simple extrapolation of data inaccurate at best, and perilous at worst. For instance, the impact of even a small amount of end-organ tissue infarction (e.g., as a result of distal embolic phenomena) is a quantitative loss for the heart or kidney, but may be a devastating qualitative loss for the brain. The expansion of therapeutic alternatives has led to a resurgent interest in peripheral vascular diseases, but it is imperative that adequate technology assessment and clinical trials catch up with the rapid evolution of endovascular devices and applications. Interventional procedures exist for multiple vascular beds, including renal, carotid, upper and lower extremity.

Fellows will participate in the pre-procedure evaluation, procedural technical considerations, and post-procedure management of patients undergoing peripheral vascular intervention. This clinical experience will be supplemented by didactic lecture experience as part of the morning conference series.

- **Coronary Atherectomy: Directional and Extraction Techniques**

Atherectomy is defined as excision and removal of obstructive tissue by a transcatheter technique, a concept first introduced by Simpson. The first directional atherectomy procedure was performed in 1985 in a superficial femoral artery using a peripheral atherectomy device. Initial experience in the peripheral circulation demonstrated the safety of directional atherectomy for peripheral vascular disease, which was approved by the Food and Drug Administration (FDA) in 1987. The directional coronary atherectomy (DCA) device was approved by the FDA in 1990 as the first nonballoon percutaneous coronary interventional device. In contrast to DCA, which relies on excision and tissue removal, the transluminal extraction-endarterectomy catheter (TEC) was designed by Stack to cut and aspirate atheroma and debris. In 1989, this device was approved by the FDA for peripheral vascular disease, and, in 1992, the FDA approved the TEC for

revascularization of saphenous vein bypass grafts and native coronary arteries. TEC and DCA have been, for the most part, abandoned due to unfavorable results. In contrast, the technique of rotational atherectomy has been developed and utilized in particular lesion subsets, namely heavily calcified vessels. The device allows canalization of the arterial lumen by “drilling” through the calcium, thereby allowing angioplasty and stent placement without complication. Nonetheless, rotational atherectomy carries with it unique challenges and complications.

The fellows will understand the technical indications and contraindications of rotational atherectomy. In addition, formal lecture series on this topic will be discussed as part of the morning conference series.

- **Indications and Limitations of Coronary Stenting**

Superior and predictable angiographic results combined with proven reductions in target lesion revascularization (TLR) have led to explosive growth in the field of percutaneous coronary stenting. This technique now constitutes most interventional procedures undertaken worldwide, exceeding 90% of cases in a large number of institutions. Coronary stenting has provided an effective technique for controlling coronary dissections, preventing acute vessel recoil, and improving the long-term durability of the coronary revascularization result. This rapid growth has been assisted by advances in pharmacotherapy (i.e., antiplatelet therapy such as the thienopyridines and the glycoprotein IIb/IIIa receptor inhibitors) coupled with improvements in stent design, such as greater flexibility and deliverability. However, coronary stenting is associated with its own set of limitations and complications, including distal embolization and in-stent restenosis. Furthermore, coronary stenting has now been applied to a diverse array of clinical subsets and lesion types beyond the indications supported by the original randomized data acquired among patients with highly selected "low risk" lesion characteristics. More recently, a number of trials have examined the role of coronary stents used for various indications and in complex lesion subtypes.

The fellowship year will focus lectures and "in lab" didactics on the evidence supporting the use of coronary stenting across a widening array of patient and lesion types, discusses the current limitations of widespread stent use, and explores the evolving data regarding strategies for the optimization of long-term results following coronary stenting. Particular emphasis will be placed on the decision to utilize bare metal versus drug-eluting stents in diverse patient subsets. Specifically, the complication of late thrombosis will be discussed in detail, as well as methods of avoiding this complication over the ensuing years post-stent placement.

- **Radiation for Restenosis**

Postangioplasty restenosis has been the major limitation confronting interventional cardiology. The three major components of restenosis following balloon angioplasty are

identified as an exuberant cellular proliferation and matrix synthesis (intimal hyperplasia) triggered by injury to the vessel wall, acute elastic recoil immediately following balloon deflation, and late vascular contraction (remodeling) resulting in a decrease in total vessel diameter. Coronary stenting eliminates elastic recoil and vessel contraction by acting as a mechanical scaffold within the vessel, thus reducing the restenosis rate. However, stents are associated with a higher degree of proliferative response and an increase in lumen late loss.

With the use of stents in nearly 90% of coronary intervention, in-stent restenosis (ISR), once it occurs, is the major challenge in prevention and treatment. Conventional treatments such as repeat balloon angioplasty, ablative treatment with atherectomy devices, laser angioplasty, and cutting balloon have been disappointing, with recurrence rates averaging 25% to 50% for focal restenosis and up to 65% for diffuse restenosis.

