# Penn State Hershey Medical Center PSHVI DIVISION OF CARDIOLOGY ECHOCARDIOGRAPHY CURRICULUM

# **EDUCATIONAL GOALS**

Cardiology Fellows will acquire the knowledge, technical skills, and interpretive skills necessary to perform, learn the appropriate indications, diagnostic yield, complications and alternatives to various echocardiographic imaging studies including: transthoracic echocardiography, contrast echocardiography, exercise echocardiography and dobutamine echocardiography and transesophageal echocardiography.

#### TRAINING OBJECTIVES

- Develop knowledge and skills necessary to select appropriate non-invasive imaging studies based on the specific history, physical findings and laboratory finding of a particular patient. (Patient Care, Medical Knowledge)
- Understand the potential diagnostic yield, potential complications and cost effectiveness of echocardiographic testing, and become familiar with Bayesian analysis to determine pre-test and post-test probability of disease after echocardiographic testing. (Patient Care, Medical Knowledge, Practice-Based Learning and Improvement)
- Obtain informed consent and communicate the risk/benefit relationship of various studies to
  patients, families and referring physicians. (Patient Care, Medical Knowledge,
  Interpersonal and Communication Skills, Professionalism)
- Perform and interpret echocardiographic imaging studies. (Patient Care, Medical Knowledge, Professionalism)
- Integrate the echocardiographic study with the patient's history, physical findings, and laboratory and radiology studies. (Patient Care, Medical Knowledge, Practice-Based Learning and Improvement)
- Communicate on a timely basis the results of echocardiographic studies to patients and their families, physicians and other health professionals. (Patient Care, Interpersonal and Communication Skills, Professionalism)
- Learn the basics of exercise physiology and pathophysiology. (Patient Care, Medical Knowledge)
- Learn the basic physical principles of ultrasound, proper operation of the equipment involved in imaging, and criteria for choosing a given imaging system. (Patient Care,

# Medical Knowledge, Practice-Based Learning and Improvement, Systems-Based Practice)

- Demonstrate respect, compassion, integrity and altruism in relationships with patients, families, and colleagues. Demonstrate sensitivity and responsiveness to the gender, age, culture, religion, sexual preference, socioeconomic status, beliefs, behaviors and disabilities of patients and professional colleagues. Recognize and identify deficiencies in peer performance. Adhere to principles of confidentiality, scientific/academic integrity and informed consent. (Patient Care, Interpersonal and Communication Skills, Professionalism)
- Access and critically evaluate current medical information and scientific evidence. Use
  information technology or other available methodologies to access and manage information,
  support patient care decisions and enhance both patient and physician education. (Medical
  Knowledge, Practice-Based Learning and Improvement, Systems-Based Practice)

# SPECIFIC CARDIOLOGY FELLOW TRAINING OBJECTIVES

Cardiology fellows are expected to obtain proficiency in transthoracic echocardiography within the first year of their fellowship and Level II skills as defined by the COCATS criteria by the time they complete three years of cardiovascular training (see below). As cardiovascular specialists, fellows must achieve a proficiency level that would allow them to independently provide echocardiographic services in a community hospital setting. Upon completion of the 3-year cardiology fellowship program, a cardiology fellow will have achieved level II training in transthoracic echocardiography; also, if desired competency in stress echocardiography and transesophageal echocardiography. If a fellow desires to achieve Level III trainingin echocardiography, additional training according to COCATS criteria is required (see below).

**ACGME Training Requirements for Echocardiography** 

Training Level	Objective	Level Duration	Total Time	# Cases for Level*	Total Cases*
I	Introduction & understanding indications for 2DE	3 months	3 Months	150 (75)	150 (75)
II	Independently perform & interpret 2DE	3 months	6 Months	150 (75)	300 (150)
III	Echo lab director & teach fellows	6 months	12 Months	450 (300)	750 (450)

<sup>\*</sup> Cases performed by trainee in parentheses

Basic principles of adult echocardiography are outlined by the American Registry of Diagnostic Medical Sonographers (attached). "Every trainee should be educated in the physical principles and instrumentation of ultrasound and in cardiovascular anatomy, physiology and pathophysiology." In addition to careful physical and echocardiographic examination of patients, trainees are encouraged to read extensively from basic echocardiographic textbooks. In particular, first year fellows are expected to read and view:

