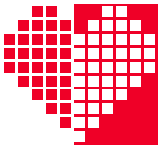
CARDIAC CARE NETWORK



Standards for Provision of Echocardiography in Ontario

April 2015

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Background – 2015 Update

Following the original publication of this document in 2012, the Cardiac Care Network of Ontario established a voluntary echocardiography quality improvement (EQI) program to help facilities achieve the standards. That process provided opportunities to assess the applicability, clarity and clinical relevance of the standards. Those insights, together with very valuable feedback from physicians and sonographers undertaking the process, has allowed us to further refine the standards to both augment their relevance to the practice of Echocardiography, and the validity of the review process.

This update was undertaken early in 2015 by the same Advisory Panel that drafted the original document. The editorial changes and additional detail provided therefore enhance but do not materially change the Standards for Provision of Echocardiography in Ontario originally published in 2012.

Yours truly,

Anthony Sanfilippo MD, FRCPC
Chair, CCN EQI Advisory Panel
Cardiologist, Kingston General Hospital
Associate Dean, Undergraduate Medical Education
Queen's University
Kingston, Ontario

Kori Kingsbury
Chief Executive Officer
Cardiac Care Network of Ontario

Introduction

The Cardiac Care Network of Ontario (CCN) serves as system support to the Ontario Ministry of Health and Long-Term Care (MOHLTC), Local Health Integration Networks and service providers and is dedicated to improving quality, efficiency, access and equity in the delivery of adult cardiovascular services in Ontario.

In January 2011, CCN was asked by the MOHLTC to convene an Echocardiography Working Group for the purpose of developing a report to include proposed standards of practice, guidelines, credentialing and accreditation criteria for echocardiography in Ontario. These standards were to be based on the guidelines published by the Canadian Society of Echocardiography (CSE), and where relevant, to include guidelines by other professional groups and associations.

The CCN Echocardiography Working Group was chaired by Dr. Anthony Sanfilippo (Kingston, Ontario). Committee membership included clinical stakeholders in the delivery of echocardiography services in Ontario, in addition to representatives from the MOHLTC and Ontario Medical Association. Our final report was submitted to the MOHLTC in April 2012.

On behalf of CCN, I would like to thank Dr. Sanfilippo and the members of the CCN Echocardiography Working Group for their clinical expertise and countless hours contributed to this important initiative. We look forward to continuing to work with key stakeholders on the implementation of these standards and recommendations for echocardiography in Ontario.

Kori Kingsbury,
Chief Executive Officer
Cardiac Care Network
2012

The history of Echocardiography over the past several decades is one of progressive technical development, occurring in tandem with increasing clinical relevance. It is now an essential component in the assessment and management of patients presenting with a wide variety of cardio - respiratory illness. It is also being increasingly used to identify patients who may benefit from an expanding array of medical and procedural therapies. These expanded applications have resulted in increasing financial impact, and a call from both physicians and providers for a more robust framework to ensure both quality and appropriate utilization.

It is in that context that a panel was convened in 2011 at the joint request of the Ministry of Health and Long-Term Care and Ontario Medical Association, and under the auspices of the Cardiac Care Network, to review and update standards of practice and to frame those standards in a way that would allow for evaluation and review. The panel took as its guiding principle the desire to ensure that patients undergoing echocardiographic examinations in Ontario would be assured of receiving quality, timely and clinically appropriate service. It is in that spirit of collaboration and mutual interest for the welfare of our patients that these recommendations are respectfully submitted.

Anthony Sanfilippo MD, FRCPC
Cardiologist, Kingston General Hospital
Associate Dean, Undergraduate Medical Education
Queen's University
Kingston, Ontario
2012

Echocardiography Working Group 2012

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Standards for Provision of Echocardiography in Ontario

In 2005 the Canadian Society of Echocardiography and the Canadian Cardiovascular Society jointly published guidelines regarding the provision of echocardiography services in Canada. Those guidelines, which were reviewed by a geographically and professionally diverse group of individuals involved in the practice of echocardiography, addressed all components of service delivery and were intended to ensure the utility, reliability and safety of echocardiography examinations. Since then, Echocardiography has become even more solidly entrenched as a key diagnostic procedure relevant to a wide spectrum of clinical disease. Its utilization has therefore continued to increase steadily and most provincial jurisdictions have imposed some form of regulatory framework to guide provision. In that regard, Ontario is a notable exception.

The purpose of this document is twofold:

1. To update the guidelines provided in the 2005 document taking into account advances in technology and clinical applications that have developed since then.
2. To describe a process that ensures echocardiography laboratories in Ontario achieve the Standards.

For the purposes of this document the term Echocardiographic Laboratory will be defined as a facility whose primary purpose is to provide echocardiographic examinations. An Echocardiographic Laboratory shall have a Medical Director and a Technical Director and may also have additional physicians and sonographers performing and/or interpreting transthoracic echocardiography. The facility may also perform stress or transesophageal echocardiography. Such facilities may vary greatly in size (single to multiple imaging systems), site (office, clinic, hospital, and/or mobile) and scope of examinations provided (inpatient, outpatient, and/or emergent services), but will be characterized by the following features:

- Provision of full transthoracic adult examinations.
- Acceptance of referrals for echocardiographic examinations.
- Space, equipment and procedures appropriate to provide such examinations.
- Engagement of appropriately trained personnel to carry out and assist with the provision of echocardiographic examinations.
- Engagement of appropriately trained physicians to interpret and supervise examinations.
- Recording and reporting of the results of those examinations.

- In addition, some laboratories may also provide the following services, which require additional service and professional considerations:
  - Pediatric echocardiographic examinations.
  - Transesophageal echocardiography.
  - Intraoperative transesophageal echocardiography.
  - Stress echocardiography.

The framework of this document will follow these requirements and the original 2005 document. It will therefore be structured in the following sections:

Section 1: Standards with respect to the echocardiographic examination.

Section 2: Standards for echocardiographic equipment, facilities and standard operating procedures.

Section 3: Standards regarding reporting of echocardiographic studies.

Section 4: Standards regarding personnel involved in echocardiographic examinations.

Section 5: Indications for echocardiographic examinations.

Section 6: Continuing quality assurance in the echocardiographic examination and laboratory.

Section 7: Framework for echocardiographic facilities to achieve the Standards.

Within each of the first six sections, a conceptual framework will be provided, describing the specific characteristics of optimal service provision. In addition, **standards** will be described, which are defined as **demonstrable performance characteristics that could provide evidence of quality service provision**. In their entirety, standards provide a means of identifying appropriate service and ensuring all patients receive timely and effective assessment.

Note: Within this document the term "shall" is used to express a requirement that echocardiography facilities are obliged to satisfy in order to comply with the standard.

