PART II

ECHOCARDIOGRAPHY LABORATORY OPERATIONS

ADULT TRANSTHORACIC ECHOCARDIOGRAPHY TESTING

SECTION 1
Instrumentation

STANDARD - Primary Instrumentation

1.1 Cardiac Ultrasound Systems

Ultrasound instruments utilized for diagnostic studies must include, at a minimum, hardware and software to perform:

A) M-Mode imaging
B) Two-dimensional (2-D) imaging.
C) Spectral display for pulsed (PW) and continuous wave (CW) Doppler studies.
D) Colorflow imaging.
E) Video screen or other display method of suitable size and quality for observation and interpretation of all modalities. The display must identify the parent institution, the name of the patient, the date and time of the study. The ECG must also be displayed.
F) Where data are derived from a given line of interrogation (e.g., M-Mode or PW Doppler), a reference line should be available on the screen within a frozen 2-D image, except for non-imaging CW Doppler.
G) Range or depth markers should be available on all displays.
H) Capabilities to measure the distance between two points, an area on a 2-D image, blood flow velocities, time intervals, and peak and mean gradients from spectral Doppler studies.
I) At least two imaging transducers, one of low frequency (2-2.5 MHz) and one of high frequency (3.5 MHz or higher); or a multi-frequency transducer which includes these frequencies. A transducer dedicated to the performance of nonimaging continuous wave Doppler must be available at each site.
J) Machines with some, but not all of the above, equipment may be used for limited or directed echocardiographic examinations. However, machines utilized for complete diagnostic procedures must include all of the above listed capabilities.

SECTION 2
Indications, Ordering Process and Scheduling

STANDARD - Indications

2.1 **Transthoracic echocardiography testing 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 Transthoracic echocardiography testing is appropriately ordered and scheduled.

2.2.1 Ordering process: The echocardiogram order and requisition must clearly 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 present in the medical record of the patient.

2.2.2 Definition of procedure types and protocols.

A) Complete studies:

1. A complete imaging study is one that examines all of the cardiac chambers and valves and the great vessels from multiple views, then uses the available information to completely define any recognized abnormalities.
2. A complete Doppler study is one that examines every cardiac valve, and the atrial and ventricular septa for antegrade and/or retrograde flow. In addition, a complete Doppler study provides functional hemodynamic data.

B) Limited study:

A limited study is generally only performed when the patient has undergone a complete recent examination and there is no clinical reason to suspect any changes outside the specific area of interest. A limited study generally examines a single area of the heart or answers a single clinical question.

2.2.3 Scheduling: Sufficient time must be allotted for each study according to the procedure type. The performance time allotted for a complete (imaging and Doppler) transthoracic examination is 45 to 60 minutes from patient encounter to departure. An additional 15 to 30 minutes may be required for complicated studies.

A) A routine study on an inpatient should be performed on the same working day as ordered, unless otherwise specified. Outpatient studies should be assigned priority as defined by the referring physician and/or the indication of the study.
B) An urgent study must be performed in the next available time period.
C) A stat study must be performed as soon as possible, preempting routine studies.
D) Availability for emergencies: Qualified personnel and equipment must be available for urgent or stat studies outside normal working hours in inpatient facilities or where appropriate.

SECTION 3
Elements and Components of Examination Performance

STANDARD - Elements of Examination Performance

3.1 Examination performance should include proper technique.

All procedures must be explained to the patient and/or parents or guardian.

Echocardiography examinations of the heart must examine all cardiac chambers and structures. The course and extent of disease must be documented.

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

A) Proper patient positioning.
B) Transducer selection and placement.
C) Optimization of equipment gain and display settings.
D) Performance of a 2-D/M-Mode/Doppler examination according to the laboratory specific and appropriate protocol.
E) Utilization of appropriate Doppler technique (including proper Doppler alignment) and measurements.

3.1.2 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) Delineation of the details of valvular anatomy.
D) Measurements of left ventricular dimensions from standard orthogonal imaging planes.
E) Optimal recording and evaluation of Doppler flows (which should include alignment of the Doppler beam parallel to flow).
F) Accurate spectral Doppler recording and recording of abnormal Doppler flow signals in multiple views.
G) Adherence to the laboratory specific and appropriate protocol.

STANDARD - Components of the Transthoracic Echocardiogram

3.2 Transthoracic echocardiograms must be comprehensive and include standard components.

3.2.1 Components of the examination: A protocol must be in place that defines the components of the standard examination. Indications for performance of a complete and/or limited examination must be included.

