

PART II

PEDIATRIC ECHOCARDIOGRAPHY LABORATORY OPERATIONS

PEDIATRIC TRANSTHORACIC ECHOCARDIOGRAPHY TESTING

SECTION 1 Instrumentation

STANDARD - Primary Instrumentation

1.1 Cardiac Ultrasound Systems

Ultrasound instruments utilized for diagnostic studies should 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) Transducers, which can provide adequate imaging across the wide range of depths encountered in pediatrics, must be available. Multiple imaging transducers, ranging from low frequency (2-2.5 MHz) to high frequency (7.5 MHz or higher) or a multi-frequency transducer which includes these frequencies, and a transducer dedicated to the performance of continuous wave Doppler studies (Pedoff) should be available as needed.
- 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.¹

STANDARD - Ordering Process and Scheduling

2.2 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, the venous connections, and the great vessels from multiple views, then uses the available information to completely define the cardiac anatomy and physiology.
2. A complete Doppler study is one that examines every cardiac valve, the great vessels, the venous connections and the integrity of the atrial and ventricular septa. In addition, a complete Doppler study provides functional hemodynamic data.

- B) Limited study: A limited study is generally only performed when the patient has previously undergone a complete examination and there is no reason to suspect any changes outside of the specific region of interest. A limited study generally examines a specific region of interest of the heart and/or answers a defined 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) pediatric 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 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/stat study must be performed as soon as possible.
- C) 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 hemodynamic and imaged abnormalities should be defined as fully as possible. The course and extent of disease must be documented.

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

- A) Proper patient positioning.
- B) Appropriate patient distraction or sedation
- C) Transducer selection for body size and placement.
- D) Optimization of equipment gain and display settings.
- E) Performance of a complete 2-D/M-Mode/Doppler examination according to the laboratory specific and appropriate protocol that incorporates all views and imaging planes mandated by the *ICAEL Standards (3.2.1)*.
- F) Utilization of appropriate Doppler technique (including proper Doppler alignment) and measurements.
- G) Accurate measurement of ventricular function.
- H) Appropriate 2-D/M-Mode/Doppler evaluation of all areas of abnormality, including unrepaired and repaired/palliated congenital heart defects.

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 should 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) Right, left or single ventricular anatomy and function
- 2) Right, left or single atrial anatomy and function
- 3) Systemic and or pulmonary semilunar valve anatomy and function
- 4) Ventricular and atrial septae
- 5) Mitral, tricuspid or single atrioventricular valve anatomy and function
- 6) Ascending, transverse and descending aorta
- 7) Main pulmonary artery and proximal branches
- 8) Inferior and superior vena cavae
- 9) Hepatic veins
- 10) Pulmonary veins
- 11) Pericardium
- 12) Measurements of the cardiac chambers and ventricular function where standard measurements are available
- 13) Coronary arteries when visible

B) Complete Doppler study - Includes spectral Doppler and/or color flow interrogation of all normal and abnormal flows within the heart including:

1. the atrioventricular and semilunar valves
2. the great vessels
3. the atrial and ventricular septae
4. all identified areas of abnormality

3.2.2 The complete examination of the anatomically normal heart must include (except where technically unobtainable), but not be limited to the following views:

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) Parasternal long axis view of the pulmonary artery
- 5) Apical four chamber view
- 6) Apical five chamber view
- 7) Subcostal four chamber view
- 8) Subcostal short axis views
- 9) Subcostal IVC/hepatic vein view
- 10) Suprasternal notch views (long axis of the aortic arch, short axis view of the aortic arch, pulmonary arteries and systemic and pulmonary venous connections)
- 11) Coronary arteries (when indicated)

B) The following 2-D or M-Mode measurements of the left heart (where appropriate):

- 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 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 pressure gradient estimation, multiple windows of interrogation must be attempted.
- 3) The use of a non-imaging Doppler Transducer (Pedoff) to assess stenotic valves, valvular regurgitation or whenever indicated may be helpful in some cases.
- 4) The tricuspid regurgitation spectrum must always be sought for estimation of systolic right ventricular pressure in patients with anatomically normal hearts.
- 5) Atrial and ventricular septa – color Doppler screening for defects.
- 6) Left ventricular outflow tract velocity
- 7) Doppler interrogation of the aortic arch
- 8) Velocity-time integrals and hepatic and pulmonary vein flow spectra are optional.

Comment: These may be different in congenitally malformed and/or surgically repaired complex malformations and cases with abnormalities of cardiac position.

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. ¹

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
 - patient height and weight for determination of BSA
 - 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 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 the components of procedure (i.e: color flow Doppler, PW/CW Doppler and comments on all structures evaluated in the examination as specified above). If any structure is not well visualized this should be noted. The report text must be consistent with the quantitative and Doppler data. Where appropriate, this must include localization and quantification of abnormal findings. If the exam is abbreviated for any reason (i.e.: patient uncooperativeness secondary to an unsedated exam), it should be noted in the report text.
- 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 is sufficient to maintain proficiency in examination performance and interpretation.

Ideally, a laboratory should perform a minimum of 200 pediatric echocardiograms annually and each member of the pediatric medical staff should interpret a minimum of 300 pediatric studies annually. Also, each member of the pediatric technical staff should perform a minimum of 100 pediatric studies annually. The total volume of pediatric studies interpreted and performed by each pediatric staff member may be combined from sources other than the applicant laboratory. It is recognized that some laboratories performing quality studies will not meet this minimum number, therefore lower volumes than those recommended here should not dissuade a laboratory that is otherwise compliant with the *ICAEL Standards* from applying for accreditation. These laboratories or individuals will be required to demonstrate competence through the submission of additional case studies and quality assurance documentation.

Bibliography:

1. **“Guidelines and Standards for Performance of a Pediatric Echocardiogram: A Report from the Task Force of the Pediatric Council of the American Society of Echocardiography.”** Wyman W. Lai, MD, MPH, FASE, Tal Geva, MD, FASE, Girish S. Shirali, MD, Peter C. Frommelt, MD, Richard A. Humes, MD, FASE, Michael M. Brook, MD, Ricardo H. Pignatelli, MD, and Jack Rychik, MD; J Am Soc Echocardiography 2006;19:1413-1430.