Section 1:

Standards Regarding the Echocardiographic Examination

1.1 Standards Regarding the Transthoracic Echocardiographic Examination

The echocardiographic examination utilizes the full complement of imaging and non-imaging modalities to provide a comprehensive assessment of cardiac structure and function. Fundamental and harmonic imaging is used to optimize visualization of cardiac structures. When the imaging is suboptimal, the use of an echocardiographic contrast agent can be used to enhance visualization. Cardiac function and intracardiac hemodynamics are assessed by a comprehensive Doppler examination including pulsed-wave, continuous-wave, and colour flow. Tissue Doppler imaging should be considered in most cases to provide additional information on systolic and diastolic function.

A comprehensive (complete) study is the goal in every patient. A complete study is defined as one that examines all the cardiac chambers and valves and the great vessels from multiple views, complemented by Doppler examination of every cardiac valve, the atrial and ventricular septa for antegrade and retrograde flow. When a specific view or Doppler signal is unavailable, the reason shall be documented.

A **focused study** is an examination limited to a single component of the cardiac assessment usually performed in the emergency situation to guide immediate management or to re-assess a specific and active clinical issue.

Proper performance of the study shall include adequate explanation of the procedure and respectful interaction with the patient. Although the sequence of views may vary according to local practice, the full complement of views including Doppler tracings and measurements should be obtained and recorded in every patient. Specific comments on the quality of study are included with comments on technical deficiencies such as foreshortening and inadequate alignment in relation to Doppler assessment.

Standard E1: Echocardiographic facilities shall have established protocols that describe the components of the comprehensive transthoracic examination:

Laboratories shall establish protocols for the acquisition and recording of echocardiographic examinations. These protocols shall be reviewed and accepted by all sonographers and physicians involved and shall be made available to all and reviewed on a regular basis.

Evaluations of Transthoracic Study quality include:

- Display of standard on axis views without foreshortening.
- Evaluation of endocardium - well visualized, poorly visualized, contrast administered.
- Evaluation of Doppler signals and measurements.

Standard E2: The comprehensive transthoracic echocardiographic examination shall contain the following imaging components:

- Parasternal long axis of the left ventricle, left atrium and aorta.
- Parasternal short axis consisting of three short axis cuts of the left ventricle (base, mid, apex), pulmonary artery view and aortic valve view.
- Right ventricular inflow view.
- Right ventricular outflow view.
- Apical four chamber view.
- Apical two chamber view.
- Apical three chamber view (long axis view).
- Apical five chamber view.
- Apical imaging with particular attention the left ventricular (LV) apex.
- Subcostal long axis view.
- Subcostal short axis view.
- Subcostal inferior vena cava view.
- Suprasternal views of the aorta.

Standard E3: The comprehensive transthoracic echocardiographic examination shall contain the following Doppler components:

- Parasternal long axis two dimensional (2D) with colour screening for aortic insufficiency and mitral regurgitation.
- Parasternal short axis 2D with pulmonary artery colour and pulsed wave Doppler.
- Right ventricle inflow view 2D with colour for tricuspid regurgitation.
- Apical four chamber view 2D with colour for mitral regurgitation and tricuspid regurgitation; pulsed and continuous wave.
- Apical five chamber view with colour for aortic and mitral regurgitation and pulsed/continuous wave Doppler of the aortic flow velocity.
- Apical three chamber (long axis) view 2D with colour and aortic flow velocity.
- Apical two chamber with colour flow Doppler of the mitral valve.
- Subcostal view with colour Doppler of the interatrial septum.
- Suprasternal view with colour and pulsed wave/continuous wave Doppler of the descending aorta.

Standard E4: The comprehensive transthoracic echocardiographic examination shall contain the following standard measurements:

The following standard measurements shall be obtained and recorded for all studies. Either M - mode or 2D can be used to obtain the measurements at end expiration, based on their respective strengths and limitations in specific situations:

- LV systolic and diastolic dimensions.
- LV diastolic wall thickness (septum and posterior wall).
- Ejection fraction should be quantitated whenever technically possible by one of the validated methods (preferably by Simpson's biplane Method of Discs) and the method used should always be identified. Visual estimation should be reserved for cases in which quantitative assessment is not technically feasible.
- Transvalvular aortic flow velocity.
- Pulmonary valve velocity.
- Diastolic parameters should be determined according to the current guidelines, and diastolic function classified into categories of normal, mild dysfunction (impaired relaxation), moderate dysfunction (pseudonormalization) and severe dysfunction (restriction). This assessment is based on consideration of the relevant parameters available from the echocardiographic examination which can include mitral inflow velocities, mitral deceleration time, isovolumic relaxation time, pulmonary venous systolic and diastolic velocities, and tissue Doppler assessment of mitral annular motion.
- Tricuspid regurgitation velocity to calculate right ventricular (RV) systolic pressure.
- Measurements of the aortic root and ascending aorta (sinuses of Valsalva and proximal ascending aorta) and to include the annulus if indicated.
- Left atrial dimensions.

Standard E5: The facility shall have established procedures to provide the following additional information where clinical indications or findings warrant:

- Blood pressure and heart rate should be included in the setting of valvular heart disease to allow proper assessment of intracardiac hemodynamics.
- Transvalvular mean and maximal gradients with continuous wave Doppler for stenotic valves and valvular prostheses, including views from multiple windows, such as the suprasternal and right sternal border.
- Spectral display of complete envelope of continuous wave Doppler signal of valvular regurgitation.
- Proximal isovelocity surface area calculation or other quantitative methods for assessment of valvular regurgitation.
- Respiratory variation of mitral and tricuspid inflow Doppler (e.g., pericardial disease).
- Hepatic venous flow pattern and inferior vena cava collapse.
- Shunt calculation.
- Descending aortic velocity and presence of flow reversal, for assessment of aortic coarctation and regurgitation.
- Protocols to address the assessment of patients with technically inadequate images that do not allow for reliable evaluation of the clinical issue in question. This should include any or all of the following:
  - Saline contrast injection.
  - Use of contrast agents to improve endocardial visualization.
  - Referral to a reference laboratory.
  - Referral to alternative available imaging modalities including stress and/or transesophageal echocardiography.

1.2 Standards Regarding the Stress Echocardiographic Examination

Standard ES1: Echocardiographic facilities that perform Stress echocardiography shall have established protocols that describe the components of a comprehensive Stress echocardiography examination:

Laboratories shall establish protocols for the acquisition and recording of Stress echocardiographic examinations and shall specify all imaging planes and required views. These protocols shall be reviewed and accepted by all sonographers and physicians involved and shall be made available to all and reviewed on a regular basis.

Standard ES2: The Stress echocardiographic screening examination shall contain the following imaging components:

- Parasternal long axis of the left ventricle, left atrium and aorta.
- Parasternal short axis consisting of three short axis cuts of the left ventricle (base, mid, apex), pulmonary artery view and aortic valve view.
- Apical four chamber view.
- Apical five chamber view.
- Apical two chamber view.
- Apical three chamber view (long axis view).

