Introduction to the Clinical Cardiology Fellowship Rotation in the Stanford Echocardiography Laboratory

Outline:
- Learning Objectives
- Work schedules/Logistics
- Non-invasive training in the Echo lab
  - Practical hands-on training
  - Reading with attending.
  - Book learning. Pubmed reading
  - Echo Conference
- Echocardiography testing
  - Transthoracic echo
  - Transesophageal echo
  - Conscious sedation
  - Stress echo
- Total training time during clinical fellowship
- Levels of training (COCATS (COre CArdiology Training Symposium) Document)
- Evaluations
- General guidelines for proficiency
- Appendix A: Reading Material
- Appendix B: Generic TEE protocol
- Appendix C: Source of Embolism TEE protocol

Learning Objectives:

Knowledge
- Every trainee should understand the basic aspects of cardiac ultrasound, including physical principles, instrumentation, cardiovascular anatomy, cardiovascular physiology, and cardiovascular pathophysiology.

Skills
- Each trainee should master the skills of performing a transthoracic echocardiogram and Doppler examination and be able to integrate their understanding of 3-dimentional cardiac anatomy.
- The trainee should understand how to perform a stress echocardiogram, including exercise stress as well as pharmacologic stress testing.
- The trainee should learn how to perform a transesophageal echocardiogram.
- The trainee is encouraged to learn how to correlate the findings from the echocardiographic and Doppler exam with the results of other imaging modalities and physical examination.
- The trainee should master the the relationship between the results of the echocardiographic examination and findings of other cardiovascular tests, such as cardiac catherization, coronary angiography, and electrophysiology.
Every cardiovascular fellow will be exposed to and become familiar with the technical performance, interpretation, strengths, and limitations of 2-dimensional echocardiography and Doppler.

Work schedule/Logistics:
Each month there is a special “teaching attending” assigned to the echo lab. This Attending will review this introduction with you and periodically check with you throughout the month, as well as giving you feedback at the end of the rotation.

The Echocardiography laboratory is open Mon-Fri 7AM to 6PM. You are expected to be available in the echo lab or in the vicinity of the echo lab 8AM to 6PM. Upon special request (to supervise stress echo or be available to nurse for same) you may be asked to be present at 7AM or 7:30 AM. If for some reason, personal or professional you cannot attend the echo lab as scheduled be sure to discuss coverage with Dr. Schnittger or one of the echo lab attendings. The echo fellow is expected to become part of the lab, learning from the sonographers, nurses and attendings as well as helping to evaluate patients for procedures.

Non-invasive training in the Echo lab:

Practical hands-on training
In order to become a skilled imager/echocardiographer it is critical to also learn how to acquire the images. This is important in order to better understand the scan planes and their relationship to one and another as well as the importance of artifacts, gain settings, depth settings, etc. The fellows are expected to learn these skills primarily from the sonographers who are professionals, specifically educated and trained to perform ultrasound procedures, specifically cardiac ultrasound. The sonographers will also teach the fellows the basic knowledge needed to operate the ultrasound scanners and EnConcert work stations. Each day, a specific sonographer will be assigned to make sure the fellows get hands-on transducer time and instructions by a sonographer.

Based on the guidelines (see below) for the recommended minimum number of studies (150) to be performed over the minimum of 3 months of echocardiography, the fellow should perform 1-2 TTE studies per day, particularly in the first month.

Reading with attending.
Whenever available, the fellow should spend time with the attendings to learn the skills of interpreting the ultrasound studies and how these studies are evaluated in context to cardiac disease. There is no specific reading time, as the attendings will read throughout the day, interrupted by procedures, conferences and other commitments. After your very initial time in the echolab it would be reasonable for you to try to “pre-read” the echocardiograms to start to fine tune your skills as an interpreter. Since the Attendings at times can be extremely busy, the Attendings will commit a dedicated time each day to review your “pre-read” studies. It is up to each attending to arrange with the fellow when such reading time will take place.
**Book learning. Pub med reading.**
There is plenty of opportunity to find issues and subjects to study while in the echo lab, both very technical aspects of echocardiography and Doppler as well as limitations of the tests and their sensitivity, specificity, accuracy, indications, contraindications. In addition, you have a wonderful opportunity to learn about cardiology in general as almost every clinical condition in cardiology at some point or another is examined using echocardiography. The Internet is available in the echo lab for ready access to Pubmed searches and other sources. Reading material is listed in Appendix A. The echo faculty will also participate in the Thursday morning Curriculum given to the fellows and in that setting periodically review practical aspects of echo examinations.