- 1. The ECHO Manual, Jae Oh. This should be completed during the first month rotation.
- 2. Viewing of the MAYO CLINIC TEACHING CDs. These will be available in the echo lab and are to be signed out from the Echo lab senior sonographer/coordinator
  - 1. Otto C. Textbook of Clinical Echocardiography, 2nd Edition. Philadelphia, WB Saunders, 2000.
  - 2. Feigenbaum H. Echocardiography, 6th Edition, Lippincott Williams & Wilkins, 2004.
  - 3. Weyman A. Principles and Practice of Echocardiography, 2nd Edition. Philadelphia, Lea and Febiger, 1994.
  - 4. DeMaria AN, Blanchard DG. The Echocardiogram. In: Fuster V, Alexander RW, O'Rourke R (eds): Hurst's the Heart (10th ed). New York, McGraw-Hill, 2001, 343-460.
  - 5. Hagen A, DeMaria AN. Clinical Applications of Two-Dimensional Echocardiography and Cardiac Doppler. Little Brown, 1989.
  - 6. Skorton D, et al. Marcus' Cardiac Imaging, 2nd ed. Saunders, 1996.
  - 7. Labovitz AJ, Williams GA. Doppler Echocardiography: the Quantitative Approach. Philadelphia, Lea and Febiger.
  - 8. Freeman W, et al. Transesophageal Echocardiography, 1994.
  - 9. Nanda N. Atlas of Transesophageal Echocardiography, 1998.
  - 10. Nishimura RA, Miller FA, Callahan MJ, et al. Doppler echocardiography: theory, instrumentation, technique, and application. Mayo Clin Proc 1985; 60:32-43.
  - 11. Perez JE. Doppler Echocardiography: A Case Studies Approach. New York, McGraw-Hill, 1987.
  - 12. Waggoner AD, Perez JE. Principles and physics of Doppler. Cardiology Clinics 1990,8:173-89.
  - 13. Hatle L, Angelsen B. Doppler Ultrasound in Cardiology: Physical Principles and Clinical Applications. Philadelphia, Lea and Febiger, 1982.

First Year fellows should concentrate on transthoracic imaging and study interpretation with some stress echo and dobutamine stress echo interpretation. Ten SE's and DSE's should each be supervised. Transesophageal exposure will be limited to conferences.

# SPECIFIC SECOND YEAR FELLOWS TRAINING OBJECTIVES

Continue to focus on principles listed above. Transesophageal training begins in the second year once sufficient studies have been performed to attain Level II training in transthoracic echo. Stress echocardiography should have more emphasis in the second year. In addition, the fellow is expected to further integrate echo findings with other modalities such as the relationship between 1) spectral Doppler and cardiac cath in the assessment of hemodynamics, 2) echo Doppler findings

and physical findings of valvular heart disease, 3) stress and pharmacologic echocardiography and clinical prognosis, nuclear cardiology and coronary angiography, 4) echo Doppler findings and electrophysiologic testing. Continued reading and scholarship is encouraged.

#### SPECIFIC THIRD YEAR FELLOW TRAINING OBJECTIVES

Continue to focus on goals outlined above for 1st & 2nd year fellow. Concentrate on technical details of advanced echo studies such as 1) transesophageal echo, 2) stress and pharmacologic echocardiography, 3) intravascular ultrasound, 4) Intraoperative echocardiography and 5) contrast echocardiography.

# PRINCIPLE TEACHING METHODS

In the non-invasive lab fellows will be exposed to a broad base of patients of all ages, including pediatrics and geriatrics. Non-invasive studies are performed in the echocardiography lab and stress lab as well a various clinical sites such as the ER, CCU, ICU, heart surgical unit and operating room. Diseases states encountered include coronary artery disease and complications, hypertensive cardiovascular disease, dilated and obstructive cardiomyopathy, pericardial disease, complex arrhythmia, valvular heart disease, cerebrovascular disease, peripheral vascular disease, pulmonary heart disease, congenital heart disease and heart disease in pregnancy.

Teaching is accomplished in the in the non-invasive laboratory through:

- Supervised interpretation and performance of transthoracic echocardiography.
- Supervised interpretation and performance of stress tests (including exercise stress echo and dobutamine stress echocardiography).
- Supervised interpretation and performance of advanced echo procedures such as TEE, interop echo, intra-cardiac echocardiography, 3-D echocardiography.
- Subspecialty conferences.
- Presentation of non-invasive tests during cath conference and morbidity and mortality conferences.
- Teaching files in the echo laboratories.