Standard ES2.1: The Stress echocardiographic screening examination shall contain the following Doppler components:

- Parasternal long axis two-dimensional (2D) with colour screening for aortic insufficiency and mitral regurgitation.
- Parasternal short axis 2D with pulmonary artery colour and pulsed wave Doppler.
- Apical four chamber view 2D with colour for mitral regurgitation and tricuspid regurgitation; continuous wave Doppler for RVSP.
- Apical five chamber view with colour for aortic and mitral regurgitation and aortic flow velocity.
- Apical two chamber with colour flow Doppler of the mitral valve.
- Apical three chamber (long axis) view 2D with colour.

Standard ES3: The comprehensive Stress echocardiographic examination shall contain the following components, as defined by the facility.

Standard ES3.1: Pharmacologic Stress Echocardiography:

Acquisition of rest images and three other stages of the pharmacologic stress echo are obtained. Standard images include:

- Rest image
- Low dose
- Peak
- Recovery

OR

- Rest
- Low dose
- Pre peak
- Peak

Standard ES3.2: Treadmill / Bike Stress Echocardiography:

- Images are acquired at rest and immediately post exercise.
- Parasternal long axis.
- Parasternal short axis.
- Apical four chamber.
- Apical two chamber/or apical three chamber.
- Other view combinations as set by the facility's protocol.
- All 17 segments of the left ventricle need to be visualized. Baseline/Rest images to Peak/ Recovery images will be compared side by side.

Standard ES3.3: Viability Pharmacologic Views:

- Parasternal long axis.
- Parasternal short axis.
- Apical four chamber.
- Apical two chamber.
- Apical three chamber.

Standard ES4: Additional Important Considerations for Stress Echocardiographic Examinations:

Appropriate acquisition times:

- Pharmacologic stress - images shall be obtained within the last 90 seconds of each stage.
- Treadmill stress - post stress images shall be obtained within 90 seconds of peak stress.
- If Image acquisition time is greater than 90 seconds in duration, documentation is required in the report.
- Shall have comprehensive capture capabilities and obtain a minimum of 3 cardiac cycles of each view at rest and peak.

Additional documentation for Stress Echocardiography reports shall include the following:

- Electrocardiogram - rhythm, heart rate and rhythm at rest and each stage of exercise.
- Target heart rate.
- Blood pressure at each stage.
- When contrast is indicated but not utilized, document the rationale in the report.

1.3 Standards Regarding the Transesophageal Echocardiographic Examination

Standard ET1: Echocardiographic facilities that perform Transesophageal echocardiography examinations (TEE) shall have established protocols that describe the components of the comprehensive transesophageal echocardiography examination:

Laboratories shall establish protocols for the acquisition and recording of transesophageal echocardiographic examinations and shall specify all imaging planes and required views. These protocols shall be reviewed and accepted by all sonographers and physicians involved and shall be made available to all and reviewed on a regular basis.

Standard ET2: The comprehensive Transesophageal echocardiographic examination shall contain the following views, according to the sequence of the facilities protocol:

Mid-esophageal Views:

- Five Chamber view - Aortic Valve, Left Ventricular Outflow Tract, Left Atrium/Right Atrium, Left Ventricle/Right Ventricle, Mitral Valve (A2, A1, P1), Tricuspid Valve.
- Four Chamber view - Left Atrium, Right Atrium, Interatrial Septum, Left Ventricle, Right Ventricle, Mitral Valve (A3, A2, P2, P1), Tricuspid Valve.

- Two Chamber view - Left Ventricle, Left Atrium, Left Atrial Appendage, Mitral Valve (P3, A3, A2, A1).
- Commissural view - Mitral Valve (P3, A3, A2, A1, P1), Papillary Muscles, Chordae Tendinae, Coronary Sinus, Left Ventricle.
- Long axis view - Left Ventricle, Left Ventricular Outflow Tract, Mitral Valve (P2, A2), Left Atrium, Aortic Valve and Aortic Root.
- Short axis view - (25 - 45 degrees) Aortic Valve, Right Atrium, Left Atrium, Superior Interatrial Septum, Right Ventricular Outflow Tract, Pulmonary Valve.
- Bi-caval view - (50 - 70 degrees) Right Atrium, Left Atrium, Mid-Interatrial Septum, Tricuspid Valve, Superior Vena Cava, Inferior Vena Cava, Coronary Sinus.
- Bi-caval view - (90 - 110 degrees) Left Atrium, Right Atrium, Right Atrial Appendage, Interatrial Septum, Superior Vena Cava, Inferior Vena Cava.
- Left Atrial Appendage view - Left Atrial Appendage, Left Upper Pulmonary Vein.

Upper-esophageal Views:

- Long axis view - (90 - 110 degrees) Mid Ascending Aorta, Right Pulmonary Artery.
- Short axis view - (0 - 30 degrees) Mid Ascending Aorta, Main Pulmonary Artery/ Bifurcation, Superior Vena Cava.
- Pulmonary Vein view - Mid Ascending Aorta, Superior Vena Cava, Right Pulmonary Vein
- Right/Left Upper Pulmonary Vein view - Pulmonary Vein - upper/lower, Pulmonary Artery.

Transgastric Views:

- Short axis view - Basal Left Ventricle, Basal Right Ventricle, SAX - Mitral Valve/Tricuspid Valve.
  - Mid Left Ventricle, Papillary Muscles, Mid Right Ventricle.
  - Apex Left Ventricle, Apex Right Ventricle.
- Two Chamber view - Left Ventricle, Left Atrium, Left Atrial Appendage, Mitral Valve.
- Long axis view - Left Ventricle, Left Ventricular Outflow Tract, Right Ventricle, Aortic Valve, Aortic Root, Mitral Valve.
- Right Ventricle (RV) Basal view - Mid Left Ventricle/Right Ventricle, Right Ventricular Outflow Tract, Short axis - Tricuspid Valve, Pulmonary Valve.

- RV Inflow/Outflow view - Right Atrium, Right Ventricle, Right Ventricular Outflow Tract, Pulmonary Valve, Tricuspid Valve.
- Five Chamber view - Left Ventricle, Left Ventricular Outflow Tract, Right Ventricle, Aortic Valve, Aortic Root, Mitral Valve.
- RV Inflow view - Right Ventricle, Right Atrium, Tricuspid Valve.

Descending Thoracic Aorta:

- Descending Aorta Short axis view - Descending Aorta.
- Long axis view - Descending Aorta.
- Long axis view Aortic Arch view - Aortic Arch.
- Short axis view Aortic Arch view - Aortic Arch.

Note: Agitated saline may be required to assess shunting at the level of the inter-atrial septum.

