PART IV

ECHOCARDIOGRAPHY LABORATORY OPERATIONS

ADULT STRESS ECHOCARDIOGRAPHIC TESTING

SECTION 1
Instrumentation

STANDARD - Primary Instrumentation

1.1 Cardiac Ultrasound Systems

Ultrasound instruments utilized for stress echocardiographic studies must include:

A) Hardware and software to perform two dimensional (2-D) imaging.
B) Image display device (monitor) which identifies the parent institution, the name of the patient, the date and time of the study, the ECG, and range or depth markers.
C) Measuring capabilities including the ability to measure the distance between two points and an area on a 2-D image.
D) A minimum of two imaging transducers, one of low frequency and one of high frequency, or a multi-frequency transducer.
E) Image recording device, videotape recorder and digital recording device.

1.2 Stress Echocardiography Acquisition Systems

Acquisition of the stress echocardiographic images must be available and utilized for the performance and interpretation of stress echocardiography. The system must allow for accurate "triggered" acquisition of images and side-by-side image display. The acquisition system must have adequate memory to allow performance of multi-stage stress echocardiogram studies and must have a recording device capable of recording the resultant side-by-side images.

SECTION 2
Indications, Ordering Process and Scheduling

STANDARD - Indications

2.1 Stress echocardiography is performed for appropriate indications[1].

2.1.1 Verification of the indication: A process must be in place in the laboratory for obtaining and recording the indication. Before a study is performed, the indication must be verified and any additional information needed to direct the examination must be obtained.

STANDARD - Ordering Process and Scheduling

2.2 Stress echocardiographic studies are appropriately ordered and scheduled.

2.2.1 Ordering process: The stress echocardiogram order and/or requisition must indicate the type of study to be performed, the reason(s) for the study and the clinical question(s) to be answered. The order/requisition must be retained in the medical record of the patient.

2.2.2 Definition of procedure types:

A) Two phase stress echocardiography examines and compares left ventricular wall segments before stress and after stress and is usually accomplished using treadmill exercise (and is sometimes accomplished using pacing methods).

B) Three phase stress echocardiography examines and compares left ventricular wall segments before, during, and after stress, and is usually accomplished using bicycle exercise ergometry (and is sometimes accomplished using pacing methods).

C) Four phase stress echocardiography examines and compares left ventricular wall segments before, during and/or after stress, and is usually accomplished using pharmacological stress agents or supine bicycle ergometry (and is sometimes accomplished using pacing methods).

D) Doppler stress echocardiography compares antegrade and retrograde flows (if present) before, during and/or after stress. Doppler stress echocardiography may be performed alone or in conjunction with a two phase, three phase or four phase stress echocardiography examination, and is sometimes accomplished using pacing methods.

E) Contrast stress echocardiography examines and compares left ventricular wall segments before stress and after stress following the injection of a contrast agent that is used to enhance endocardial border definition. Contrast may also be used to enhance the Doppler signal when performing Doppler stress echocardiography. Contrast stress echocardiography may be used in conjunction with two phase, three phase, four phase and Doppler stress echocardiography.

2.2.3 Scheduling: Sufficient time is allotted for each study according to the procedure type. The performance time allotted for a two phase or three phase stress echocardiogram is 45 to 60 minutes from patient encounter to departure. An additional 15 to 30 minutes per study may be needed for the performance of a pharmacologic stress echocardiogram since these procedures require that intravenous access be obtained. Additional time will also be required when adding Doppler to any standard stress echocardiogram.

SECTION 3
Elements and Components of Examination Performance

STANDARD - Training

3.1 Stress echocardiography is a diagnostic test which, if performed and/or interpreted incorrectly, can lead to serious consequences for the patient.

3.1.1 Accurate performance of stress echocardiography requires that the performing sonographer and interpreting physician are adequately trained and experienced to perform and interpret stress echocardiograms. It is strongly recommended that all sonographers performing stress echocardiograms have a minimum of one year of cardiac ultrasound experience with particular attention paid to appropriate techniques for stress image acquisition, display, storage and recognition of regional wall motion abnormalities. Guidelines for adequate physician training have been published and it is strongly recommended that all physicians interpreting stress echocardiograms meet these guidelines[2].

STANDARD - Elements of Examination Performance

3.2 Examination performance must include proper technique.

3.2.1 Elements of study performance include, but are not limited to:

A) Proper patient positioning during image acquisition.
B) Appropriate transducer selection and placement.
C) Achievement of optimal heart rate.
D) Optimization of the ultrasound equipment gain and display settings.
E) Appropriate and consistent scan depth selection for each phase of image acquisition.
F) Rapid post stress image acquisition (post stress images must be obtained within 60-90 seconds of stress cessation).

G) Optimization of digitized images for side by side comparison.
H) Utilization of artifact free ECG for digital triggering purposes.
I) Appropriate ECG lead placement.
J) Utilization of appropriate Doppler technique (including proper alignment) and measurements.
K) Performance of a stress echocardiogram according to the laboratory specific and appropriate protocol that incorporates all views and imaging planes mandated by the *ICAEL Standards* (3.4).

3.2.2 Elements of study quality include, but are not limited to:

A) Definition of endocardium.
B) Display of standard, on axis, imaging planes (e.g., avoidance of foreshortening).
C) Measurements of left ventricular dimensions (when performed) obtained from standard orthogonal imaging planes.
D) Accurate digital triggering (from ECG R wave).
E) Appropriate side by side image display.
F) Adherence to the laboratory specific and appropriate protocol.