# **EDUCATIONAL CONTENT**

A) First year fellow responsibilities include:

# 1) ECHO Lab

a) Interpret numerous standard echo/Doppler studies prior to reading sessions with the echocardiographic attending. (Fellows will not receive credit for interpreting studies which contain major errors). Fellows should inform the senior echo fellow or attending with suspected critical findings (i.e., aortic dissection, cardiac tamponade, undiagnosed vegetation etc...).

- b) Perform at least 75 and interpret >150 echoes with the supervision of the echocardiographic technicians, senior fellows and attendings to attain Level 1 training. Fellows will not be able to begin TEE training until 150 studies are imaged. It is recommended that these be performed in the first year of fellowship.
- c) Review studies with referring house staff and attendings as required.
- d) Evaluate patients in the echo lab with acute complaints such as chest pain, dyspnea or syncope. Evaluate patients with suspected critical findings such as aortic dissection, pericardial tamponade, acute valvular regurgitation, vegetation or intracardiac thrombus.
- e) Administer IV microbubble contrast, fluorocarbon contrast agent, or amyl nitrite as required during echo examination.
- f) Present echo case conference when assigned on Tuesdays at 12:30 in the HVCU Conference room at 12:30 PM..
- g) The first year non-invasive fellow is expected to remain in the echo lab area in order to perform above responsibilities between 8 AM and 5 PM Monday to Friday daily except as required to attend clinic, conferences, lunch, and perform studies in the patient care areas.
- B) Second year fellow responsibilities include:
  - 1) The second year fellow is required to perform sufficient additional studies to attain 150 performed and interpret an additional 150 echo studies to attain level two certification.
  - 2) Attend all reading sessions with the echocardiographic attending.
  - Assist and supervise the first year fellow in performing and interpreting standard echo Doppler studies. Serve as backup for the first year fellow in assessing critical echoes or medical emergencies. Interpret echoes that the first year fellow cannot interpret due to time constraints or absence.
  - 4) Perform and interpret stress and dobutamine echoes. Third year echo fellows will be given first choice in performing these procedures if required for their certification.
  - 5) Perform and interpret portable echoes with the supervision of the technicians. Upper year fellows are responsible for triage of urgent and stat studies in order of medical urgency. However every attempt should be made to perform all portable echoes for which there is reasonable medical need.
  - 6) Perform TEE and intraoperative echocardiography in rotation with the third year fellows once they have completed level 2 training.
  - 7) Assist first year fellow in presenting at echo conference.

- 8) The second year fellow is expected to committed to echo lab responsibilities in the hospital between 8 AM and 5 PM Monday to Friday daily and be available on beeper.
- 9) Write echo fellows monthly schedule when no 3<sup>rd</sup> year fellow in the lab.
- C) Third year fellow responsibilities for those fellows pursuing Level III training in Echocardiography. (Fellows must attain Level 1 and Level 2 certification before they can perform third year echo fellow responsibilities).
  - a) Attend all reading sessions with the echocardiographic attending.
  - b) Perform in rotation special echo studies such as TEE, intravascular ultrasound, dobutamine stress echo. Third year fellows should submit a schedule indicating which fellow is responsible for each type of special echo studies on a particular day.
  - c) Performance of 300 and interpretation of 450 echo studies are required to complete level 3 training. Note that special studies are included in the 450 additional studies required for level 3.
  - d) Supervise and teach first and second year fellows. Third year fellows should be available to back-up junior fellow during medical and echo emergencies.
  - e) The fellow is expected to have submitted an echo based research project before the start of his/her third year. The project is to be completed during the third year fellowship including manuscript submission.

# **EDUCATIONAL METHODS**

The following references should be utilized as appropriate.

- 1. The Practice of Clinical Echocardiography, Otto & Pearlman, W. B. Saunders Company, Phila., Pa. Third Edition, 2004.
- 2. Echocardiography, Sixth edition, Harry Feigenbaum, 2004.
- 3. Clinical Applications of Two-Dimensional Echocardiography and Cardiac Doppler, Second Edition, Hagan & DeMaria, Little Brown and Company, Boston, MA., 1989.
- 4. Textbook of Echocardiography and Doppler in Adults and Children, Martin St. John Sutton, Paul J. Adersh, Morris N. Kotler, Blackwell Sciences Cambridge Mass 1996.
- 5. Role of echocardiography in perioperative management of patients undergoing open heart surgery, Joffe II, Jacobs LE, Lampert C, Owen AA, loli AW, Kotler MN., Am Heart J, Vol. 131, No.l pp. 162-178.
- 6. Procedural Considerations in Transesophageal Echocardiography, Jacobs LE, Fine RH, Kotler MN. J of Invasive Cardiology, Vol.4, No.7, September 1993, pp. 359-365.
- 7. The American Society of Echocardiography Committee on Nomenclature and Standards in Two-Dimensional Echocardiography. www.asecho.org
- 8. Recommendations for Quantitation of the Left Ventricle by Two-Dimensional Echocardio-graphy. www.asecho.org
- 9. Standardized Myocardial Segmentation And Nomenclature for Tomographic Imaging of the Heart, www.asecho.org
- 10. American Society of Echocardiography: Recommendations for a Standardized Report for Adult Transthoracic Echocardiography. www.asecho.org