Standard ET3: The comprehensive TEE examination shall contain the following Doppler components:

- Colour flow of all 4 valves and the IAS.
- Spectral and Continuous Wave when right ventricle systolic pressure, diastolic LV function, valve gradients, Pulmonary Venous Flow or Left Atrial Appendage velocities are necessary.
- Pulse Wave Doppler of the pulmonary veins to assess Mitral Regurgitation severity, diastolic function and pulmonary vein stenosis post ablation.
- Pulse Wave Doppler of the arch vessels to assess stenosis or to identify the left subclavian artery.
- Pulse Wave Doppler to determine types of arrhythmia and to assess left atrial appendage function.
- Continuous Wave Doppler to assess Pulmonary Stenosis, Tricuspid Regurgitation, Aortic Stenosis, Mitral Stenosis and Mitral Regurgitation as clinically indicated particularly if the TTE is suboptimal.
- Mid-esophageal four chamber view Colour and Pulsed Wave Doppler for mitral stenosis/ regurgitation and tricuspid stenosis/regurgitation and pulmonary venous flows.
- Mid-esophageal two chamber view Colour and Pulsed Wave Doppler for mitral stenosis/ regurgitation.

- Mid-esophageal long axis view - Colour Doppler to assess for mitral and aortic regurgitation.
- Transgastric two chamber view - Colour Doppler to assess for mitral regurgitation.
- Transgastric basal short axis view.
- Mid-esophageal mitral commissural view Colour flow Doppler to assess origin of regurgitation.
- Mid-esophageal aortic short axis view - Colour Doppler to assess for aortic regurgitation.
- Mid-esophageal aortic long axis view - Colour Doppler to assess for aortic regurgitation, flow velocities across the left ventricular outflow tract.
- Transgastric long axis view - Colour Doppler to assess aorta and regurgitation Continuous Wave Doppler to assess aortic velocities and Pulsed Wave Doppler for Left Ventricle Outflow Tract velocities.
- Deep Transgastric long axis view - Colour Doppler to assess aorta and regurgitation. Continuous Doppler to assess aortic velocities and Pulsed Wave Doppler for Left Ventricle Outflow Tract velocities.

Section 2:

Standards Regarding Echocardiographic Facilities, Equipment and Standard Operating Procedures

2.1 The Examining Room

A complete transthoracic echocardiographic examination takes between 30 and 60 minutes. During this time, patient privacy and comfort shall be maintained. In addition, the sonographer shall carry out the examination in a manner that minimizes physical stress and the risk of repetitive stress injury to themselves. Infection control practices shall be in place.

Standard F1: Echocardiographic examining rooms shall provide the following:

- Approximately 120 – 150 square feet of patient care space with adequate ventilation and temperature control.
- An examining bed appropriate to echocardiographic image acquisition.
- Adjustable ergonomic chairs with back support for the sonographer.
- Patient privacy shall be assured with the use of curtains and/or doors, as appropriate.
- A sink and antiseptic soap must be readily available for hand washing in accordance with the infection control policy of the facility.

2.2 Echocardiographic Imaging Systems

Fully equipped, highly functioning and well maintained equipment is essential if optimal examinations are to be produced. Because echocardiography has been and continues to be the subject of rapid technological advances, the definition of "state of the art" is a moving target. In addition, although multiple manufacturers are known to produce excellent equipment, there is considerable variation as to configuration and specific analysis packages available.

Standard F2: Ultrasound instruments utilized for diagnostic studies shall include, at a minimum, hardware and software to perform:

1. M-Mode imaging.
2. Two-dimensional (2D) imaging. The system must include harmonic imaging capabilities, and should also include instrument settings to enable optimization of ultrasound contrast agents.

3. Spectral display for Pulsed (PW) and Continuous Wave (CW) Doppler studies. There should be a system setting to display low frequency Doppler filtering for tissue Doppler display.
4. Monitoring or other display method of suitable size and quality for observation and interpretation of all modalities.
5. Continuous ECG display.
6. Where data are derived from a given line of interrogation (e.g., M-Mode or PW Doppler), a reference image should be available on the screen within a frozen 2D image, except for non-imaging CW Doppler.
7. Range or depth markers shall be available on all displays.
8. Capabilities to measure the distance between two points, an area on a 2D image, blood flow velocities, time intervals, and peak and mean gradients from spectral Doppler studies.
9. 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 a range of frequencies specific to the clinical needs in adult echo. A transducer dedicated to the performance of non-imaging continuous wave Doppler and shall be available at each site and each imaging system shall have the capacity to utilize that transducer.
10. An audible output shall be present at the time of acquisition. A permanent recording of the Doppler waveform and corresponding image that utilizes a digital image storage method that should be compatible with Digital Imaging and Communications in Medicine (DICOM) standards.
11. Respirometry for selected indications.
12. Laptop-designed ultrasound/imaging systems shall be structured and positioned to optimize image acquisition and ergonomics.

Note: Imaging systems regardless of manufacturer, model, size or configuration shall meet all of the above criteria.

Standard F3: Equipment shall be maintained in good operating condition:

The accuracy of the data collected by ultrasound instruments is paramount to the interpretation and diagnostic utilization of the information collected. Regular equipment maintenance by appropriately trained individuals is essential. This can be carried out either through maintenance and service agreements with manufacturers, or by other appropriately trained personnel.

Guidelines for equipment maintenance include, but are not limited to, the following:

- Recording of the method and frequency of maintenance of ultrasound instrumentation and digitizing equipment.
- Establishment of and adherence to a policy regarding routine safety inspections and testing of all laboratory electrical equipment.
- Establishment of and adherence to an instrument cleaning schedule that includes routine cleaning of equipment parts, including filters and transducers, according to the specifications of the manufacturer.

2.3 Standard Operating Procedures

Echocardiographic examinations provide information important to patient management. In some cases, the findings are unexpected and can be critical to patient care. It is therefore essential that examinations be documented appropriately, sufficient time be provided to acquire full information, and reports be provided to referring physicians in a timely fashion. Studies shall also be stored and available for future reference and comparison to subsequent examinations. Storage facilities shall ensure patient confidentiality.

Standard F4: All orders or requisitions for echocardiographic procedures shall include at a minimum:

- The type of study to be performed.
- A standard indication (refer to Appendix B).
- The name of the referring physician.

Standard F5: Sufficient time shall be allotted for each examination:

For a complete (imaging and Doppler) transthoracic examination, 30 to 45 minutes from patient encounter to departure is allotted. An additional 10 to 15 minutes is generally required for offline measurements and analysis, preliminary report generation, and preparation for the next examination. Due to additional patient and technical considerations, an additional 10 to 20 minutes may be needed in preparation for pharmacologic stress examinations.

Standard F6: Echocardiographic reports shall be provided within the following timeframes.

- Inpatient and urgent outpatient studies shall be interpreted and the report made available to the referring physician by the end of the next working day from completion of the examination, and preferably by the end of the day of the exam.

- Outpatient studies shall be interpreted by a qualified physician and be made available to referring physicians within five working days of the examination.
- Unexpected high risk findings shall be communicated immediately by the interpreting physician to the referring physician.