**Echo Conference**
There is a conference at Noon every other week dedicated to echocardiography and cardiovascular imaging. The goal is to present interesting cases to fellows, faculty, and staff and to provide an opportunity for more in-depth learning for the fellow. It is expected that the fellow will compile a number of studies (4-6 on average), which can often revolve around a clinical disorder. Attendings are available for consultation and image review in selecting and preparing cases. The primary focus should be on presenting images, with supporting didactic and clinical information.

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**Echocardiography testing:**

**Transthoracic echo:**
Transthoracic echocardiography (and Doppler) is the backbone of echocardiography. It is important to learn all the basic scan planes and learn to evaluate at a minimum, cardiac chambers, including volume, function and mass, cardiac valves, pericardium and myocardium. Doppler assessment affords you the capability to truly examine cardiac physiology, including valvular stenosis and regurgitation, cardiac shunts as well as diastolic ventricular function.

**Transesophageal echo:**
Fellows will be introduced to transesophageal echo on their first day of the Stanford echo rotation. Work is one-on-one with the echo attending throughout the procedure. You will learn carefully the indications, contraindications and preparation of the patient prior to the procedure. It is important for you to secure access to the Pyxus system in the echo lab as we need to withdraw narcotic drugs from the supply in the lab. The pharmacy at phone number 3-5272 can give you access if you don’t already have it in advance to you starting your first rotation. As of spring 2003, we now have echo lab nurses attend all TE echoes performed in the lab and their assistance should make life easier for the fellows taking care of these patients pre-, during and post- procedure. However, please understand that the echo faculty and staff have no control over the number of TE requests and we are there to take care of patients. The load varies, from 1-4 TEE:s per day.

During the first several TE echo procedures it is important that the attending is with you from the very beginning to make sure that you learn proper preparation techniques. The attending will always be with you as you are ready to intubate the patient and throughout the procedure.
Conscious sedation:
You need to learn to evaluate the patient prior to procedure for indications, contraindications and safety issues. Patients are monitored by SAT, BP, HR and RR at the beginning and continuously thereafter. Versed and fentanyl are given. Doses of ½ mg to 4 mg Versed, 25-150 mg Fentanyl. Give the drugs gradually in ½ to 1-mg increments and 25-50 mg increments respectively. You will want your attending with you at the outset of the study for the first several procedures to learn how to consent the patient appropriately prior to the procedure and understand how to judge the patient’s level of sedation and evaluate potential problems. Oxygen is available in the room and should be given any time SAT is less than 95% (general guideline).
Main indications are SOE, endocarditis, prosthetic valve assessment, aortic dissection, congenital heart disease, unstable post cardiac surgery patients, exclusion of clot prior to cardioversion and transseptal guidance.

A strict protocol for performing a TEE does not exist, as we usually work with consciously sedated patients where time is an issue. Thus, the procedure should be tailored to the specific clinical question. However, we have provided a “generic” roadmap for performing a comprehensive study (see Appendix B).

Stress echo:
Stress echo is a very important part of our echo lab activities. A sonographer and nurse carry out the stress echo examination. Although you are not routinely asked to supervise this test it is important that you learn the indications, contraindications and performance of the test so that you understand the benefit and limitations of the test. You will not be asked to scan a patient during stress testing but you may occasionally be asked to supervise the treadmill test or dobutamine drug infusion.

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Total training time during clinical fellowship.
Minimum training in Echocardiography (Stanford and the VA) is 3 months to be board eligible. Most Stanford fellows complete a minimum of 4 months of echo training and many end up doing an additional 1-2 months.
In echocardiography we have established guidelines for time and procedures needed for different competency levels. See below

Levels of training (COCATS Core Cardiology training Symposium) Document)

There are three levels of training.

Level 1: 3 months training, considered “introductory training”. Minimal number of Transthoracic performance and interpretation of examinations:150. No TEE or Stress required.
This training allows a physician to understand the functional anatomy and physiology in relation to the echocardiographic examination.
Level 2: 6 months training
Minimal number of Transthoracic performance *and* interpretation of examinations: 300. No TEE or Stress required.
This training emphasizes the intensity, quality and completeness of diagnostic studies.
Competence at the second level denotes that the trainee is sufficiently experienced to interpret the echocardiographic examination accurately and independently.

Level 3: 12 months training
Minimal number of Transthoracic performance *and* interpretation of examinations: 750.
Procedural echo, including TEE and stress, intraoperative, contrast, interventional and complex congenital heart disease.
This training is needed for someone who aspires to be the director of a laboratory. Exposure and proficiency of all echocardiographic procedures is expected at the end of level 3 training.

**Documenting procedures:**
As part of your training requirements, you will need to provide documentation that you have performed the recommended number of procedures as detailed above. You should maintain a log or collect the reports for all echo studies in which you participated in over the course of the month, indicating performance, interpretation, or both. This will be reviewed at the end of the month.