Ionizing radiation occurs in many forms, ranging from lightly ionizing x-rays, electrons, and beta or gamma rays to more densely ionizing neutrons, alpha particles, and other heavy particles. Vascular brachytherapy has emerged as a promising means for reducing the restenosis recurrence rate. For years, the growth-inhibiting properties of ionizing radiation have been used successfully to control benign proliferative disorders such as keloid formation, ophthalmic pterygium, macular malformations, arteriovenous malformations, and heterotopic ossification. Based on this experience, vascular brachytherapy, the intravascular delivery of radiation, was viewed as a viable solution to inhibit neointimal hyperplasia. In 1965, before the angioplasty and restenosis era, Friedman and colleagues reported the use of iridium-192 at 14 Gy delivered intraluminally to the injured aorta of cholesterol-fed rabbits, and demonstrated inhibition of smooth muscle cell (SMC) proliferation and intimal hyperplasia in the irradiated atherosclerotic arteries.

Vascular brachytherapy following angioplasty for the prevention of restenosis was introduced in 1992 by several investigators who performed a series of preclinical studies and demonstrated consistently profound reduction of neointima formation following balloon injury. In these experiments, the radiation was delivered into the vessel wall either by high-dose-rate catheter-based systems, or by low-dose-rate radioactive implants such as radioactive stents. The results of these preclinical trials were encouraging and facilitated the initiation of the feasibility clinical trials, first in the peripheral arteries, later in coronary arteries through pivotal trials, and then through commercialization of the technology for clinical use in Europe in 1999. In November 2000, the U.S. Food and Drug Administration (FDA) approved vascular brachytherapy therapy for ISR. In the ensuing years, brachytherapy was utilized with good result. However, new problems developed, namely late thrombosis, as well as the challenges of incorporating radiation oncologists into the cath lab routine.

By 2003, with the introduction of drug-eluting stents, new interest was placed on using these newer stents instead of brachytherapy to treat restenosis. Despite lack of randomized controlled clinical trials, registry data supported such use. As a result, brachytherapy is rarely utilized today.

Nonetheless, fellows will understand the historical role of brachytherapy in treating restenosis, and the literature for and against such therapy, including the complication of late stent thrombosis.

- **Intracoronary Doppler and Pressure Monitoring**

Andreas Gruntzig performed the first percutaneous transluminal coronary angioplasty (PTCA) in 1977 using 4 French dilation catheters with a double lumen, allowing on one side balloon inflation and on the other side pressure recordings. He described trans-stenotic pressure gradient measurements as a guide to the progress of the dilation. At that time, pressure gradient measurements were routinely performed and used to monitor the intervention and to assess the final results; a residual trans-stenotic gradient less than 20 mm Hg was considered optimal. However, with technical developments such as the flexible-tipped guidewire introduced in the lumen previously used to measure pressure, and the introduction of low-profile balloons, pressure recordings became more difficult to perform. Moreover, the relation between the measured pressure gradient, the diameter stenosis (DS), and the lesion length were imprecisely known, and dependent on the presence of the catheter itself in the stenosis. Finally, the pressure gradient had a limited prognostic value, and distal pressure recordings were abandoned because the pressure channel was eliminated to improve the crossing profile of the balloons and because of the advent of quantitative coronary angiography (QCA).

In parallel, attempts were made to mount a piezoelectric crystal at the tip of a catheter in order to characterize coronary blood flow, but the partial obstruction of the coronary ostium by those relatively large catheters limited their clinical use. With the development of parameters to assess the functional significance of a stenosis from its geometry using QCA, many interventional cardiologists considered that the available anatomic information was sufficient and that attempts to perform physiologic pressure and flow recordings could be reserved for research purposes.

The limitations of QCA for the physiologic assessment of intermediate coronary lesions in unselected patients with extensive coronary atherosclerosis have been recognized; the haziness of the borders of the vessel after PTCA also limits the use of QCA to assessing the acute results of an intervention. However, technical improvements led to the development of miniaturized pressure and Doppler transducers, mounted on 0.014-in. guidewires, which alleviate the initial fluid dynamics problems.

The fellowship year will focus lectures and "in lab" dictatics on fundamental assumptions, methodology, validation, and clinical applications of coronary physiology using intracoronary pressure and flow, as measured in patients in the cardiac catheterization laboratory. Fellows will have hands-on experience on using the pressure wire, and will understand the indications and contraindications to its use.

- **Intravascular Ultrasound**

Intravascular ultrasound (IVUS) imaging has provided, for the first time, a clinical method to directly visualize atherosclerosis and other pathologic conditions within the walls of blood vessels. Because ultrasound is able to penetrate below the luminal surface, the entire cross section of an artery—including the complete thickness of a plaque—can be imaged in real time. This offers the opportunity to gather new diagnostic information about the process of atherosclerosis and to directly observe the effects of different interventions on the plaque and arterial wall.