- 11. ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography: Summary Article, www.asecho.org
- 12. Recommendations for Quantification of Doppler Echocardiography. www.asecho.org
- 13. Recommendations for Evaluation of the Severity of Native Valvular Regurgitation with Twodimensional and Doppler Echocardiography. www.asecho.org
- 14. Contrast Echocardiography: Current and Future Applications, www.asecho.org
- 15. ASE/SCA Guidelines for Performing a Comprehensive Intraoperative Multiplane Transesophageal Echocardiography Examination: Recommendations of the American Society of Echocardiography Council for Intraoperative Ehocardiography and the Society of Cardiovascular Anesthesiologists Tasks Force For Certification in Perioperative Transesophageal Echocardiography. www.asecho.org
- 16. ACC/AHA Clinical Competence Statement on Echocardiography. www.asecho.org
- 17. Multiplane Transesophageal Echocardiography Performed According to the Guidelines of the American Society of Echocardiography in Patients With Mitral Valve Prolapse, Fail, and Endocarditis: Accuracy in the Identification of Mitral Regurgitant Defects By Correlation With Surgical Findings, www.asecho.org

#### **EVALUATION METHODS**

A written evaluation of the cardiac fellows' performance on the echocardiology service will be made at the end of each rotation by the lab director with input from all attendings in the echo lab. At the conclusion of each rotation, echo cardiology attendings will evaluate each fellow according to the ACGME general competencies including: patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism and systems-based practice. In addition, bedside skills such as obtaining history, physical examination and performance of cardiac procedures will be evaluated. The cardiology teaching attending will meet with each cardiac fellow at the end of the rotation to review their evaluation.

#### STRENGTHS AND LIMITATIONS

Strengths of the non-invasive rotation include the large volume and diversity of patients, the state of the art imaging equipment and extremely capable technicians and supervising attendings. The main deficiency of the echo lab is the large patient volume may over-extend fellows in their attempt to meet the requirements for both interpretation and performance of studies.

# APPENDIX TO NON-INVASIVE LABORATORY CURRICULUM POLICY CONCERNING STAT TRANSTHORACIC AND TRANSESOPHAGEAL ECHOCARDIOGRAMS DURING NIGHTS AND HOLIDAYS

When a STAT echocardiogram is requested, the on call cardiology fellow should be called. Indications for STAT echocardiography generally include but are not limited to the following:

- 1. Assessment of hemodynamic collapse or cardiogenic shock when other diagnostic modalities have not elucidated the diagnosis.
- 2. Assessment of suspected cardiac tamponade when suggested by a clinical history, physical exam or hemodynamic monitoring.
- 3. Suspected aortic dissection. Patients with bona fide suspicion for traumatic aortic dissection should be directly studied by transesophageal echo.
- 4. Suspected cardiac contusion in the hemodynamically unstable patient or in patients requiring urgent surgical intervention. Patients with suspected cardiac contusion, who are clinically stable without suspicion of traumatic aortic dissection, can be studied routinely in the Echo Lab. On the weekends, we request that contusion studies be performed within 24 hours of request. In addition, the 12 lead EKG should be reviewed at the time the echo is performed.
- 5. Evaluation of LV function or valvular heart function in the acutely ill patient requiring urgent percutaneous coronary revascularization, percutaneous valvuloplasty, or cardiac surgery.

The fellow is expected to contact the cardiology attending on call for TEEs when an after hour STAT TEE is ordered. Coordination of the TEE should be made with the attending. For STAT transthoracic echos, the fellow should fill out a preliminary report on ProSolv and communicate the findings verbally or by writing a preliminary note in the chart. The fellow should discuss any questions with the on call ECHO attending.