Standard F7: Echocardiographic data (images, measurements and final reports) obtained for diagnostic purposes shall be recorded, stored and archived in a format that ensures ready retrieval (such that the parameters outlined in Standard F6 are met), complete review, clear communication and patient confidentiality.

Standard F8: A permanent record of the images and interpretation shall be made and retained in accordance with provincial guidelines for medical records.

Standard F9: Laboratories shall have protocols whereby unexpected high risk findings are communicated immediately by the interpreting physician to the referring physician and managed as required by the interpreting/responsible echocardiologist.

Standard F10: Echocardiography Laboratories shall have Infection Prevention and Control (IPAC) Policies and Protocols in place.

All health care providers shall follow Routine IPAC Practices for all patients during all care in all echocardiography laboratory settings. Protocols shall contain the following elements of routine IPAC practices:

- Hand Hygiene.
- Risk Assessment.
- Personal Protective Equipment (PPE).
- Control of the Environment.
- Cleaning the Environment.
- Safe Administration of Injectable Medications.
- Cleaning of Medical Equipment.
- Healthy Workplace Policy.

2.4 Additional Considerations for Laboratories Providing Stress Echocardiography Examinations

Standard FS1: Appropriately trained and qualified personnel are required to monitor the patient, operate the treadmill or supine bicycle, record the electrocardiogram and, in the case of pharmacologic stress echo, administer medication. The individual(s) carrying out the examination shall not be expected to provide these functions.

Standard FS2: All stress procedures shall be explained to the patient and/or the substitute decision maker of those unable to give informed consent. Consent shall be obtained in a manner consistent with the rules and regulations outlined by the hospital or facility.

Standard FS3: Larger rooms shall be provided to perform stress echo, in order to accommodate extra equipment, personnel and potential resuscitation procedures. It is recommended that the procedure room be a minimum of 150 to 200 square feet.

Standard FS4: Facilities and procedures shall be available for observation and recovery of patients by appropriately trained and qualified personnel prior to the patient's discharge home or back to their referring location.

Standard FS5: In addition to the echocardiographic imaging system requirements, as outlined above, echocardiography equipment utilized for stress echo studies shall:

- Allow for accurate "triggered" acquisition of images and side-by-side image display.
- Ensure adequate memory to allow performance of multi-stage stress echocardiogram studies.
- Have the capability of side-by-side comparison of images from baseline and different stages of stress. Side-by-side review may be accomplished within the ultrasound stress package or on a dedicated offline workstation.

Standard FS6: In addition to the standard features noted above, laboratories providing stress echocardiographic examinations require the following additional items in the procedure room:

- Treadmill/bicycle EKG monitoring.
- Vital signs monitor for blood pressure, heart rate and oxygen saturation monitoring.
- Medical oxygen.
- Emergency cart containing a defibrillator, airway management equipment, emergency medications and other related equipment.
- Available intravenous equipment.

- A means of rapidly calling for help with an unstable patient (e.g., phone, intercom, arrest buzzer).
- A bed that is able to be moved and positioned appropriately for resuscitation.
- An appropriate bed for stress echocardiography with a drop-down section located at the left chest area is highly recommended.

2.5 Additional Considerations for Laboratories Providing Transesophageal Echocardiographic Examinations

Standard FT1: Appropriately trained and qualified personnel are required to provide sedation and monitoring of the patient through the procedure and recovery. The individual(s) carrying out the examination shall not be expected to provide this monitoring function during the procedure.

- A minimum of one staff member shall be trained and dedicated to ensure the patients' airway and oxygen saturation level is maintained during the procedure.
- Recommend a minimum of one staff involved with each TEE procedure is Advance Cardiac Life Support (ACLS) certified.

Standard FT2: All TEE procedures shall be explained to the patient and/or the substitute decision maker, and understanding confirmed prior to obtaining informed consent. Consent shall be obtained in a manner consistent with the rules and regulations outlined by the hospital or facility. Where sonographers are involved in the consent process, procedures shall be in keeping with the provisions of their credentialing body as well as relevant scope of practice principles established by the hospital or facility.

Standard FT3: In addition to the echocardiographic imaging system requirements, as outlined above, transesophageal transducers shall be available and meet the following requirements:

- Transesophageal ultrasound transducers shall be those manufactured for the ultrasound system of the laboratory.
- Transesophageal ultrasound transducers shall incorporate multiplane imaging capabilities.

Standard FT4: Larger rooms shall be provided to perform Transesophageal echo, in order to accommodate extra equipment, personnel and potential resuscitation procedures. It is recommended that these procedure rooms have a minimum of 150 to 200 square feet available.

Standard FT5: In addition to the standard features required to perform Transesophageal examinations, laboratories providing Transesophageal echocardiographic examinations shall have the following additional requirements in the procedure room:

- Vital signs monitor for blood pressure, heart rate and oxygen saturation monitoring.
- Suction.
- Medical oxygen.
- Emergency cart containing a defibrillator, airway management equipment, emergency medications and other related equipment.
- Available intravenous equipment.
- Lockable cabinet for controlled drugs.
- A means of rapidly calling for help with an unstable patient (e.g., phone, intercom, arrest buzzer).
- A large sink for rinsing probes and/or a process for handling of used ("dirty") probes.

Standard FT6: The echocardiography laboratory shall follow proper cleaning, disinfection, and maintenance procedures as stipulated by manufacturer and hospital or facility policies which meet Public Health Ontario Standards (see Standard F10).

Standard FT7: Physical space and procedures shall be available to support the observation and recovery of patients by appropriately trained and qualified personnel, prior to the patient's discharge home or back to their referring location.

Section 3:

Standards for Reporting of Echocardiographic Examinations

The echocardiographic report shall provide specific information for the referring physician, including the key elements of (1) demographics, (2) complete echocardiographic findings, and (3) a summary/interpretation statement, and is provided in a clinically relevant, useful and timely manner. Echocardiography reporting shall be standardized in the laboratory. All physicians interpreting echocardiograms in the laboratory shall agree on uniform diagnostic criteria and a standardized report process and format. The final report shall be completely typewritten. The final report shall be approved by the interpreting physician.

Standard R1: All echocardiographic reports shall include the information outlined in Appendix A.

Standard R2: In addition to the standard information outlined in Appendix A, specific evaluation will be provided regarding the presenting problem.

Specific indications or pathology require further targeted imaging and/or hemodynamic assessment. Stated findings shall be consistent with the quantitative data. A full review of the specific data required for evaluation of all possible pathologies is beyond the scope of this document, and the reader is referred to one of the many excellent comprehensive texts available.

Standard R3: An assessment of study quality shall be included in every report and, where appropriate, a statement regarding any study limitations.

It is recognized that echocardiography is sensitive to various technologic limitations and the acquisition of a full set of interpretable data may not be possible for all patients. It is therefore important that such limitations be clearly stated within the report, in order to avoid the assumption of normality by the referring physician. Statements such as “imaging was suboptimal or impossible” or “reliable interpretation not possible” shall be used where appropriate.

