GOALS AND OBJECTIVES

The program goals defined below represent those necessary to effectively function as an independent pediatric cardiologist and fulfill the requirements established for Board Certification in Pediatric Cardiology by the American Board of Pediatrics. These program goals are obtained through a program of graduated expectations and responsibilities during the three year fellowship. Evaluation of progress in achieving these goals is made at the conclusion of each level of expertise by faculty directly involved in the specific arena of interest. In general evaluations are made every 1 to 2 months and are shared with the pediatric cardiology fellow. The pediatric cardiology fellow, in turn at similar intervals, evaluates the rotations and the program for content, the faculty for teaching within the context of the rotation and finally, provides input for means of improvement of both the rotations and the program. The program follows the six competencies established by the ACGME.

Outpatient Pediatric Cardiology Clinic

The Pediatric Cardiology Fellow attends a one-half day outpatient clinic once a week for the entire 36-month period of the fellowship. The date and time of the follow-up clinic is assigned by the Pediatric Cardiology Fellowship Program Director and this assignment remains the same throughout fellowship. The fellow is supervised in the outpatient clinic by the Attending Pediatric Cardiologists. The fellow sees no patients without supervision. The goals and objectives for the outpatient clinic rotation are defined on a yearly basis as identified by Levels 1, 2 and 3.

Level 1 (one year)
- Obtain an accurate cardiac history, including present complaint, past medical history, family history, social history
- Perform an accurate cardiac examination
- Formulate a differential diagnosis
- Present findings and differential diagnosis to Attending Pediatric Cardiologist
- Dictate letter to referring physician
Level 2 (one year)
• Obtain history, examination, differential diagnosis and presentation as in Level 1
• Propose and defend further investigation to Attending Pediatric Cardiologist
• Dictate letter to referring physician
• Present patient, as indicated, at Combined Pediatric Cardiology-Cardiovascular Surgery Conference

Level 3 (one year)
• Obtain history, examination, differential diagnosis and presentation as in Level 1
• Propose and defend further investigation as in Level 2
• Propose and defend further medical or surgical treatment to Attending Pediatric Cardiologist
• Present patient and defend proposed medical or surgical therapy at Combined Pediatric Cardiology-Cardiovascular Surgery Conference
• Dictate letter to referring physician with inclusion of conference results

Clinical Service Rotation

Pediatric Cardiology Fellows spend 7 months on the clinical service at University of Minnesota Amplatz Children’s Hospital during the Pediatric Cardiology Fellowship training program.
  o Two months are spent in the PICU and five months are spent in the Pediatric Cardiology Wards.
  o The last month in Cardiology Wards will give the fellow the opportunity to function as a junior attending.

During this time the fellow’s responsibilities increase as he/she transitions from general pediatrician to subspecialist in pediatric cardiology. The clinical rotation is divided into 4 levels, corresponding to the fellow’s level of expertise. Each level builds upon knowledge and skills obtained in previous levels.
  o Acquisition of factual information is emphasized in Levels 1 and 2.
  o Implementation of skills is emphasized in Levels 3 and 4.
  o Development of clinical judgment is heavily emphasized in Level 4.

In general, it is anticipated that learning objectives for each level will be accomplished with every 2 months of service. The Pediatric Cardiology Fellow will achieve these objectives by reading of textbooks and the literature; by attendance at Pediatric Cardiology-CV Surgery Conference, by frequent discussion of patient issues with the Attending Pediatric Cardiologist and other members of the Cardiovascular, Intensive
Care and Neonatal Teams. The Pediatric Cardiology Fellow evaluates and proposes treatment but does not initiate treatment, except in emergency circumstances, without the consent of the Attending Pediatric Cardiologist. The Attending Pediatric Cardiologist holds the final ethical and legal responsibility for the care of all patients on the Pediatric Cardiology Service.

**Level 1 (two months)**
At the completion of this level the Pediatric Cardiology Fellow will be able to:

- Obtain a cardiovascular history, perform a cardiovascular examination, including auscultation on infants, children and adolescents with congenital or acquired cardiovascular disease, and present the pertinent findings to attending cardiologist.
- Recognize abnormalities found on plain chest x-ray.
- Recognize abnormalities found on routine electrocardiogram.
- Understand the basic pathophysiology of common congenital cardiac conditions, such as left-to-right shunts, left and right-sided obstructive lesions and admixture lesions.
- Understand the basic pathophysiology of congestive cardiac failure.
- Understand the basic pathophysiology of reactive pulmonary vasculature.
- Understand and recognize the basic abnormalities of cardiac rhythm, including all degrees of atrioventricular block; narrow and wide complex tachyarrhythmia’s.
- Recognize the clinical, electrocardiographic, echocardiographic and laboratory findings of myocardial infarction.

**Level 2 (two months)**
- At the completion of this level the Pediatric Cardiology Fellow will be able to:
  - Recognize symptoms and signs of cardiogenic shock and administer appropriate therapy.
  - Recognize the symptoms and signs of tamponade and administer appropriate therapy.
  - Recognize symptoms and signs of congestive heart failure in infants, children and adolescents and administer appropriate therapy.
  - Recognize the noninvasive symptoms and signs of cardiac transplant rejection.
  - Understand the pathophysiology of ductal dependent congenital cardiac conditions.
  - Understand the pharmacology of inotropic agents and their side effects.
  - Understand the pharmacology of antiarrhythmic agents and their side effects.
  - Understand the pharmacology of standard anti-rejection drugs and their side effects.
  - Be able to program and interrogate temporary pacemakers in all modes.
• Be able to cardiovert rhythm disturbances by esophageal pacing or by use of defibrillator.
• Understand the mechanics of cardiopulmonary bypass, circulatory arrest, cross clamping and cardioplegia.