STANDARD - Stress Echocardiography Laboratory Arrangement

3.3 Stress echocardiograms must be performed in a laboratory designed to assure patient safety and to facilitate rapid acquisition of post stress images.

3.3.1 Elements of the stress echocardiography laboratory arrangement include, but are not limited to (also reference Section 2.1 of the *ICAEL Standards, Part I Echocardiography Laboratory Operations -Organization*):

A) Proper placement of the examination table next to the treadmill.
B) Proper placement of the ultrasound equipment next to the examination table.
C) Proper placement of the examination table to allow for access to both sides of the table.
D) Proper placement of emergency equipment (crash cart and oxygen) such that they are easily accessible.

STANDARD – Stress Echocardiogram Components

3.4 Stress echocardiograms must be comprehensive and include standard components.

3.4.1 Components of the examination: A protocol must be in place that defines the components of the various types of stress echocardiograms. Indications for the performance of a pharmacologic stress echocardiogram and/or a standard exercise stress echocardiogram must be included. Note: Alternate views may be obtained if contrast is used.

A) A two-phase stress echocardiogram includes the following views, obtained both before and immediately following stress: parasternal long axis view, parasternal short axis view (mid-papillary muscle level), apical four-chamber view and apical two-chamber view. The use of timers is required and must be activated when exercise stops. It is recommended that post stress images be obtained within 60 seconds but must be obtained within 90 seconds of stopping exercise.

B) A three-phase stress echocardiogram includes the following views, obtained before, during and immediately following stress: parasternal long axis view, parasternal short axis view (mid-papillary muscle level), apical four-chamber view and apical two-chamber view.

C) A four-phase stress echocardiogram includes the following views, obtained before, during and immediately following stress: parasternal long axis view, parasternal short axis view (mid-papillary muscle level), apical four-chamber view and apical two-chamber view. Additional images obtained during a four-phase stress echocardiogram may include low level stress images, mid-level stress images, and/or peak-level stress images, recovery or back to baseline images depending on the clinical question that is being answered with the stress echocardiogram.

D) A Doppler stress echocardiogram includes interrogations of flow velocities (from the same site) before, during and/or immediately following stress. Doppler stress echocardiography may be utilized to document gradient changes that occur with stress, or to evaluate diastolic filling pattern changes that occur with stress.

3.4.2 Patient preparation: To adequately perform stress echocardiogram studies, appropriate safety guidelines must be in place.

A) All stress echocardiogram procedures must be explained to the patient and/or the guardian of those unable to give informed consent. Consent must be obtained in a manner consistent with the rules and regulations outlined by the hospital or facility.
B) Patients undergoing pharmacologic or contrast echocardiography must have a functioning intravenous access in place.
C) A fully equipped cardiac arrest cart (crash cart) as outlined in Section 4.1.1 of the *ICAEL Standards, Part I Echocardiography Laboratory Operations -Organization*, with additional medications utilized for reversing the effect of the pharmacologic stress agent(s) must be readily available at all times.
D) Adequate personnel (a minimum of two individuals) must be present during all stress echocardiogram procedures. Personnel must be certified in Basic Cardiac Life Support (BCLS).

3.4.3 Patient monitoring:

A) During the image acquisition phase and during the recovery phase of the examination, the vital signs of the patient must be periodically evaluated in accordance with the stress testing protocol.
B) Cardiac monitoring with standard stress testing leads must be utilized.
C) A list of procedural complications must be maintained.

3.5 Stress Echocardiogram Report Components

Stress echocardiography reporting must be standardized in the laboratory. All physicians interpreting echocardiograms in the laboratory must agree on uniform diagnostic criteria and a standardized report format.

The report must accurately reflect the content and results of the study. The report must include, but may not be limited to:

A) A report header must include, but may not be limited to:
- the date of the study
- the name and/or identifier of the laboratory
- the name and/or identifier of the patient
- the date of birth and/or age of the patient
- the primary indication for the study
- the name of the performing sonographer
- the name of the ordering physician and/or identifier

The information must be sufficient to allow for the identification and retrieval of previous studies on the same patient.

B) Report text must include
- the protocol used
- the exercise time, or maximum dose of pharmacologic agent used
- the target heart rate
- the maximum heart rate achieved
- whether or not target HR was achieved and/or stress adequate
- blood pressure response
- reason for termination
- patient's cardiac symptoms, if any, during the examination
- any ECG changes during the examination
- pre-exercise segmental wall motion and global systolic function
- post-exercise wall motion comparison and global systolic function
- a summary of the results of the examination, including any pertinent positive and negative findings

C) Summary of pertinent findings.

D) Reports must be typewritten, include a physician signature line (including the name of the interpreting physician) and be manually or electronically signed by the interpreting physician.

SECTION 4
Procedure Volumes

STANDARD - Procedure Volumes

4.1 The annual procedure volume must be sufficient to maintain proficiency in examination performance and interpretation.

A laboratory should perform a minimum of 100 stress echocardiograms annually. Each member of the medical staff should interpret a minimum of 100 stress echocardiograms annually. Each member of the technical staff should perform a minimum of 100 stress echocardiograms annually. The total volume of studies interpreted and performed by each staff member may be combined from sources other than the applicant laboratory. Lower volumes than those recommended here, however, should not dissuade a laboratory that is otherwise compliant with the *ICAEL Standards* from applying for accreditation.

Bibliography:

1. "ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography" Journal of the American College of Cardiology 2003; Vol 42:954-70

2. "ACC/AHA Clinical Competence Statement on Echocardiography", Quinones et al, Journal of the American College of Cardiology 2003, Vol 41, No 4:687-708