Standard R4: Amended reports shall be identified as such and shall include the date and time of the change, as well as the specific changes from the original report.

Standard R5: Final reports should be consistent in format and completed only after full review of all acquired data and necessary re-measurement and shall include the following:

1. Overall interpretation/summary of findings, including any pertinent positive and negative findings, as it relates to the assessment of the presenting issue/reason for study.
2. Consistent with the qualitative and quantitative data elements.
3. Findings of other significant pathology.
4. Relevant comparisons to prior studies or reports as available. If prior studies are not available, this should be documented.
5. Study limitations.
6. Recommendations regarding alternative or additional investigations where appropriate.
7. Routine patient demographics, including Blood Pressure, Heart Rate and Rhythm, and Body Surface Area (BSA).

NOTE: if standard views are not acquired, the deficiency and rationale shall be documented in the report.

Standard R6: Mechanisms shall be in place for immediate communication of urgent findings (Preliminary Reporting).

Echocardiography is able to quickly derive very valuable information regarding the status of critically ill patients. In order to avoid delays in transmitting valuable information (especially findings that immediately impact patient care) to referring physicians, it is imperative that a mechanism exists for the immediate communication of echocardiographic findings. Such mechanisms shall be developed within each laboratory and hospital setting, in accordance with local practices. In doing so, it shall be recognized that it is not the responsibility of the sonographer to generate final reports, nor shall they be compelled to report preliminary findings if they are not confident or comfortable in doing so for any reason. In addition, such a mechanism shall in no way be interpreted as a substitute for urgent access to physician backup and interpretation.

Section 4:

Standards Regarding Laboratory Type and Personnel Involved in Echocardiographic Examinations

An echocardiography laboratory is composed of at least one ultrasound instrument, a Medical Director and a Technical Director performing and/or interpreting transthoracic echocardiography, encompassing a single or multiple geographic sites. When multiple sites are utilized, it is understood that all sites fall under a common governance structure and fulfill all standards. There may be additional physicians and sonographers. The laboratory may also perform stress and/or transesophageal echocardiographic examinations. Smaller facilities may have one person fulfilling both the Medical and Technical Director positions.

An echocardiography laboratory requires the interpreting physicians and practicing sonographers to be adequately trained and experienced to interpret and perform echocardiograms.

Published documents recognize that echocardiography requires considerable training and expertise. Although published opinions vary with regard to the absolute numbers necessary for attaining and maintaining competence in echocardiography, all agree that numbers of studies performed or interpreted are not sufficient by themselves to assure clinical competence. In developing these standards, the Canadian Cardiovascular Society/Canadian Society of Echocardiology Guidelines for Training and Maintenance of Competency in Adult Echocardiography (Burwash IG et al, Can J Cardiol 2011; 27: 862 - 4) were utilized, including definitions of Level 2 and 3 training.

4.1 Standards Regarding the Medical Director

Standard P1: The echocardiographic laboratory will have a designated Medical Director, who shall be a licensed physician and holds one of the following qualifications:

- Level 3 training in echocardiography; or
- Level 2 training in echocardiography and continuing echocardiography practice including interpretation of at least 1800 Echo/Doppler examinations over the previous 3 years.

Standard P1.1: Additional qualifications for Medical Directors at sites interpreting Stress Echocardiographic Examinations:

- Level 3 training; or
- Level 2 training with an additional 3 months of full time training (which could be extended over a 6 month period) dedicated to Stress echocardiography, during which supervision and interpretation of at least 100 stress examinations occurs.

Standard P1.2: Additional qualifications for Medical Directors at sites interpreting Transesophageal Echocardiographic Examinations:

- Level 3 training; or
- Level 2 training with an additional 3 months of full time training (which could be extended over a 6 month period) dedicated to Transesophageal echocardiography, during which performance and interpretation of at least 50 Transesophageal examinations occurs.

Standard P2: The Medical Director carries out and/or has oversight for the following:

- All clinical services provided and determination of the quality and appropriateness of care provided.
- Assuring compliance of the medical and technical staff to these standards and the supervision of their work.
- Active participation in the interpretation of studies performed in the laboratory.
- For laboratories with multiple/mobile sites, the Medical Director is responsible to ensure all standards are consistently followed at all sites.

Standard P3: To ensure continuing maintenance of competence, the Medical Director attends at least 24 hours of accredited Continued Medical Education activities relevant to echocardiography over a period of two years and interprets at least 400 transthoracic echocardiographic studies per year. For laboratories carrying out transesophageal echo, the Medical Director must perform and interpret at least 25 transesophageal examinations per year. For laboratories providing stress echocardiography, the Medical Director must interpret at least 75 stress echocardiography examinations per year.

4.2 Standards Regarding the Technical Director

Standard P4: The laboratory shall have a designated Technical Director who has credentialing from the American Registry of Diagnostic Medical Sonography (ARDMS) or equivalent credential, and experience as assessed and approved by the Medical Director. In laboratories with no appropriately qualified sonographers, a physician assumes the role of Technical Director and shall have Level 2 or 3 training.

Standard P5: The Technical Director carries out and/or has oversight for the following:

- Performance of echocardiographic examinations.
- General supervision of the technical and support staff.
- The delegation, where appropriate, of specific responsibilities to the technical or support staff.
- Daily administration of the laboratory (scheduling, record keeping).
- Operation and maintenance of laboratory equipment.
- The compliance of technical staff to these standards.
- Maintenance of quality patient care.
- Technical training and mentorship of all staff.

Standard P6: The Technical Director documents at least 30 hours of echocardiography related continuing education over a period of three years.

4.3 Standards Regarding Medical Staff

Standard P7: Members of Medical Staff shall be licensed physicians who hold one of the following qualifications:

- Level 2 or 3 training in Adult Echocardiography; or
- Documented performance in an established laboratory, with interpretation of at least 400 Echo/Doppler studies per year and maintenance of competence as defined in **Standard P3** for the preceding 3 years.

Standard P7.1: Additional qualifications for Medical Staff at sites interpreting Stress Echocardiographic Examinations:

- Level 3 training; or
- Level 2 training with an additional 3 months of full time training (which could be extended over a 6 month period) dedicated to Stress echocardiography, during which supervision and interpretation of at least 100 stress examinations occurs.

Standard P7.2: Additional qualifications for Medical Staff at sites interpreting Transesophageal Echocardiographic Examinations:

- Level 3 training; or
- Level 2 training with an additional 3 months of full time training (which could be extended over a 6 month period) dedicated to Transesophageal echocardiography, during which performance and interpretation of at least 50 Transesophageal examinations occurs.

Standard P8: Members of Medical Staff are responsible for:

- Interpretation of examinations.
- Reporting of examinations.
- Triaging of emergency requests.
- Supervision and support of sonographers carrying out examinations, to include availability for review of patients or acquired information before the patient is discharged from the facility.
- In laboratories providing procedural echo, carrying out or supervising transesophageal and ensuring appropriate supervision of stress echocardiography studies.
- Providing emergency assistance for patients as required.