**Evaluations:**
At the end of each month of rotation you will be reviewing your experience with one of the echo lab Attendings and get feedback on your progress. Likewise this would be an opportunity to express any constructive criticism of attending teaching, availability, learning experience, etc.

**General guidelines for proficiency in echocardiography during training:**

*After your 1st echo month:*
The fellow should make sure to get enough “hands-on” experience so he/she will be able to perform a standard 2D echocardiogram with routine Doppler for assessment of presence or absence of aortic and mitral stenosis, valvular regurgitation, presence of wall motion abnormalities, LV function, RV function and pericardial effusion.
There will be plenty of TE echos to be performed, so the fellow should feel comfortable in assessing patients prior to the procedure and have a basic understanding of the examination. The fellow should also begin to become familiar with the basic performance and evaluation of stress echocardiograms. Start “pre-reading” echocardiograms as soon as you are comfortable with the computers and have the very basic understanding of echocardiography.

*After your 2nd echo month:*
The fellow should learn more about different types of valvular heart disease, complications of CAD/MI, hypertrophic cardiomyopathy, diastolic function, etc.
The fellow should feel comfortable to assess patients prior to stress testing and be able to perform exercise and Dobutamine stress studies independently. The fellow can start to generate a preliminary report by “pre-reading” studies that have been entered by the sonographers before the attending interprets them.

*After your 3rd - 4th echo months:*

The fellow should now feel comfortable with the basic echocardiography and Doppler examination of most common cardiac diseases. The fellow should be able to recognize all common pathologic entities. Some exposure to congenital heart disease is expected. The fellow should now be able to generate a fairly accurate preliminary report by “pre-reading” studies before the attending interprets them.

*After your 5th - 6th month:*

The fellow should now have a comprehensive understanding of what constitutes a high quality and complete study. The fellow should understand the correlation with clinical results in a broad range of problems. A fellow that has completed 6 months of echocardiography training should be able to independently perform and interpret an echocardiographic study and Doppler that is diagnostic, complete and accurate.
Appendix A: Reading material

Textbook of Clinical Echocardiography (Otto)

Echocardiography (Feigenbaum)

The Echo Manual (Oh, Seward, Tajik)

Principles and Practice of Echocardiography (Weyman)

Anatomic atlases:
  Cardiac Anatomy (Anderson, Becker)
  Heart and Coronary Arteries (McAlpine)
Appendix B: Generic TEE protocol

The initial imaging should focus on the most important clinical question. The goal of this “roadmap” is to make it easier for the fellow to focus on looking carefully at the images as they are being acquired, rather than focusing on what to do next.

**Aortic valve**: 45 degrees, [zoom on], pan (in/out), [zoom off], color Doppler, pan. Change to 110 degrees, [zoom], pan (rotate), [zoom off], color Doppler, pan. Also image ascending aorta here (pull out probe)

**Mitral valve**: 0 degrees, [zoom on], pan (in/out), [zoom off], color Doppler, pan. Change to 90 degrees, [zoom], pan (rotate), [zoom off], color Doppler, pan.

**Tricuspid valve**: 0 degrees (may need to unflex probe), color Doppler, ~50-60 or 90 degrees, color Doppler.

**Pulmonic valve**: 50-90 (usually 70) degrees, color Doppler.
At this point you can also follow pulmonary artery out to the bifurcation at 90 degrees

**Atria**:

0 degrees:
- LA: pan (in/out along lateral wall, in/out along septum),
- RA: pan (in/out), color Doppler of septum.

Change to 90 degrees:
- LA: pan (rotate).
- RA: pan (rotate), visualize SVC (probe out), and IVC (probe in). Focus on IAS, color Doppler, [measure septal separation], [bubble study].

90 degrees:
- LA Appendage: behind MV, zoom, [color Doppler and PW Doppler].

0 degrees:
- LA Appendage, examine [color Doppler, PW Doppler].

**Ventricles**: Left and right ventricle: 0 degrees, unflex probe for apical 4C view (with apex), 90 degrees for apical 2C, 120-130 degree for apical 3C view.

Transgastric - 0 degrees to view LV/RV (in/out), 90 degrees for long-axis LV/RV (rotate).

**Descending Aorta and arch**: 0 degrees, probe not too deep, rotate toward left heart. Withdraw probe slowly while keeping Ao centered. [measure as needed]. At arch follow and then change to 90 degrees.