The first ultrasound imaging catheter system was developed by Bom and colleagues in Rotterdam in 1971 for intracardiac imaging of chambers and valves. In the early to mid-1980s, several groups began work on different catheter systems designed to image plaque and facilitate balloon angioplasty and other catheter-based interventions. The first images of human vessels were recorded by Yock and colleagues in 1988, with coronary images following the next year by the author's group and Hodgson and colleagues. The intervening period has seen rapid technical improvements of the systems, with enhancements in image quality, miniaturization of the catheters, and development of combined imaging/therapeutic devices.

Fellows will gain experience in the indications for IVUS evaluation, and will learn the technical aspects of performing and reading these images. The clinical experience will be supplemented by didactic lectures during the morning conference series.

- **Mitral Valvuloplasty**

Until the first publication by Inoue and coworkers on percutaneous mitral commissurotomy (PMC) in 1984, surgery was the only treatment for patients with mitral stenosis. Most reports concerning PMC have been published since 1986. Since then, a considerable evolution in the technique has occurred. A large number of patients have now been treated, enabling efficacy and risk to be assessed, and midterm results are available so we are better able to select the most appropriate candidates for treatment by this method.

As expected from the earlier experience with closed surgical commissurotomy, the good immediate and midterm results obtained during this period have led to increased worldwide use of the technique, which has become the second most important in the field of interventional cardiology.

Although the absolute number of this procedure is limited in the United States, fellows will gain an understanding of the risks, benefits and alternatives to balloon mitral valvuloplasty. Due to the small number of patients, fellows will not likely gain sufficient experience in this procedure to be certified.

- **Medical Economics in Interventional Cardiology**

Interventional cardiology is the prototype of a medical field marked by rapid technologic advances over a short period of time. Current practice of routine stenting and adjunctive glycoprotein (GP) IIb/IIIa use has substantially improved patient outcomes over those obtained in the early years of conventional balloon angioplasty. According to American Heart Association estimates, percutaneous coronary intervention (PCI) is now performed in the United States about 926,000 times each year on over one-half million patients. Despite this astonishing level of adoption into mainstream cardiovascular practice in a little over a decade, many controversies persist about the appropriate indications for PCI and about its value provided for money spent.

Specifically, fellows will be exposed to issues surrounding cost effectiveness of interventional therapy versus medical therapy in a variety of clinical situations. Fellows will also gain exposure to practice management concerns, including malpractice insurance, practice development, interaction with referring physicians, and coding of billable procedures.

- **Detection of Vulnerable Plaque**

Three million Americans develop acute myocardial infarction or unstable angina each year and present to the hospital alive. Unstable angina, myocardial infarction, and often sudden cardiac death result from disruption of a vulnerable coronary atherosclerotic plaque and consequent development of superimposed flow-limiting thrombosis. Recent advances in our understanding of the structural, cellular, and molecular mechanisms underlying plaque instability have engendered intense research efforts to detect and further characterize vulnerable atherosclerotic plaque in vivo. Efforts to identify atherosclerotic plaque at greater risk of disruption and subsequent thrombosis could extend our understanding of its pathophysiology permit the application of new or established therapies directed at patient or lesion vulnerability, and result in primary and secondary prevention of the acute coronary syndromes.

Fellows will gain exposure and understanding of the number of invasive (i.e., catheter-based) and noninvasive technologies that quantitatively or qualitatively assess plaque structure, composition, or function and that are either currently available or under evaluation.

- **Percutaneous ASD and PFO Closure**

Over the past decade, percutaneous methods of repairing atrial septal defects (ASD) and patent foramen ovals (PFO) have become available. In the case of the ASD, well-defined indications for closure/repair have been available for some time. These include evidence of right heart volume overload and RA or RV dilation, pulmonary hypertension

or right heart failure. In such patients, who typically have a Qp:Qs ratio in excess of 1.5:1, closure of an ASD may be carried out percutaneously when anatomic criteria have been met based on pre-procedure transesophageal echocardiogram.

The interventional fellows will become versed on the diagnosis and workup of patients with ASD, prior to elective percutaneous or surgical closure. The fellows will also learn the procedure, and be certified based on the requisite number of procedures and demonstration of technical proficiency while they perform the critical components.

As for PFO closure, well-defined indications for percutaneous closure are not known, mainly due to the prevalence of PFO in the general community, and the equivocal association between PFO, stroke and migraines in any given patient.

Nevertheless, interventional fellows will be involved in consultative interventional cardiology evaluating such patients, and in the decision process of whether percutaneous PFO closure is reasonable as part of a clinical trial or off-label in a given patient. As with ASD closure, the fellows will learn the procedure, and be certified based on the requisite number of procedures during which they perform the critical components. To supplement their clinical and procedural experience, formal didactic lectures and case reviews of these procedures will be provided during the course of the year.