A) Complete M-Mode and 2-dimensional examination - Includes standard views from multiple planes including views of all cardiac structures and selected extracardiac structures. These include, but are not limited to:

1) Left ventricle
2) Right ventricle
3) Left atrium
4) Right atrium
5) Aortic valve
6) Pulmonic valve
7) Mitral valve
8) Tricuspid valve
9) Proximal ascending aorta
10) Aortic arch
11) Main pulmonary artery and proximal branches
12) Inferior vena cava
13) Pericardium

B) Complete Doppler study - Includes spectral Doppler and/or color flow interrogation of all normal and abnormal flows within the heart including the valves, the great vessels and the atrial and ventricular septa.

C) Limited examination - A limited study is generally only performed when the patient has undergone a complete recent examination and there is no clinical reason to suspect any changes outside the specific area of interest. A limited study generally examines a single area of the heart or answers a single clinical question.

3.2.2 The complete examination must include (except where technically unobtainable), but not be limited to:

A) The following standard 2-D views:
   1) Parasternal long axis view
   2) Parasternal short axis views (basal, mitral valve, left ventricle at the mid papillary muscle level, left ventricular apex)
   3) Right ventricular inflow view
   4) Apical four chamber view
   5) Apical two chamber view
   6) Apical five chamber view
   7) Apical long axis view
   8) Subcostal four chamber view
   9) Subcostal short axis view (when indicated)
   10) Subcostal IVC/hepatic vein view
   11) Suprasternal notch view (when indicated)

B) The following 2-D or M-Mode measurements of the left heart:
   1) The left ventricular internal dimension at end-diastole
   2) The left ventricular internal dimension at end-systole
   3) The left ventricular posterobasal free wall thickness at end-diastole
   4) The ventricular septal thickness at end-diastole
   5) The left atrial dimension at end-systole
   6) The aortic root dimension at end-diastole

C) The following standard Doppler flow evaluations:
   1) The four cardiac valves – forward flow spectra for each valve, and any regurgitation, shown in at least two imaging planes with color Doppler
   2) For aortic stenosis, the systolic velocity must be evaluated from multiple transducer positions (e.g., apical, suprasternal and right parasternal). This must include interrogation from multiple views with a dedicated nonimaging continuous wave Doppler transducer (at least one clear envelope must be obtained).
   3) Also use of non-imaging Doppler Transducer (Pedoff) to assess stenotic valves, valvular regurgitation or whenever indicated.
   4) The tricuspid regurgitation spectrum must always be sought for estimation of systolic right ventricular pressure when tricuspid regurgitation is present.
   5) Atrial and ventricular septa – color Doppler screening for defects
   6) Left ventricular outflow tract velocity
   7) Velocity-time integrals and hepatic and pulmonary vein flow spectra are optional
   8) Optional Doppler studies include: tissue Doppler, strain, strain-rate
   9) Contrast studies are not required but should be considered when patients are technically difficult.

SECTION 4
Examination Interpretation

4.1 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. [2]

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) A table of 2-dimensional and/or M-mode numerical data which must include:
- the measurements performed in the course of the examination and/or interpretation.
- the table of 2-dimensional and/or M-mode numerical data for transthoracic echocardiograms, must include, but not be limited to (except where technically unobtainable),
  - measurements of the left ventricular internal dimension at end-diastole
  - the left ventricular internal dimension at end-systole
  - the left ventricular posterobasal free wall thickness at end-diastole
  - the ventricular septal thickness at end-diastole
  - the left atrial dimension at end-systole
  - the aortic root dimension at end-diastole.

C) A report of the Doppler evaluation must include, but not be limited to:
- the evaluation of peak and mean gradients, as well as valve area, if stenotic
- degree of regurgitation as warranted by the indication and pathology present.
- other pathology

D) Report text must include comments on:

- Left Ventricle (size, global and regional function)
- Right Ventricle (size and global function)
- Right Atrium (size)
- Left Atrium (size)
- Mitral Valve (structure and function)
- Aortic Valve (structure and function)
- Tricuspid Valve (structure and function)
- Pulmonic Valve (structure and function)
- pericardium
- aorta

Note: If any structure is not well visualized this should be noted. The report text must be consistent with the quantitative data. Where appropriate, this must include localization and quantification of abnormal findings.

E) Summary of pertinent findings

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

SECTION 5
Procedure Volumes

STANDARD - Procedure Volumes

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

A laboratory should perform a minimum of 600 echocardiograms annually. Each member of the medical staff should interpret a minimum of 300 studies annually. Each member of the technical staff should perform a minimum of 300 studies 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, Cheitlin, M. et al, Journal of the American College of Cardiology, 2003;42:954-70

2. "Recommendations for a Standardized Report for Adult Transthoracic Echocardiography," Gardin, J, et al, Journal of the American Society of Echocardiography, September 2001