When the patient is clinically unstable, the TEE team should be mobilized without further delay. The echo echo attending must be present for all TEEs. The only exception to this policy would be the hemodynamically unstable patient when the transesophageal echocardiography is an absolute emergency and the fellow has sufficient experience to operate semi-independently. In this extremely rare situation, the senior cardiology fellow on call should communicate the specifics of the procedure as soon as it is completed. A TEE attending is always available on call. As with any emergent imaging study, the results of the study must be fully documented in the progress notes and directly communicated to the responsible physician.

#### SPECIAL PROCEDURES

A) Transesophageal echo (TEE)

- 1) In order to perform TEE a fellow must complete level 1 training and their first year of cardiology fellowship plus enough imaging (150 cases) for Level II training.
- In order to be certified in TEE the fellow should perform at least 100 studies under direction supervision. At least 25 studies should be performed during the last 6 months of fellowship. In addition to attaining the manual skills of TEE, the fellow must demonstrate cognitive skill in rapid interpretation of TEE 3 dimensional anatomy. In situations where at the end of the third year it is unclear if the fellow has developed adequate skills, the fellow will undergo a verbal examination with the Director of echo or his/her designee during which studies will be reviewed.
- B) For exercise and pharmacologic stress echo, certification requires participation in a sufficient number (at least 100 studies) of supervised interpretations.

# DETAILED PRINCIPLES OF ADULT ECHOCARDIOGRAPHY

- A) Anatomy and physiology 5 %-10%
  - 1) Ventricular wall segments (as recommended by American Society of Echocardiography)
  - 2) Nomenclature
    - a) Subdivisions of ventricles
      - 1. inflow tract
      - 2. outflow tract
    - b) Valves
    - c) Great vessels
  - 3) Coronary Sinus (vs descending aorta)
  - 4) Coronary arteries
  - 5) Normal pressures (in all four cardiac chambers and great vessels)
    - a) Phases of cardiac cycle
      - 1. electrical mechanical systole
      - 2. filling phases of diastole
    - b) Timing of events (relative to ECG)
  - 6. Miscellaneous
- B) Technique 10%-20%
  - 1) Use of equipment controls
  - 2) Recognition of technical artifacts
  - 3) Recognition of setup errors
  - 4) Use of contrast agents
  - 5) Provocative maneuvers
  - 6) Best approach for Doppler studies
  - 7) Miscellaneous
  - 8) Two-dimensional study
  - 9) M-mode patterns

#### 10) **CPR**

- C) Valvular Heart Disease 15 %-25 %
  - 1) Mitral valve
    - Physiology/hemodynamics
    - b) Mitral Stenosis
      - M-mode 1.
      - two-dimensional study
      - <u>3.</u> Doppler study
      - 4. effects on:
        - <u>a.</u> atria
        - ventricles b.
        - cardiac vessels c.
    - Mitral regurgitation c)
      - M-mode <u>1.</u>
      - two-dimensional study
      - <u>2.</u> <u>3.</u> Doppler study
      - 4. effects on:
        - atria <u>a.</u>
        - b. ventricles
        - cardiac vessels
      - <u>5.</u> mitral prolapse
      - <u>6.</u> chordal rupture
      - <u>7.</u> flail leaflet
      - <u>8.</u> mitral annular calcification
      - 9. mixed mitral valve disease (MS/MR)
  - Aortic Valve 2)
    - Physiology/hemodynamics a)
    - b) Aortic stenosis
      - <u>1.</u> M-mode
      - <u>2.</u> <u>3.</u> two-dimensional study
      - Doppler study
      - 4. effects on:
        - atria <u>a.</u>
        - ventricles <u>b.</u>
        - cardiac vessels c.
      - <u>5.</u> etiologies
        - <u>a.</u> congenital
        - rheumatic b.
        - degenerative
      - mixed lesions (AS/AR) <u>6.</u>
      - distinctions between aortic stenosis and sclerosis
    - Aortic regurgitation c)
      - M-mode <u>1.</u>
      - <u>2.</u> two-dimensional study