Requisite procedural numbers are currently not described by the ACGME or interventional societies (i.e. SCAI). Currently, our Program requires 10-15 PFO closures and 10-15 ASD closures to demonstrate proficiency. While PFO closures are typically performed in numbers sufficient to train both interventional fellows each year, ASD closures are not. Therefore, fellows typically do not leave the fellowship certified in ASD closure.

- **Alcohol Septal Ablation for Hypertrophic Cardiomyopathy**

Hypertrophic Cardiomyopathy is a genetic disease that may present phenotypically at any age, and is associated with significant and abnormal hypertrophy of the myocardium. As a result, patients develop severe diastolic dysfunction and heart failure symptoms. In a subset of patients, significant obstruction to outflow of blood occurs across the LV outflow tract, owing to asymmetric hypertrophy (ASH) of the interventricular septum. This ASH also causes significant mitral regurgitation in some patients, compounding the heart failure. Although first line therapy involves lifestyle modification and aggressive medical therapy, a portion of patients continue to have severe dyspnea, lightheadedness, or chest pain at low workload. For these patients, alcohol ablation or surgical myectomy may be offered, and performed.

Fellows will be involved in the consultations of patients with hypertrophic cardiomyopathy, and will understand how to treat such patients conservatively in order to alleviate symptoms. Fellows will understand the echocardiographic and angiographic features of hypertrophic cardiomyopathy, as well as the hemodynamic maneuvers necessary in making the diagnosis of LV outflow tract obstruction, mitral regurgitation and heart failure. For patients who require alcohol septal ablation, fellows will come to learn the procedural details, including pre-procedure and post-procedure management. Supplementing clinical and technical care, fellows will receive lectures on this subject as part of their interventional lecture series. Due to the small number of patients on whom alcohol septal ablation is performed, fellows typically do not leave with proficiency in performing this highly-specialized procedure.

10. SUGGESTED READING

1) Textbooks

- Grossman's Cardiac Catheterization, Angiography and Intervention
- Topol's Textbook of Intervention Cardiology
- Kern's Interventional Cardiology Handbook

2) Key Journals

- JACC and JACC: Cardiovascular Interventions
- Circulation and Circulation: Cardiovascular Interventions

3) General and Interventional Cardiology Websites

- www.theheart.org
- www.cardiosource.com
- www.tctmd.com
- www.uptodate.com

11. EVALUATION PROCESS: FELLOWS, FACULTY AND PROGRAM

Fellow Evaluations:

Fellow evaluations are performed on an ongoing basis due to the close and daily interaction with the Program Director and/or the Co-Program Director. There is also daily interaction between fellows and other voluntary and full-time faculty, nurses, technicians, and physician assistants, who participate in 360 degree evaluations. Direct observation of procedural and technical skill, medical and procedural reasoning, and medical management post-procedure are assessed. In addition, interpersonal skills, communication, and professionalism are evaluated. There is also review of fellow consultations and ambulatory experience for assessment of clinical reasoning ability and decision-making.

Semi-annually, fellow evaluations and performance (including procedural numbers) are reviewed by the Program Director and/or Co-Program Director, and progress towards proficiency documented in New Innovations. Fellow concerns are also discussed and addressed. All such evaluations and meetings are documented in the hospital's New Innovations system and/or minutes obtained by the Coordinator. Fellows also have the ability to evaluate the program during semi-annual meetings, which is documented both verbally and confidentially in the New Innovations program.

Fellow Evaluation of Faculty:

Fellow evaluations of the faculty with regard to their teaching and other relevant issues, including the overall learning environment, are reviewed semi-annually. The faculty evaluations as reported through New Innovations serve as the basis for these meetings. Issues raised are reported to the relevant faculty in order to improve the learning environment and faculty teaching ability.

Fellow Evaluation of Program:

Fellow evaluations of the Interventional Cardiology Program occur semi-annually, with minutes recorded. Areas for improvement are specifically sought, in addition to additions to the Curriculum, and these form the basis for modifications to the Curriculum and training environment.

Faculty Evaluation of Program:

Faculty evaluations of the Program are recorded through New Innovations and also discussed during the Quarterly Curriculum Conference (see Quality Improvement Section). Issues raised through these channels guide changes to the Curriculum.

12. SAMPLE EVALUATION INSTRUMENTS

Sample evaluation forms are provided and attached as part of the curriculum, so fellows can understand more fully the evaluation process. These include on-line forms of fellow evaluation of faculty, faculty evaluation of fellows, 360 degree evaluations, mid-year evaluation by Program Director, year-end evaluation by Program Director, Faculty evaluation of Program, and Fellow evaluation of Program.