Level 3 (one month’s)
• At the completion of this level the Pediatric Cardiology Fellow will be able to:
• Provide routine post-operative management for infants, children and adolescents after cardiac surgery.
• Provide full initial evaluation and management of neonates with suspected congenital cardiac anomalies.
• Provide full clinical evaluation and management of infants, children and adolescents suspected of cardiovascular disease.
• Provide full clinical evaluation and management of infants, children and adolescents for cardiac transplantation.
• Provide full clinical evaluation and management of post-transplant recipients for rejection.
• Provide full clinical evaluation and stabilization of infants, children and adolescents with syncope.
• Provide full clinical evaluation and stabilization of infants, children and adolescents with narrow and wide QRS tachycardia.
• Be able to interrogate and program permanent pacemakers.
• Know the indications for electrophysiologic evaluation of syncope, narrow and wide QRS tachycardia.
• Know the indications for catheter ablation of tachyarrhythmias.
• Know the indications for pacemaker placement.
• Know the indications for cardiac catheterization.
• Know the indications for endomyocardial biopsy for transplant rejection.
• Know the indications for cardiac surgery.

PICU Rotation (Pediatric Intensive Care Unit)

Clinical rotation in major tertiary/quaternary University pediatric hospital in which subspecialty fellow has responsibility for clinical care and coordination of care for critically ill pediatric cardiac patients as well as consultations on other services for stabilization and/or transfer to the PICU.

Rotation Goals

Clinical experience will facilitate evidence-based knowledge acquisition regarding the physiology, pathophysiology and pharmacology of critical illness due to cardiac disease such that the fellow is able
to provide compassionate, age appropriate and effective management of neonates and children with single organ to multiple organ system failure due to congenital or acquired cardiac disease.

**Patient Care:**

*Goal*
Comprehensive knowledge of the physiology, pathophysiology, pharmacology, and evidence-based literature to enable proficient, compassionate, age-appropriate clinical management of children critically ill due cardiac disease or interventional management of cardiac disease.

*Objectives*

Direct cardiology patient care objectives:

1. **Evaluate and manage neonates and infants with critical structural cardiac disease.**
   a) Perform comprehensive physical exam, generate differential diagnosis, understand how to establish accurate anatomic diagnosis with chest radiograph, echocardiography, electrocardiography, angiogram, and laboratory data, and ascertain relevant cardiopulmonary physiology. Specific lesions: VSD, ASD, PDA, AS, PS, AV canal, Coarctation, Transposition, Hypoplastic Left Heart, Tuncus Arteriosus, Total/Partial Anomalous Pulmonary Venous Return.
   b) Provide appropriate medical therapy to stabilize patient.
   c) Understand what medical and surgical treatment options are appropriate for short and long-term management of the condition.

2. **Be able to manage:**
   a) Ductal-dependent right- and left-sided obstructive lesions.
   b) D-Transposition.
   c) Total anomalous pulmonary venous connection with obstruction.
   d) Anomalous origin of the left coronary artery.

3. **Evaluate and treat neonates, infants and children with critical cardiac disease.**
   a) Primary myocardial dysfunction.
   b) Acute decomposition due to myocarditis or cardiomyopathy.
   c) Acutely symptomatic arrhythmias, including appropriate use of cardioversion and pacing options.
   d) Pericardial effusion/ cardiac tamponade.
   e) Hypertension and hypotension.
   f) Hypercyanotic episode.
   g) Elevations of pulmonary vascular resistance.

4. **Understand how to incorporate diagnostic studies, such as echocardiograms and catheterization data, into patient care decisions.**

5. **Provide peri- and post-operative patient care.**
   a) Understand current surgical techniques, particularly neonatal cardiac surgery, mechanical ventilation, cardiopulmonary bypass and hypothermia, to provide appropriate post-operative care.
   b) Manage pharmacologic agents to support cardiovascular function including intravenous inotropes, vasodilator, diuretics, sedatives and analgesics.
   c) Optimize respiratory support and provide ventilator management.
   d) Optimize nutrition.
e) Recognize and manage post-operative complications
f) Manage ECMO
6. Understand how to manage a cardiac transplant patient pre-and post-operatively.
7. Recognize and perform any necessary resuscitation and stabilization:
   a) Promptly recognize clinical signs and symptoms heralding the onset of life-threatening events.
   b) Expeditiously and appropriately intervene to prevent the onset of cardiopulmonary arrest.
   c) Thoroughly understand the basic principles of cardiopulmonary resuscitation and stabilization.
   d) Perform appropriately as the critical care team leader during cardiopulmonary resuscitation and stabilization.
   e) Recognize the pathophysiology associated with tissue hypoxia/ischemia and properly institute medical management to minimize secondary injury.
8. General information gathering:
   a) Perform an appropriately detailed problem-oriented history and physical examination.
   b) Assimilate, organize, and succinctly summarize all pertinent previously obtained medical information from the Emergency Department, general medical/surgical unit, outside hospital, and/or clinic.
   c) Informatively discriminate diagnostic interventions based upon parent/patient information, previous medical information, patient and family preference, scientific evidence, and clinical judgment.
   d) Discuss the indications, limitations, and risks of diagnostic studies and interpret abnormalities in the context of disease-specific pathophysiology.
   e) Formulate an age-appropriate differential diagnosis with appropriate prioritization.
   f) Expeditiously utilize all diagnostic information in the development, execution, and evolution of logical, effective therapeutic management strategies.
9. General patient management and decision-making:
   a) Discuss the indications for admission to and discharge from the Pediatric Intensive Care Unit (PICU), including indications for emergent intervention and stabilization prior to transport to the PICU.
   b) Coordinate care of the PICU patient with the senior Cardiology fellow or Cardiology attending, cardiothoracic surgeon, critical care attending, consultants, ancillary services, and primary care physicians.
   c) Coordinate orderly transfer of care to another health care provider when PICU care is no longer required.
   d) Notify the Senior Fellow/ Faculty regarding major changes in the clinical status of any patient in the PICU.
   e) Review, evaluate, and triage referrals from the Emergency Department, Post-Anesthesia Care Unit (PACU), and general medical/surgical areas. All patients who are evaluated, but not transferred to the PICU require a note in the medical chart outlining recommendations from the Cardiology Service.
10. Acquisition of procedural skills:
   a) Thoroughly understand the anatomic considerations, correct techniques, indications/contraindications, and potential complications for all clinical procedures required for the care of critically ill cardiac patients.
b) Expertly perform appropriate procedures based on skill level with appropriate supervision:
   - Arterial Puncture
   - Lumbar Puncture
   - Peripheral Vein Cannulation
   - Umbilical Vein Cannulation
   - Umbilical Artery Cannulation
   - Femoral Vein Cannulation
   - Femoral Artery Cannulation
   - Swan-Ganz catheter placement
   - Pericardiocentesis