Standard P9: Members of Medical Staff shall undertake and document continuing maintenance of competence as described in Section P3.

4.4 Standards Regarding Technical Staff

Standard P10: All Technical Staff performing echocardiographic examinations shall meet one of the following criteria:

- Appropriate credentialing from ARDMS or equivalent agency, as approved by the Medical and Technical Directors.
- Successful completion of an accredited Echocardiography training program which includes both didactic teaching and supervised clinical experience.
- Completion of at least 12 months of full time (35 hours per week) clinical echocardiography performing echocardiographic examinations and completion of a formal 2 year program in another allied health profession.
- Sonographers who have recently completed an accredited echocardiography training program may be engaged in echocardiography for 2 years prior to qualifying for ARDMS, or equivalent credentialing.
- BCLS certified.

Standard P10.1: Qualifications for sonographers performing Stress Echocardiography:

- Further dedicated training is required, in a laboratory actively engaged in Stress echocardiography, for a period of 4 weeks, during which a minimum of 50 Stress echocardiograms are performed.

Standard P10.2: Qualifications for sonographers participating in Transesophageal Echocardiography:

- Further dedicated training is required, in a laboratory actively engaged in Transesophageal echocardiography, during which a minimum of 10 Transesophageal echocardiograms are observed prior to participating.

Standard P11: Technical Staff work under the direction of the Technical Director and are, in general, responsible for:

- Ensuring patient identity and documentation of information.
- Ensuring patient comfort and safety.
- Acquisition and recording of all echocardiographic images and data as defined by established laboratory protocols.
- Alerting supervising physicians as to any technical deficiencies in study acquisition.
- Alerting the supervising physician as to any urgent conditions identified in the course of the examination.
- Alerting the supervising physician as to any significant symptoms or distress experienced by the patient during the course of the examination or while in the echocardiography laboratory.

Standard P12: All Technical Staff shall document at least 30 hours of echocardiography related CME every 3 years.

Section 5:

Indications for Echocardiographic Examinations

Echocardiography is a non-invasive, non-toxic, portable diagnostic technique that provides a great deal of imaging and quantitative information relevant to cardiac structure and function. It has therefore taken on a key role in the assessment of patients presenting with numerous clinical problems. Responsible utilization of this technology requires regular assessment of its appropriate indications. Such assessment should be based, where possible, on objective evidence supporting a significant impact on clinical practice. The absence of such evidence does not exclude benefit. Therefore, where such evidence is lacking, justification shall be based on accumulated clinical experience.

Appendix B lists conditions in which echocardiography is known to have such an impact and is therefore indicated in the care of affected patients.

In developing this list, the authors were cognizant of the primary role of the treating physician in determining test utility and did not wish to either deny patients potential benefit of this technique, nor suggest that all patients presenting with particular issues would necessarily benefit from echocardiographic assessment.

As a guiding and overriding principle, the Authors advocate the use of echocardiography if, and only if, results have potential to influence clinical decisions and patient management.

Standard I1: Echocardiographic Laboratories will have mechanisms which ensure that a standard indication (as per Appendix B) is documented as a component of every referral.

Standard I2: For referrals without a standard indication (as per Appendix B), laboratories will have mechanisms whereby referring physicians are contacted for clarification before the study is carried out. Based on that clarification, the study will be carried out at the discretion of the supervising physician.

Standard I3: Echocardiographic Laboratories will have mechanisms to:

- Track indications of completed studies.
- Ensure that at least 95% of studies carried out meet standard indications (as per Appendix B).
- Provide education of referring physicians regarding appropriate indication for echocardiography examinations.

Section 6:

Continuing Quality Assurance in the Echocardiographic Laboratory

Quality assurance (QA) is seminal to all medical activities and is particularly central to procedural activities such as echocardiography, which are frequently pivotal to high-impact clinical decisions. Every echocardiographic laboratory is expected to develop, describe and make available its own internal QA program, or partner with a reference laboratory with an established QA program. The QA program of the laboratory shall include methodology, implementation, documentation and review that address the following standards:

Standard Q1: Regular review of study acquisition, including the quality and completeness of the images and the accuracy of the measurements by each sonographer, a function that might be satisfied by regular review of a set number of random studies over a set time-interval using a pre-defined point-score system and pre-set standards of accuracy under the auspices of the Laboratory Director or his/her designate.

Standard Q2: Review of study interpretation, including the accuracy, completeness and timeliness of the reports of each interpreting physician, a function that might be satisfied by a regular review of a set number of random interpretive reports over a set time-interval using a pre-defined point-score system and pre-set standards of accuracy by the Medical Director or his/her peer designate(s).

Standard Q3: Staff meetings to review and discuss the results of QA process and introduce system-wide remedial or improvement measures.

Standard Q4: External Review. Processes that allow for regular (at least bi-annual) independent constructive feedback and review of either confirmatory or discordant findings by other laboratories.

Standard Q5: Validation against other diagnostic modalities. A process for validating test findings by correlating them with other diagnostic procedures, such as hemodynamic results from coronary angiography, nuclear perfusion studies, MRI and intra-operative findings and pathology.

Standard Q6: Case Review. Organization of and/or attendance at rounds and/or conferences focused on interesting case reports or series cases, or specific disease entities with an instructional content relevant to the activities of the laboratory.

Note: The Personal Health Information Protection Act is applicable whenever echocardiography case studies are shared for the purpose of quality assurance and/or education.

Section 7:

A Process for Echocardiography Laboratories to Achieve the Standards

In order to positively influence patient care and service delivery, methods shall be developed whereby standards become implemented and thereby influence laboratory processes. In the case of Echocardiography, this can occur in one of three ways:

1. **Self Review:** The simple availability of these standards allows all operators of echocardiography facilities to utilize them to modify their processes and procedures in a way that will better assure optimal service delivery. Developing, accepting and publishing these standards will hopefully promote that process and thereby enhance quality in and of itself.

2. **Voluntary External Review:** This is a process whereby laboratories can choose to engage an external, arm's length agency to review their operation with respect to accepted standards and provide constructive feedback as to their performance. In order to be effective, such feedback shall include education and practical suggestions as to how full compliance can be achieved.

3. **Mandatory External Review:** This is a process whereby all laboratories providing echocardiography would require external review which would attest that they are achieving all standards. The failure to achieve the standards with such external mandatory review shall result in the loss of public approval or reimbursement for echocardiography services.

The authors recommend a mandatory review to ensure all echocardiography facilities in Ontario achieve the Standards.

Recognizing that implementation shall be carried out in a manner that does not inhibit the provision of echocardiographic services, the authors advocate a phased implementation, as follows:

Phase 1: Publication and dissemination of these standards

This will provide all echocardiographic facilities a common reference to facilitate review of their procedures. This should be carried out immediately.