- <u>3.</u> <u>4.</u> Doppler study
- effects on:
  - atria a.
  - <u>b.</u> ventricles
  - cardiac vessels <u>c.</u>
- etiology <u>5.</u>
  - congenital <u>a.</u>
  - rheumatic b.
  - infectious <u>c.</u>
  - secondary (e.g., aortic root abnormality) d.
  - flail <u>e.</u>
- mixed (AS/AR) 6.
- 3.) Tricuspid Valve
  - Physiology hemodynamics a)
  - Tricuspid stenosis b)
    - M-mode
    - <u>1.</u> <u>2.</u> two-dimensional study
    - <u>3.</u> Doppler study
    - effects on: <u>4.</u>
      - a. atria
      - ventricles b.
      - cardiac vessels c.
    - etiologies <u>5.</u>
      - rheumatic
    - with mixed lesions <u>6.</u>
  - Tricuspid regurgitation c)
    - M-mode <u>1.</u>
    - <u>2.</u> two-dimensional study
    - <u>3.</u> Doppler study
    - 4. effects on:
      - atria a.
      - ventricles <u>b.</u>
      - cardiac vessels <u>c.</u>
    - 5) etiologies
      - rheumatic <u>a.</u>
      - <u>b.</u> carcinoid
      - tricuspid prolapse <u>c.</u>
      - chordal rupture d.
      - flail leaflet <u>e.</u>
  - Pulmonary Valve d)
    - Physical/hemodynamics 1)
    - 2) Pulmonary stenosis
      - M-mode <u>a.</u>
      - two-dimensional study b.
      - Doppler study <u>c.</u>
      - effects on: d.

- atria <u>1.</u>
- 2. ventricles
- <u>3.</u> cardiac vessels
- etiologies <u>e.</u>
- <u>f.</u> congenital
- carcinoid g.
- 3) Pulmonary regurgitation
  - M-mode
  - two-dimensional study <u>b.</u>
  - Doppler study <u>c.</u>
  - effects on: <u>d.</u>
    - 1. atria
    - <u>2.</u> ventricles
    - <u>3.</u> cardiac vessels
  - etiologies <u>e.</u>
    - carcinoid <u>1.</u>
    - <u>2.</u> pulmonary hypertension
  - fixed PS/PI f.
- Endocarditis e)
  - 1) Physiology/hemodynamics
  - 2) involvement of adjacent cardiac structures
  - 3) M-mode patterns
  - Two-dimensional study 4)
- Prosthetic Valves f)
  - Mechanical 1)
    - types <u>a.</u>
      - <u>1.</u> ball-and-cage
      - <u>2.</u> disc in cage
      - <u>3.</u> tilting-disc
    - dysfunction b.
      - <u>1.</u> stenosis
      - <u>2.</u> regurgitation
      - <u>3.</u> thrombosis
  - 2) Tissue types (bioprostheses)
  - 3) Means of evaluation
    - M-mode <u>a.</u>
    - two-dimensional study <u>b.</u>
    - Doppler study <u>c.</u>
    - d. other
- Pericardial Disease 2 % -8 % D)
  - 1) Constrictive
    - Physiology /hemodynamics a)
    - b) **Etiologies**
    - Echogocardiographic manifestations c)
  - 2) **Effusion**

- a) Physiology/hemodynamics
  - 1. tamponade
- b) Etiologies
- c) Differentiation from pleural effusion
- 3) Tumor
  - a) Primary
  - b) Metastatic
- 4) Miscellaneous
  - a) Adhesions
  - b) Nonspecific thickening
  - c) False positives
- E) Systemic & Pulmonary Hypertensive Heart Disease 1 %-3 %
  - 1) Systemic
    - a) Physiology/hemodynamics
    - b) Echocardiographic findings
  - 2) Pulmonary
    - a) Physiology/hemodynamics
    - b) Doppler assessment
      - 1. from tricuspid regurgitant jet
      - <u>2.</u> from pulmonary artery acceleration time
    - c) Image findings
- F) Cardiomyopathies 5%-15%
  - 1) Hypertrophic
    - a) With/without obstruction
    - b) Associated abnormalities
      - 1. mitral annular calcium
      - <u>2.</u> mitral regurgitant/left atrial enlargement
      - 3. fibrous scarring of septum
      - 4. thickening of anterior mitral valve leaflet
    - c) Methods of evaluation
      - <u>1.</u> provocative maneuvers
        - a. amyl nitrite
        - b. Valsalva
      - 2. M-mode
      - 3. Two-dimensional study
      - <u>4.</u> Doppler study (specifically for localizing of obstruction and accessing LVOT gradients)
  - 2) Dilated
    - a) Etiologies
      - 1. idiopathic
      - 2. ischemic
      - 3. alcoholic
    - b) Associated findings
      - 1. mitral regurgitation