Competencies
1. Cardiology Faculty Evaluation (See Faculty Evaluation Form, Appendix A).
2. Pediatric Intensive Care Unit Staff 360 Evaluation (See Staff 360 Evaluation Form, Appendix C).
4. Society of Critical Care Medicine’s Multidisciplinary Critical Care Knowledge Assessment Program (MCCKAP).
5. Procedural Skills Documentation (See Procedure Log, Appendix B).
6. Participation in the required clinical curriculum.

Medical Knowledge

Goals
1. Perpetual acquisition of knowledge regarding established and evolving biomedical, clinical, and cognate sciences, with the resultant application of that knowledge to the compassionate, age appropriate, and effective treatment of critically ill children with cardiac disease.

2. Comprehensive knowledge of the physiology, pathophysiology, pharmacology, and literature evidence for all determinants and phases of critical illness coincident with cardiac disease, culminating in excellence in the clinical management of children with single organ to multiple organ system failure

Objectives
1. Understand the embryology, fetal and perinatal physiology, and postnatal physiology and anatomy of normal cardiac development and the spectrum of congenital heart lesions and acquired cardiac disorders (Box) and the consequent acute and chronic circulatory pathophysiology associated with each
2. Utilize principles of physiology, pathophysiology, pharmacology, and evidence-based medicine to recognize signs and symptoms of, and expediently and logically treat the following conditions:
3. Understand specific facets of cardiopulmonary physiology
   a) Determinants of and means of influencing oxygen delivery, cardiac output and vascular resistance.
   b) Specific lesion physiology, including determinants of and means of influencing systemic arterial saturation, systemic perfusion and myocardial work.
      - Single ventricle
      - Ductal-dependent left sided obstructive lesion
      - Fixed restriction of pulmonary blood flow
      - d-transposition of the great arteries
   c) Relationship between structure, function and clinical state and potential methods to assess status.
      - Echocardiography
      - Laboratory tests, including blood gases, lactate and end-organ measures
      - Calculations, interpretation, and utilization of hemodynamic data
   d) Cardiopulmonary interactions and the effects of positive pressure mechanical ventilation on cardiovascular function.
      - positive pressure on venous return
      - inspired FiO2 on pulmonary vascular resistance
      - work of breathing on systemic oxygen demand and supply

4. Understand the pharmacological actions, uses, and clinical indications/contraindications:
   a) Inotropic agents (digoxin, agrenergic agonists, phosphodiesterase inhibitors).
   b) Vasodilators / anti-hypertensive agents (alpha-adrenergic antagonists, angiotensin converting enzyme inhibitors, calcium channel antagonists, beta adrenergic antagonists).
   c) Common antiarrrhythmics (digoxin, procainamide, lidocaine, amiodarone, sotolol).
   d) Pulmonary vasodilators (inhaled nitric oxide, sildenafil, prostacyclin, nitroglycerine).
   e) Prosaglandin E2.
5. Understand the basic principles and the associated acute effects of cardiopulmonary bypass on organ function.

6. Understand the potential general and procedure-specific complications following corrective or palliative surgery for congenital heart disease and apply appropriate intervention strategies for each:
   - Lesion-specific complications
   - Residual lesion management
   - Paralyzed hemidiaphragm
   - Large airway malacia or obstruction
   - Prolonged chest tube drainage
   - Complications associated with vascular access
   - Evaluation and management of multi-system organ failure
   - Diagnosis and management of renal failure, including indications for renal replacement therapy
   - Diagnosis and management of neurologic dysfunction (seizures, stroke, ischemia, hemorrhage, choreoathetosis)
   - Transfusion-related complications

7. Understand diagnosis and management of arrhythmias, specifically the use of transesophageal pacing, epicardial pacing, atrial and ventricular pacing leads and implanted pacemakers.

8. Understand indications, applications and complications of mechanical support for the failing heart, including ECMO, ventricular assist devices and intra-aortic balloon pumps.

9. Understand the effect of stress, altered substrate utilization, energy requirements, and the indications, risks and benefits of various modes of nutritional support in the special cardiac situations:
   - Umbilical intravenous lines, inotropic support, outflow lesions or other alterations of mesenteric blood flow.
   - Patient with failure to thrive due to cardiac disease.
   - Patient with protein-losing enteropathy.

10. Understand process of cardiac transplant:
    - Understand identification, evaluation and selection of potential heart transplant recipients.
    - Understand the chronic management issues of the heart transplant candidate.
    - Understand the immediate pre-transplant preparation, including immunosuppression administration.
    - Understand the basic surgical technique of heart transplant.
    - Understand post-operative management of the heart transplant patient.
    - Generally understand the mechanism of action of the most frequently utilized immunosuppressant pharmaceuticals for prevention of transplant rejection.
    - Generally understand the potential opportunistic organisms associated with infection in inherited and acquired disorders of immune function.
    - Recognize the signs and symptoms of organ rejection in heart transplant recipients, and the potential acute and chronic post-operative complications for each.

11. Generally understand and have a working knowledge of the pharmacokinetics, mechanisms of action, pharmacodynamics, contraindications, side effects, and potential complications for each of the commonly used sedatives, analgesics, and muscle relaxants in the patient with cardiac
considerations (cyanotic, ductal-dependent lesions, left-sided obstructive lesions, poor cardiac output, etc.)