Please note, There may also be specific instructions for the performance and reporting of particular research-related studies (see appendix for Source of Embolism protocol).
Appendix C: Source of Embolism TEE protocol

Equipment: All Transesophageal echocardiograms will be performed according to our standard clinical guidelines in regards to conscious sedation. A Hewlett Packard, Sonos 5500, state-of-the-art equipment will be used with a multi-plane transducer, 5 MHz. In the event that the standard, multi-plane probe cannot be inserted/ tolerated by the patient, the smaller bi-plane pediatric probe will be used. NOTE ON FINAL REPORT WHICH PROBE WAS USED.

Individual structures to be imaged:

Left ventricle:
  Purpose: rule out apical thrombus
  Views: Apical 4-chamber, apical 2-chamber and apical long axis (135 degree) views.

Left atrium:
  Purpose: rule out clot, myxoma, smoke
  Views: 0 degrees and 90 degrees.

  Special procedure: Smoke has to be evaluated as none (0), mild (1+) mild-to-moderate (2+), moderate (3+) or severe (4+).
  1+ = minimal echogenicity, may be detectable only transiently, imperceptible at operating gain settings for 2D.
  2+ = more dense than 1+, detectable without changing gain settings
  3+ = dense swirling, detectable constantly during the cycle. LAA>LA
  4+ = severe. LAA=LA

Left atrial appendage:
  Purpose: rule out clot, smoke, assess function
  Views: 0-30 degrees and 90 degrees.

  All views will be done with ZOOM or at least no more depth scale than necessary.

  Special procedure: Color Doppler and PW Doppler (obtained at the orifice of the appendage) should be applied in at least one of the views. Note the maximum filling/emptying velocities (average 3 beats in sinus and 5 beats in a.fib)

  Smoke has to be evaluated as none (0), mild (1+) mild-to-moderate (2+), moderate (3+) or severe (4+).
  1+ = minimal echogenicity, may be detectable only transiently, imperceptible at operating gain settings for 2D.
  2+ = more dense than 1+, detectable without changing gain settings
  3+ = dense swirling, detectable constantly during the cycle. LAA>LA
  4+ = severe. LAA=LA

Mitral valve:
  Purpose: rule out myxomatous valve with MVP, endocarditis, papilloma and MAC and MVR.
Views: 0 degree and 90 degree (minimum)
Both views should include ZOOM or at least no more depth scale than necessary.

Aortic valve:
- **Purpose:** rule out endocarditis and papilloma and AVR.
- **Views:** Approximately 45 degrees and 110 degrees.
  Both views should include ZOOM or at least no more depth scale than necessary.

Intra-atrial septum:
- **Purpose:** rule out PFO and ASD
- **Views:** 90 degree view (range: 70-110 degrees).

Special procedure:
1) Presence/absence of aneurysm. Measure the MOBILITY of the septum Primum: Total deviation from the mid-line (total excursion into the right and the left atrium).
2) Measure the separation between the septum Primum and septum Secundum during REST and during VALSALVA. (Assess the largest opening by going frame-by-frame (off line). Please label image as “Rest” and “Valsalva”
3) Contrast –injection at REST and with VALSALVA. Please label image as “Rest” and “Valsalva”. The right atrium should be completely opacified. The number of targets crossing should be assessed as: 1+ = (< 1-5), 2+ = (6 - 25), 3+ = (> 25).

Aorta:
- **Purpose:** Rule out atheroma/clots in the aorta from the Aortic valve to the left subclavian.
- **Views:** Ascending aorta: long axis (approximately 110 degrees) of the valve and the root.
  Short axis (0 degrees), pulling back from the valve plan as far proximal as possible.
  Aortic arch: long axis (0 degrees) and short axis (90 degrees).
  Descending aorta: (0 degree)

Special procedure: All plaques larger than 2 mm should be specifically noted. If less than 2 mm: mild disease. If equal to or thicker than 2mm, please note absolute thickness. The thickest plaque for each segment of the Aorta should be registered if there are more than one plaque. The measurement should be obtained perpendicular to the wall segment in question. Also note: MOBILITY OF PLAQUE; mobile/non-mobile, presence of ULCERATION a/o CALCIFICATION.

Summary of SOE reports for TE Echo:

Please mention the following items:
1) LV thrombus.
2) LA thrombus. LAA thrombus.
3) Smoke in LA or LAA; none to 4+
4) LAA emptying/filling velocities, with measurement of velocities. (>0.5 m/s is nl)
5) Inter-atrial septum; normal or inter-atrial septal aneurysm.
6) Contrast injection; no shunt or +shunt (describe shunt (septal mobility, targets, separation)
7) Mitral valve.
8) Aortic valve.
Ascending aorta, arch (and descending aorta). Describe plaques thicker than 2mm. Ulcerated a/o mobile.