- <u>2.</u> other chamber enlargement
- 3. thrombus
- 3) Restrictive
  - a) Etiologies
- G. Ischemic Heart Disease 10% 20%
  - 1) Wall motion abnormalities
  - 2) Associated findings
    - a. Thrombi
    - b. Changes in appearance of involved myocardium
    - c. Aneurysm
    - d. Valve dysfunction
    - e. Pericardial effusion
    - f. Cardiomyopathy
    - g. Ruptured myocardium
    - h. Right ventricular involvement
- H. Cardiac Tumors 2%-5%
  - 1) Benign (e.g., myxoma)
  - 2) Malignant
    - a) Primary vs, secondary (metastatic)
  - 3) Pericardial involvement
  - 4) Differentiation from other masses of artifacts
- I. Miscellaneous 5%-10%
  - 1) Arrhythmias and conduction disturbances
    - a) Effect on valve motion
    - b) Production of wall motion abnormalities
    - c) Effect on Doppler flow velocity waveforms
  - 2) Parameters of left ventricular function
  - 3) Other
- J. Adult Congenital Heart Disease 2 % -8 % (senior fellows or as assigned by PACHD faculty).
  - 1) Categories
    - a) Aortic valve
      - <u>1.</u> bicuspid
      - 2. supravalvular/subvalvular stenosis
    - b) Pulmonic stenosis
    - c) Cleft mitral valve
    - d) Atrial septal defect
      - <u>1.</u> types
      - 2. means of assessing
        - a. contrast
        - b. Doppler
      - 3. Physiology/hemodynamics

- <u>a.</u> associated chamber enlargement
- <u>b.</u> directions for shunt flow
- e) Ventricular septal defect
  - <u>1.</u> types
  - <u>2.</u> means of assessing
    - a. contrast
    - b. Doppler
  - 3. Physiology/hemodynamics
    - <u>a.</u> associated chamber enlargement
    - b. directions for shunt flow
- f) Endocardial cushion defect
- g) Ebstein's anomaly
- h) Patient ductus arteriosus
- i) Tetralogy of Fallot
- j) Coarctation of the aorta
- k) Most congenital cases and all complex congenital cases will be interpreted by the ACHD echo faculty with the TEE fellow.
- K) Diseases of the Aorta 3 %-8 %
  - 1) Marian's syndrome
  - 2) Miscellaneous aortic dilatation
  - 3) Aortic aneurysm
  - 4) Aortic dissection
  - 5) Sinus of Valsalva aneurysms
  - 6) Coarctation of the aorta
- L) Doppler3%-8%
  - 1) General information
  - 2) Formulas for measurement
    - a) Modified Bernoulli equation
    - b) Pressure half-time formula
    - c) Doppler formula
  - 3) Color flow mapping

# **Echo Lab Fellow Orientation**

# **Echo Lab Policy and Procedure Manual**

Review the echo lab policy and procedures prior to participation in lab procedures. All TEE echo lab procedures are performed with the attending echo cardiologist present.

# **Patient Readiness for TEE and DSE**

Physicians are responsible for the welfare of the patient including determining patient appropriateness for a procedure and identifying/considering risk factors based on a complete history and physical exam. It is expected that the management plan include appropriate planning and readiness for potential adverse reactions.

# **History & Physical**

An up to date H&P for out patients is required prior to any TEE procedure and includes but is not limited to the following key elements:

- NPO status
- Medication allergies
- Current medications
- History and status of asthma/ reactive airway disease
- History of difficult airway management
- History of esophageal disease
- Baseline and present vital signs, mental status, oxygenation, pain
- History of sleep apnea and if uses CPAP
- History of sedation issues (TEE only)
- History of pain management issues or chronic analgesia usage (TEE Only)

The chart H&P & progress notes are reviewed on inpatients.

Review the exact order to be certain of the test requested and the indications.

#### **Contraindications of TEE**

# A. Absolute contraindications:

- Esophageal stricture.
- Esophageal laceration.
- Esophageal perforation.
- Perforated viscus
- Unstable cervical fracture

# **B.** Relative contraindications:

- Esophageal diverticula (e.g. Zenker's diverticulum)
- Large diaphragmatic hernia may significantly hinder TEE imaging because of lack of transducer mucosal approximation.

- Atlantoaxial disease and severe generalized cervical arthritis: TEE should not be performed if there is any question about stability of cervical spine without consultation with neurosurgery, orthopaedics or trauma surgery.
- Patients who received extensive radiation to the mediastinum: this can cause significant difficulty in probe manipulation within the esophagus and is a relative contraindication if the anatomy of the esophagus is not known.
- Esophageal bleeding, significant <u>dysphagia</u> and <u>odynophagia</u> are also relative contraindications (Khoury et al., 1994).
- Esophageal spasm
- GI Consultation is necessary prior to TEE in patients with clinically active or significant esophageal disease.