Competencies
1. Cardiology Faculty Evaluation (See Faculty Evaluation Form, Appendix A).
2. MCCKAP examination.
4. Procedural Skills Documentation (See Procedure Log, Appendix B).
5. Active participation and contribution during the Cardiology Fellows’ lecture curriculum, Pre-operative Conference, Post-operative Management Conference, Journal Club, QA, and Cardiac Surgery conference.

Practice-Based Learning and Improvement

Goals
To acquire skills to enable investigation and evaluation of patient care practices, appraisal and assimilation of scientific evidence, and improvement of patient care practices.

Objectives
1. Analyze one’s practice experience, recognizing strengths, deficiencies, and knowledge limits; perform practice-based improvement activities using a systematic methodology.
2. Consider and utilize performance evaluations from peers, attendings, patients, parents, nurses, respiratory therapists, and other ancillary health care providers for clinical performance improvement in the care of critically ill children.
3. Locate, appraise, and assimilate evidence from scientific studies directly related to the management of critically ill children.
4. Procure and utilize information relative to critically ill children and the larger population from which these patients are drawn.
5. Appraise study designs and statistical methods of clinical studies that demonstrate diagnostic or therapeutic effectiveness.
6. Utilize information technology to access and manage medical information.
7. Facilitate the education of residents, students, and other health care professionals.

Competencies
1. Cardiology Faculty Evaluation (See Evaluation Form, Appendix A).
2. Participation in cardiology conferences (Pre-operative, Post-operative, QI and/or Journal Club, depending on weeks of rotation).
3. Participation in practice-based learning and improvement that involves investigation and evaluation of fellow’s individual patient care by presenting Case Presentations and Morbidity and Mortality at Divisional Conference as outlined.
4. Facilitating teaching and learning of students and other health care providers by leading teaching during patient care rounds.
**Systems Based Practice**

**Goals**
Achieve cognizant responsiveness to the larger context of the health care system and the effective employment of system resources to provide care that is of optimal value.

**Objectives**
1. Understand the effect of patient management decisions and professional practices upon other health care professionals, the health care organization, and the larger society.
2. Appreciate the differences in medical practice and health care delivery systems, and their effect upon medical management, such as impact on referrals and transfer decisions.
3. Practice cost-effective health care and resource allocation while maintaining an uncompromised quality of care.
4. Advocate for quality patient care and assist patients in dealing with system complexities.
5. Partner with health care managers and health care providers to assess, coordinate, and improve health care and system performance, such as implementing care maps or care plans.
6. Acknowledge medical errors and assist in developing or improving systems for their prevention.

**Competencies**
1. Cardiology Faculty Evaluation (See Faculty Evaluation Form, Appendix A).
2. Participation in Chronic Care Conference.
3. Participation in Cardiology Pre-operative Case Conference and Post-operative Management Conference.

**Professionalism**

**Goals**
Commitment to executing professional responsibilities, adherence to ethical principles, and sensitivity to diverse populations.

**Objectives**
1. Demonstrate respect, compassion, integrity, honesty, compassion, and empathy.
2. Respond to the needs of patients and society in a benevolent manner that supersedes self-interest.
3. Demonstrate accountability to patients, society, and the profession.
4. Commit to consistently performing professional responsibilities, including complete medical record.
5. Demonstrate HIPPA compliance.
6. Participate in program requirements in clinical, research and educational curricula.
7. Commit to excellence and continuing professional development.
8. Commit to ethical principles pertaining to provision, withholding, or withdrawal of clinical care, patient confidentiality, informed consent, and clinical practices.
9. Demonstrate sensitivity and responsiveness to patients’ and colleagues’ culture, age, gender, beliefs, and disabilities.
10. Present oneself in professional manner, both in behavior and dress.
11. Submit fellowship paperwork in a timely fashion.

**Competencies**

1. Cardiology Faculty Evaluation (See Evaluation Form, Appendix A)

**Interpersonal and Communication Skills**

**Goals**

Development of interpersonal and communication skills resulting in effective information exchange and collaboration with patients, families, and health care professionals.

**Objectives**

1. Develop and maintain a therapeutic and ethically appropriate relationship with patients and their families.
2. Listen effectively.
3. Elicit and provide information using effective nonverbal, informative, interrogative, and writing skills.
4. Communicate and work effectively with other fellows, residents, attendings, consultants, nurses and ancillary health care providers as a member of the critical care medicine team.
5. Communicate effectively with surgeons and other subspecialists involved in management of cardiology patients.
6. Consistently maintain accurate, timely, and legally appropriate medical records.

**Competencies**

1. Cardiology Faculty Evaluation (See Evaluation Form, Appendix A).
2. Attendance at Cardiology Pre-operative Case Conference and Post-operative Management Conference.
3. Complete compliance with procedure note documentation.

**Teaching Method(s)**

- Didactic teaching on rounds.
- Didactic Cardiology Fellow lecture series.
- Didactic Cardiac Surgery lecture series.
- Direct supervision of triage, decision making, etc.
- Discussion of echocardiographic and electrocardiographic examinations.
- Discussion of chest x-ray, angiograms, CT and/or MRI interpretation and results.
- Case presentation at Pre-operative Conference and Post-operative Management Conference.
- Cardiology Journal Club.
- Cardiology QA.
Assessment Method - Resident
Faculty performance evaluations
MCCKAP examination

Assessment Method – Rotation
The fellows provide an anonymous review of the rotation, including comment on patient volume, quality of supervision and overall value of rotation.

Level of Supervision
The fellow is directly supervised by pediatric cardiology faculty, more senior fellows or other pediatric subspecialty faculty. However, ALL of the above fellow responsibilities related to the Cardiology rotation are to be performed only under the direct leadership, knowledge, and approval of the Cardiology Attending Physician.

Educational Resources
Resident library:
- Allen HO, Clark FB, Gutgesell HP. Moss and Adam’s Heart Disease in Infants, Children and Adolescents. Lippincott, Williams and Wilkins
- Moller and Hoffman
- Moller and Johnson
- Wernofsky
- Conference schedule
- Didactic courses
- Web-based educational sites
- Professional meetings (ACC, Pediatric Cardiac Care Colloquium, ATS)

Catherization Rotations

Rotation Priorities
- Continuity Clinic
- Didactics
- Hemodynamic and or interventional caths
- EP invasive studies and tilts
- EP Clinic
- Holters and stress tests

Beginner Level Fellow (1st-2nd Cath Month)

Theoretical Knowledge – Hemodynamic and Data Collection
By completion of the first 2 months of cath lab rotations, the “Beginner Level” Fellow should gain and demonstrate an understanding of:

1. Basic radiation safety
   - Adequacy of knowledge will be assessed by successful completion of all safety prerequisites and on-going training, as mandated by Fairview and the University Of Minnesota

2. Normal and abnormal intracardiac/intravascular pressures.
   - The fellow should understand how the intrathoracic pressures are affected by the respiratory cycle and type of ventilation (spontaneous negative pressure vs. positive pressure ventilation) and use this knowledge to correctly interpret the pressure data recordings obtained.
   - The fellow is expected to be able to generate a differential diagnosis of abnormal findings on review of the pressure tracings
   - The assessment of the fellow’s understanding will be by discussions of the pressure recordings during and after the procedure, discussion of the differential diagnoses of abnormal pressure gradients, and by review of the interpretations made by the fellow in the reports and during conferences.

3. Hemodynamic Calculations. The fellow should be able to:
   - understand and interpret the oximetry data obtained
   - Calculate the Qp and Qs by the Fick equation.
   - “back-calculate” the VO2, based on the thermal dilution CO determination
   - calculate the Qef and use it to quantify left-to-right and right-to-left shunts
   - understand how inclusion or exclusion of the dissolved oxygen in calculating the O2 content affects the results of Qp and Qs calculations
   - demonstrate a basic understanding of the assumptions that are made in the calculations performed and how the assumptions may affect the data generated
   - plan a basic right and left heart catheterization, with appropriate selection of sheaths, catheters, and angiograms to be performed
   - The assessment of the fellow’s understanding will be by discussions of the calculations during and after the procedure, discussion of the differential diagnoses of findings, and by review of the interpretations made by the fellow in the reports and during conferences.

4. Angiogram Interpretation
   - The fellow should be able to describe the angles of the image acquisition, the position of the catheters, and the basic cardiovascular structures visualized in the angiogram.

**Theoretical Knowledge – Interventional Catheterizations**

By completion of the first 2 months of cath lab rotations, the “Beginner Level” Fellow should gain and demonstrate an understanding of:

1. the indications for percutaneous interventions, including:
   - Pulmonary Balloon Valvuloplasty
   - Aortic Balloon Valvuloplasty
2. PDA Occlusion
3. ASD Occlusion

2. goals of the intervention and how to assess the adequacy of the afore mentioned interventions
3. and ability to relate to others the risks of interventional procedures

Practical Skills

By completion of the first 2 months of cath lab rotations, the “Beginner Level” Fellow should be able
to demonstrate an ability to perform the following with proficiency:

✓ Proper positioning of the patient, with attention to leg positioning to optimize femoral vascular
accessibility
✓ Prepare the sterile field
✓ Provide adequate local anesthesia safely and effectively
✓ Demonstrate the proper steps in performance of the modified Seldinger technique for obtaining vascular access
✓ Properly prepare and secure vascular access sheaths
✓ Properly prepare hemodynamic, angiographic, and balloon catheters
✓ Demonstrate proper “airless” technique for attaching catheters to the contrast injector
✓ Properly insert different types of catheters into the access sheaths and maneuver them into the heart
✓ Assist in performance of endomyocardial biopsies

By completion of the first 2 months of cath lab rotations, the “Beginner Level” Fellow should be able
to demonstrate an ability to perform the following with developing ability:

✓ Achieve femoral vascular access > 50 % of patients taken to the cath lab
✓ Demonstrate the ability to perform the basic catheter manipulations required to enter all unobstructed cardiovascular structures, including the systemic veins, RA, RV, PAs, aortic arch, and retrograde approach into the LV. The fellow should also begin to have the ability to cross a preexisting intraatrial communication, enter the pulmonary veins, and obtain LV access from an ante grade approach.
✓ Demonstrate the ability to assist in the performance of catheter exchanges over a wire.
✓ Demonstrate ability to properly position a balloon catheter within a stenotic semilunar valve and perform a hand inflation to dilate the valve.
✓ Observe and, if the appropriate case arises, perform a balloon atrial septostomy

Intermediate Level Fellow (3rd-4th Cath Month)

Theoretical Knowledge – Hemodynamic and Data Collection
By completion of the second 2 months of cath lab rotations, the “Intermediate Level” Fellow should gain a progressive proficiency of all of the objectives of the “Beginning Level” Fellow, as well as demonstrate an understanding of:

**Hemodynamic calculations**

The fellow should be able to:

- Demonstrates a developing ability to analyze and interpret hemodynamic data as it is being collected during the case
- Determines whether or not the data seems accurate as well as to begin to develop a differential diagnosis and draw clinical conclusions before the termination of the procedure.
- Analyzes data to determine whether patients with single-ventricle physiology are acceptable candidates for surgical palliation

This will be assessed by questions and discussions during the catheterizations, as well as during conferences.

**Angiogram Interpretation**

The fellow should be able to interpret complex structural abnormalities, as well as functional information about ventricular function and valve function (i.e. degree of regurgitation).

This will be assessed by discussions in the cath lab, review of reports, and during conferences.

**Theoretical Knowledge – Interventional Catheterizations**

By completion of the second 2 months of cath lab rotations, the “Intermediate Level” Fellow should gain a progressive proficiency of all of the objectives of the “Beginning Level” Fellow. Additionally they should demonstrate an understanding of the indications for percutaneous interventions, (including transseptal puncture, pulmonary artery angioplasty/stenting, and aortic angioplasty/stenting,) goals of the intervention, and how to assess the adequacy of the aforementioned interventions.