# **Anesthesia Referrals (TEE only)**

Patients with the following characteristics should be considered for anesthesia management of conscious sedation:

- History of sleep apnea, especially if CPAP usage
- Extreme morbid obesity
- Spinal deformities that impact flexibility of cervical spine
- Any airway abnormality or anatomic variation if pt is not intubated
- History of difficult induction/sedation or intubation
- Inability to coorperate under conscious sedation
- Narcotic and/or benzodiazepine addiction or high dose chronic use

#### Risks associated with TEE

Complications can be related to the probe, the procedure or the medications used during the procedure.

- A. Probe related complication
- B. Failure of probe introduction
- C. Trauma (dental, oral pharyngeal, esophageal)

# II. Procedure related complications

- D. Respiratory compromise
  - Laryngospasm: may occur due to instillation and aspiration of topical anesthetic spray or inadvertent endotracheal intubation, secretions or gastric contents
  - Unrecognized tracheal intubation
  - Hypoxia not responsive to treatment
  - Bronchospasm

Please note that with tracheal intubation there will be echo images. If there is doubt as to the location of the probe, with the probe at approximately 34cm at the lip, apply gentle downward pressure. If you encounter resistance, you are at the carina and should immediately extubate and reintubate.

# E. Cardiovascular complications:

- Tachyarrhythmias: Ventricular tachycardia
- Supraventricular tachycardia / new atrial fibrillation

- Bradyarrhythmias: Third degree atrioventricular block
- Transient hypotension or hypertension if sustained beyond study time
- Angina pectoris not responsive to treatment
- Precipitation of <u>heart failure</u>

# C. Others:

- Minor pharyngeal bleeding
- Nausea and vomiting

# **Contraindications of DSE**

# A. Absolute

- Acute MI (within 2 days)
- High-risk unstable angina
- Uncontrolled cardiac arrhythmias causing symptoms of hemodynamic compromise
- Active endocarditis
- Symptomatic severe aortic stenosis
- Decompensated symptomatic heart failure
- Acute pulmonary embolus or pulmonary infarction
- Acute non-cardiac disorder that may be aggravated by increased heart rate (e.g. infection, renal failure, thyrotoxicosis)
- Acute myocarditis or pericarditis
- Inability to obtain consent

# **B. Relative\***

- Left main coronary stenosis or its equivalent
- Moderate stenotic valvular heart disease
- Electrolyte abnormalities
- Tachyarrhythmias or bradyarrhythmias
- Atrial fibrillation with uncontrolled ventricular rate
- Hypertrophic cardiomyopathy
- Mental impairment leading to inability to cooperate
- High-degree AV block

# Risks associated with DSE

- Intraventricular blocks
- Conduction abnormalities
- Pre-excitation syndrome
- Arrhythmias
- MI
- Cardiac arrest

<sup>\*</sup>Relative contraindications can be superseded if benefits outweigh risks of exercise.

#### **Room Readiness**

Physicians are expected to be familiar with lab procedures, stock and set up. Personnel are assigned to do routine stocking and maintenance, but it is the responsibility of the physicians performing and assisting with procedures to assure room readiness and orderliness prior to each procedure, including resuscitation equipment.

# **Medication Readiness**

Medication administration is performed as per HMC policy.

All syringes with medications are labeled.

Technicians are not prepared, licensed or insured to administer medications.

# **Moderate or Conscious Sedation**

Conscious sedation is performed as per HMC policy.

Oxygenation is assessed and recorded prior to, during and after procedure

Air way assessment is completed prior to procedure

Pain score is documented prior to and at the end of each procedure

Vital signs are done every 3 minutes during the procedure

If oxygenation doesn't return to baseline, there must be documentation to indicate that this was identified, the cause and the resulting management.

If reversal agents are used, there must be a compelling clinical reason documented to support such management.

Airway management is the responsibility of the physician. Technicians are present to assist only.

# **Documentation**

At the end of each procedure, document a post procedure note including type of procedure, type and amount of any medications used, preliminary findings, patient's response to procedure and any adverse events and orders are completed. Review any ancillary staff documentation for accuracy and completeness.

#### **Communication**

Communicate unexpected, significant findings or events by phone to the ordering physician immediately. Adverse events are documented as per AEMC policy, on an incident report. (See attached policy.)

I have reviewed this orientation, understand the expectations and agree to co	omply.
Signature	Date