**Practical Skills**

By completion of the second 2 months of cath lab rotations, the “Intermediate Level” Fellow should be able to demonstrate an ability to perform the following with proficiency:

- All of the goals and objectives of the “Beginner Level” Fellow
- Be the primary operator in performance of catheter exchanges

By completion of the second 2 months of cath lab rotations, the “Beginner Level” Fellow should be able to demonstrate an ability to perform the following with developing ability:

- Achieve femoral vascular access > 80 % of patients taken to the cath lab
- Demonstrate the ability to perform the basic catheter manipulations required to perform a right and left heart catheterization in a patient with a structurally normal heart or with less complex congenital heart defects. The fellow should be able to enter all unobstructed cardiovascular
structures, including preexisting intra-arterial communications, pulmonary veins, and cross the mitral valve antegrade into the LV. The fellow should demonstrate a beginning ability to cross some stenotic lesions by using different combinations of catheters and wires.

- Demonstrate the developing knowledge of the different types of wires/catheters and the advantages/disadvantages of the different properties of each.
- Demonstrate ability to properly prepare balloon catheters, place them within a stenotic vessel and perform a device-assisted inflation to dilate the vessel.
- Perform a balloon atrial septostomy under transthoracic echocardiographic guidance
- Perform angiograms, with proper consideration of the appropriate type of catheter, selection of camera angles, and determination of acceptable contrast delivery.
- Have a working knowledge of how to manipulate the cath lab table, biplane cameras, and use of software for making basic angiographic measurements

**Advanced Level Fellow (5th-6th Cath Month)**

**Theoretical Knowledge – Hemodynamic and Data Collection**

By completion of the fellowship, the “Advanced Level” Fellow should gain a progressive proficiency of all of the objectives of the “Beginning and Advanced Level” Fellow, as well as demonstrate an understanding of:

1. **Hemodynamic Calculations.** The fellow should be able to:
   - Generate a complete report, with correct calculations that use reasonable assumptions. The fellow should be able to explain the assumptions used and be able to defend the data in a reasonable manner.
   - Demonstrate a developing ability to critically analyze data collected and reported by other physicians. The fellow should be able to determine what assumptions are made by other physicians and to be able to discuss how those assumptions affect the calculations and conclusions. This will be assessed by discussions during conferences, as well as by discussions in the clinical setting.

2. **Angiogram Interpretation.** The fellow should be able to:
   - Interpret complex structural abnormalities, as well as describe the severity of stenotic lesions and the degree of improvement after interventions. This will be assessed by discussions in the cath lab, review of reports, and during conferences.

**Theoretical Knowledge – Interventional Catheterizations**

By completion of the fellowship, the “Advanced Level” Fellow should gain a progressive proficiency of all of the objectives of the “Beginning and Intermediate Level” Fellow, as well demonstrate an understanding of:

1. the indications for percutaneous interventions, including:
   - Selection of proper PDA coils/device
- ASD device
- advanced stenting procedures (systemic/pulmonary veins)
- advanced occlusion procedures (AVMs, large collaterals)
- hybrid catheter-surgical procedures
- some advanced/experimental techniques (i.e. VSD closure)
- Knowledge will be assessed by discussions in the cath lab, as well as during conferences

**Practical Skills**

By completion of the fellowship, the “Advanced Level” Fellow should be able to demonstrate an ability to perform the following with **proficiency**:

- all of the goals and objectives of the “Beginner and Intermediate Level” Fellow
- Independently plan and perform a diagnostic right and left heart catheterization, with proper selection of sheaths, catheters, and angiograms.
- Achieve femoral vascular access > 90% of patients taken to the cath lab, including the ability to use advanced techniques for vascular access (use of 2D ultrasound, Doppler assistance, contrast injection).
- Perform an emergency balloon atrial septostomy under transthoracic echo guidance.
- Ability will be assessed by direct observation in the cath lab

By completion of the fellowship, the “Advanced Level” Fellow should be able to demonstrate an ability to perform the following with **developing ability**:

- Ability to achieve internal jugular venous access, using ultrasound guidance.
- Beginning ability to select proper interventional devices
- Advanced techniques for guiding catheters to difficult-to-enter cv structures, including understanding of different wire properties, selection of catheters, use of contrast

**Electrophysiology Rotation / Center**

- Able to read normal and abnormal Pediatric Electrocardiograms, including a good understanding of age related changes of the ECG
- Obtain knowledge and logistical experience in ordering, applying and performing Holter tests, event recorder testing, exercise testing, pacemaker interrogation and interpretation (permanent) pacemaker interrogation and interpretation (temporary)
- Assist with invasive electrophysiology studies including device implantation, device revisions and diagnostic and interventional ablation procedures
- Learn about indications for TILT table testing
- perform TILT table testing
Rotation Priorities
  a. Continuity Clinic
  b. Didactics
  c. EP invasive procedures and tilts
  d. Hemodynamic and or interventional caths
  e. EP Clinic
  f. Holters and stress tests

Level I
Educational objectives for the first electrophysiology rotation are directed toward teaching interpretation of ECG, Holter, event recordings and ETMST. Understand the basic principles and components of an Electrophysiology study and device implantation. By the conclusion of this rotation the pediatric cardiology fellow will be able to accomplish the following items:

Basic Knowledge
1. Normal and abnormal ECG – and age related changes
2. Event recorders and their role in evaluation of palpitations
3. Able to read and interpret Holters and ETMST
4. Perform daily telemetry review
5. Learn about bedside temporary epicardial pacing

Pre-EP study / Device procedure / Tilt Testing
1. Obtain a pre-procedure history and physical examination
2. Order and collect and interpret pre-procedure laboratory data
3. Learn the risks of the aobeelectrophysiology procedures for neonates, infants, children and adolescents
4. Write appropriate pre-procedure orders including counseling and obtaining consent
5. Order age-appropriate pre-procedure sedation

Procedure in EP laboratory

Tilt
1. Position and restrain the patient appropriately
2. Need / use Tilt table, Finipress, BP cuff +/- venous access, central access, art line
3. Learn how data is documented using electrophysiology equipment
**EPS**
1. Position and restrain the patient appropriately
2. Perform sterile prep and drape
3. Obtain local anesthesia of the skin and subcutaneous tissues
4. Choose appropriately sized sheaths and catheters
5. Obtain femoral venous and arterial access in patients older than 6 months
6. Successfully position biplane cameras
7. Know indications for, and appropriate doses of, systemic heparin
8. Appreciate the normal course for venous and arterial catheters
9. Know the value of normal conduction intervals and how they can be obtained
10. Understand basic pacing maneuvers
11. Perform catheter removal and obtain hemostasis

**Devices**
1. Position and restrain the patient appropriately
2. Prepare arm for an anticipated venogram to evaluate patency of appropriate venous structures
3. Know indications and dosages for pre-procedure antibiotic prophylaxis
4. Learn indications for device implantation
5. Perform sterile prep and drape
6. Obtain local anesthesia of the skin and subcutaneous tissues
7. Choose appropriately sized sheaths for access
8. Obtain femoral access in preparation if patient is pacemaker dependent or has an unreliable escape rhythm
9. Know indications for, and appropriate doses of transthoracic pacing, cardioversion and defibrillation
10. Understand loss of capture and inappropriate sensing
11. Understand basic pacing maneuvers perform pocket closure / appropriate dressing application

**Post procedure**
1. Write age-appropriate post procedure orders
2. Know and anticipate common complications of the procedure including bleeding, venous and arterial thrombosis, and hematoma, stroke
3. Understand wound care post device implantation
4. Successfully discharge patient’s post-procedure including post-procedure education
5. Dictate procedure reports
6. Dictate letters to referring physicians regarding procedure
6. Present and interpret data at Cardiology-CV Surgery Conference

**Level II**

Educational objectives for the second electrophysiology rotation are to build and expand upon the knowledge and skills obtained in the first rotation. By the conclusion of the second rotation the fellow will be able to accomplish the following:

Diagnose complex arrhythmias and formulate a hypothesis driven rationale for documented arrhythmias

**Pre Procedure**
1. Know the risks and benefits of electrophysiologic testing
2. Know the risks and benefits of ablation therapy (cryoablation / radiofrequency ablation)
3. Know the risks and benefits of device therapy

**Procedure**
1. Obtain venous access (entertain need for arterial +/- second venous access)
2. Perform a successful positioning of electrophysiologic catheters for electrophysiology studies
3. Obtain subclavian vein access in children and adolescents
4. Understand the indications contrast to evaluate venous patency
5. Learn to place permanent leads, including defibrillator leads

**Post Procedure**
1. Synthesize and interpret obtained data
2. Educate family regarding the care of the device implanted
3. Arrange for appropriate follow-up for devices
4. Discuss controversies around different alternative for therapy for complex arrhythmias

**Echo/Non-invasive Laboratory Rotations**

**ECHO Lab**

The overall goal is that pediatric cardiology fellows understand the principles of echo and Doppler, and become proficient in performing and interpreting
transthoracic, transesophageal and fetal echocardiograms. These goals pertain to congenital and acquired pediatric heart disease. A minimum of 300 studies will be performed by each fellow. Fellows will spend 6 - one-month rotations (6 months total) on the echocardiography service. In addition they will perform and interpret studies on night calls.

**Level 1 (two months)**
- Become familiar with the basic principles of echocardiography and Doppler, transducer selection, and operation of the equipment
- Obtain basic transthoracic echocardiographic views
- Assess independently: systolic ventricular function, pericardial effusion, situs, and simple forms of congenital heart disease.
- Become familiar with the basic principles of exercise testing in children and adolescents.
- Become familiar with the basic techniques and limitations of ambulatory monitoring.

**Level 2**
- Assess the more complex types of congenital and acquired heart disease
- Increase the number and quality of studies performed
- Read and dictate echocardiograms with the pediatric echo reader (M.D.)
- Supervise performance of standard and cardiopulmonary exercise tests in children and adolescents.
- Understand the indications for transthoracic echocardiography, ambulatory monitoring and exercise testing in patients with congenital or acquired cardiovascular disease.

**Level 3**
- Learn the techniques of fetal echocardiography
- Understand fetal cardiac physiology as defined by cardiac ultrasound and Doppler techniques.
- Learn the techniques of transesophageal echocardiography
- Learn the technique of stress dobutamine echocardiography.
- Provide assistance to Level 1 and 2 Pediatric Cardiology Fellows in obtaining transthoracic echocardiograms
- Interpret standard and cardiopulmonary exercise tests in children and adolescents.
- Interpret ambulatory monitoring data in infants, children and adolescents.
Research Experience: Goals and Objectives

The goal of the research training program is to provide the fellow with the training and experience to advance the field of pediatric cardiology. The Department of Pediatrics at the University of Minnesota has made training subspecialists committed to academic medicine and outstanding research in basic sciences, translational sciences and clinical sciences a priority. The Department of Pediatrics has prepared a guide for the academic expectations for fellows above and beyond what is required for Board Certification which will be distributed separately. To this end the pediatric cardiology fellowship program has increased potential research training time to 17 months, three in the first year of training, three in the second year of training and 11 in the third year of training. This research time will be geared towards the accomplishment of a specific research project that culminates in a first authored manuscript submitted for publication, and may include time for acquiring skills which will assist with future academic endeavors (ie coursework, laboratory skills or clinical skills).

Research Experience: Year 1 - Establishment of a Research Training Plan

In year one, the cardiology subspecialty resident will be expected to identify an area of research interest, and to identify a Research Mentor in this area who will help the resident outline and execute the research training plan. An area of general interest and research mentor should be established and submitted to the Program Director and the Scholarship Oversight Committee (SOC) in writing at completion of the first sixth months of training. Exposure to areas of interest and potential mentors will be ensured by attendance at the required seminars, discussion with pediatric cardiology faculty mentors, and discussion with researchers in areas of interest. Opportunities for research experience and mentorship are available within the Division of Cardiology and the Department of Pediatrics, The Lillehei Heart Institute, and the Stem Cell Institute, as well as in other departments within the Medical School. Subspeciality residents will also be given the opportunity to explore research options in other areas at the University of Minnesota, including the Institute of Human Genetics, The Developmental Biology Center, The School of Public Health, The Center for Bioethics and the College of Biological Sciences.
During the second six months of fellowship training, the resident and chosen Research mentor will refine the resident’s area of interest and develop a specific research question to be addressed. In addition, a brief project proposal will be prepared and submitted to the SOC for approval at the conclusion of the first year of training. This proposal should include sufficient background information to ensure the resident has an understanding of the problem to be studied, a statement of the specific hypothesis(es) to be tested and a summary of the research methods to be employed and the type of data analysis to be performed. In addition, the resident and Research Mentor should submit a detailed research training plan which includes a timeline for obtaining necessary coursework or background skills, completing the research proposed, and preparing an oral presentation and written manuscript based on the work accomplished. (See enclosed sample timelines for a basic science and clinical research proposal attached).

**Research Experience: Years 2/3**

In year two, the resident will have an additional three months of protected time devoted to progress on the outlined research project. This time may be used as is appropriate for the project and as outlined by the resident and Research Mentor and approved by the Program Director and SOC. In year three, the resident will have up to 11 months protected time devoted to completion of this research project.

During research time, clinical duties will be limited to every 4th night call, one half-day of clinic per week and attendance at the weekly patient care and didactic conferences. Ensuring adequate research progress is primarily the responsibility of the resident and Research Mentor, however the resident and Research Mentor will be required to meet with the SOC every six months during training to assess research progress. During the second and third years, the resident will be required to submit an abstract for presentation at a national or regional meeting, prepare an oral presentation to give at a local, regional or national meeting, and prepare a manuscript to submit for publication. Submission of grant applications to extend the research experience and training will also be encouraged.

Experimental design, data collection and analysis, and laboratory techniques will be introduced through the first year Department of Pediatrics’ Fellows Seminar, Journal Club, and Faculty Research Seminars and Specialty Seminars in the field.
of interest. Introduction to project specific methods will be the responsibility of
the Research Mentor, and will be supervised by the Program Director and SOC.

Goals and Objectives for Jesse E. Edwards Cardiovascular Registry

Fellows attend sessions at the Cardiovascular Registry in year one. Fellows are
required to attend during their first research rotation. They may attend additional
sessions.

GOALS:

1. Obtain fundamental knowledge of the structure of normal and malformed
   hearts.
2. Be able to relate their knowledge to the interpretation of diagnostic studies
   and the details of cardiac operations.

OBJECTIVES:

A. Study the following important anatomical features of a normal heart
   1. Anterior/posterior relationship of cardiac structures
   2. Difference between atrial appendages
   3. Detail of atrial septum, eg. Fossa ovalis, crista terminatis
   4. Right ventricular infundibular separation between tricuspid and
      pulmonary valves
   5. Position of pulmonary artery and its major branches to aorta and to
      major bronchii
   6. Posterior position of left atria and its relationship to major bronchi &
      esophagus
   7. Details of mitral valve and papillary muscles
   8. Characteristics of left ventricular septal surface
   9. Aortic-mitral valve continuity
   10. Position of aortic arch and in relation to pulmonary artery and position
       of ductus arteriosus (patent or ligamentus)

B. Study malformed hearts
   1. Position of various types of ASD and effects of other structures of the
      heart
   2. Abnormalities of the tricuspid valve- tricuspid atresia and Ebsteins
      malformations
   3. Defects in ventricular septum, with particular attention to relationship
      of defects below the aortic valve to the RVOT
4. Details of types of pulmonary stenosis and associated anatomic changes
5. Review variations of anomalies of pulmonary veins including associated effects on the heart and lungs
6. Abnormalities of the mitral and aortic valves
7. Relationship between coarctation and the ductus arteriosus
8. Anatomic varieties of tetralogy of Fallot and interrupted aortic arch
9. Study and understand complete and corrected transposition of the great vessels
10. Review hearts with cardiac malposition

Sub-Subspecialty Clinic Rotation information can be found on the next page
Sub-Subspecialty Clinic Rotations  
Pediatric Cardiology Fellowship Program

**Purpose:** The purpose of sub-specialty clinics is to provide minimal introduction to areas not covered in the usual continuity clinic. Fellows who wish to pursue a more in-depth experience in a given sub-specialty may choose to attend the clinic for an additional 24 sessions during their 3rd year.

**Format:** The fellow will attend a ½ day session per week of the clinics listed below during their research months. These are considered mandatory clinics. The third year, 6 month experience, is an optional experience.

**1st Year**
- Research 1: Jesse E. Edwards Heart Registry, Tuesday mornings
- Research 2: EP Clinic
- Research 3: Hyperlipidemia Clinic

**2nd Year**
- Research 1: EP Clinic
- Research 2: Transplant Clinic
- Research 3: Adult Congenital Clinic

**3rd Year**
Choose any of the previous clinics to complement clinical interest*

* Or  Attend genetics clinic

*6 month minimum (24 – ½ day sessions) commitment required

Experiences off-site at Gillette (Duchenne clinic) or with Dr. Martin in St. Cloud will need further work (site approvals, program agreements) before implementation.
Clinic Options

1. Transplant
   a. Becky Ameduri

2. EP
   a. Parvin Dorostkar
   b. Ann Dunnigan

3. Adult Congenital
   a. Jamie Lohr
   b. James Moller
   c. Cindy Martin

4. Preventative
   a. Julia Steinberger

5. Private Practice
   a. Chip Martin

6. Metabolic Clinic-Hurler’s
   a. Elizabeth Braunlin

7. Genetics