Phase 2: Provision of opportunities for Voluntary Review

Voluntary external review requires a process whereby accepted standards are used to assess the performance of an echocardiography laboratory. In order to accomplish this, internal and external laboratory review as well as adjudication of that review by a qualified third party is required.

The end result of the process should be the provision of instructive feedback to the laboratory regarding their performance with respect to all of the standards. That review should include suggestions as to how the laboratory can improve its performance with respect to standards in which it is found to be deficient. It is recommended that the period of Voluntary Review last no longer than 3 years.

Phase 3: Mandatory Review and Credentialing

Mandatory review of echocardiography laboratories must evolve in Ontario. This will require a governmental regulatory framework, the development of which is beyond the scope of this paper.

In order to facilitate the voluntary and mandatory review processes, the following processes are suggested:

1. That an **Echocardiography Review Panel** be established to oversee assessment of echocardiography laboratories in Ontario.

2. That **Structured Review Templates** be developed based on the standards outlined in these documents. These templates should provide guidance as to how laboratories can demonstrate and provide evidence with regard to their performance in each standard.

3. That **Qualified Reviewers** be engaged to carry out and coordinate assessments of echocardiography laboratories. These reviewers would be both qualified and highly experienced in the application of echocardiography. They would assist the laboratory in development of their internal review and coordinate the review with the central panel.

4. The **Process for Review** would therefore take the following seven steps:

   Step 1 – During the voluntary phase, the laboratory identifies itself as wishing to undertake review. During the mandatory phase, laboratories would be notified of a scheduled review.

   Step 2 – The laboratory is provided with instruction and documentation templates necessary for carrying out its internal review.

   Step 3 – A reviewer is assigned to assist and guide the laboratory in the review process.

   Step 4 – The material is submitted to the central review panel.

   Step 5 – A laboratory visit is undertaken by the assigned reviewers, and one member of the review panel.

   Step 6 – The review panel assesses the submitted material and results of the laboratory visit. Detailed feedback with respect to performance in all standards is provided to the laboratory. Where appropriate recommendations are made with respect to how the laboratory can improve its performance in areas of deficiency.

   Step 7 – If necessary a review visit is scheduled to reassess standards found to be in noncompliance.

Laboratories found to achieve the standards shall be entitled to be recognized as such in a variety of ways including publication on a public website and prominent displays within their laboratory and on their reports.

As a next step to establish quality assurance standards for echocardiography in Ontario, CCN will work with service providers and stakeholders to implement a system and resources that will support and facilitate self-review and voluntary external review processes.

Appendix A:
The Standard Echocardiographic Report

Basic Information:

- Name and/or identifier of the laboratory, location, contact information.
- Study date.
- Patient identification and demographics, date of birth +/- age, gender.
- Patient location (inpatient vs. outpatient), study location (echo lab, portable – ICU, ER, etc.).
- Height, weight, body surface area.
- Rhythm and heart rate.
- Study indication.
- Referring physician identification.
- Interpreting physician identification.
- Sonographer ID.
- Type of study (e.g., adult TTE, neonatal TTE, TEE, stress echo etc.).
- Study technical quality (e.g., quality, good, fair, poor, incomplete) and limitations.

Cardiac Dimensions – Measurements:

- Left ventricular internal systolic and diastolic dimensions.
- Left ventricular (basal) septal and posterior wall thickness.
- Left atrial size (anteroposterior dimension).
- Aortic root and ascending aorta dimensions.

Note: Normal ranges should be included in the report. The text of the report should comment on whether a given dimension is within normal limits, or if abnormal, to what extent.

Evaluation of the structure and function of the anatomic components of the examination, to be included in the standard report, include the following:

Left Ventricle

- Assessment of left ventricular dimensions, wall thickness, global left ventricular systolic function and ejection fraction (and method used), and presence or absence of regional wall motion abnormalities.
- Evaluation of left ventricular diastolic function (if relevant to the clinical indication).

Right Ventricle

- Assessment of right ventricular size and systolic function, presence of right ventricular hypertrophy.

Left Atrium

- Assessment of size.

Right Atrium

- Assessment of size.

Aortic Valve

- Aortic valve cusp morphology, presence and severity of stenosis or regurgitation.
- Evaluation of gradients (peak and mean) and valve area, if stenotic.

Mitral Valve

- Mitral valve leaflet morphology, presence and severity of stenosis or regurgitation.
- Evaluation of gradients (peak and mean) and valve area, if stenotic.

Tricuspid Valve

- Tricuspid valve leaflet morphology, presence and severity of stenosis or regurgitation.
- Evaluation of gradients (peak and mean), if stenotic.
- Estimation of right ventricular systolic pressure, if sufficient tricuspid regurgitation is present.

Pulmonic Valve

- Pulmonic valve morphology, presence and severity of stenosis or regurgitation.
- Evaluation of gradients (peak and mean), if stenotic.

Aorta (including aortic root and ascending aorta)

- Dimensions.

Interatrial Septum

- Intact – presence or absence of ASD/shunt.

Pericardium

- Presence and size of pericardial effusion, assessment of hemodynamic effects of pericardial effusion (if present).

Appendix B:

Indications for Echocardiography – Standards 2012

1. Heart Murmurs:

1.1. Initial evaluation of a murmur in a patient with cardiorespiratory symptoms.

1.2. A murmur in an asymptomatic patient where structural heart disease cannot be excluded by clinical assessment.

1.3. Re-evaluation of known valvular disease with a change in clinical status or cardiac exam.

2. Native Valvular Stenosis:

2.1. Initial assessment of etiology, severity, chamber dimensions, ventricular systolic function and overall hemodynamic impact.

2.2. Assessment of patients with known valvular stenosis of any severity and changing clinical status or discrepancy between clinical and echocardiographic severity.

2.3. Reassessment within 6 - 12 months of patients with an initial echocardiographic assessment indicating valvular stenosis of any severity.

2.4. Reassessment (≥2 yr) of mild valvular stenosis without a change in clinical status or cardiac exam.

2.5. Reassessment (≥1 yr) of moderate valvular stenosis without a change in clinical status or cardiac exam.

2.6. Reassessment (≥6 mos) of severe valvular stenosis without a change in clinical status or cardiac exam.

3. Native Valvular Regurgitation:

3.1. Initial assessment of etiology, severity, chamber dimensions, ventricular systolic function and overall hemodynamic impact.

3.2. Assessment of patient with known valvular regurgitation of any severity and changing clinical status or discrepancy between clinical and echocardiographic severity.

3.3. Reassessment (≥1 yr) of patients with asymptomatic moderate valvular regurgitation.

3.4. Reassessment (≥6 mos) of patients with asymptomatic severe valvular regurgitation.

4. Known or Suspected Mitral Valve Prolapse:

4.1. Diagnosis and assessment of hemodynamic severity, leaflet morphology, ventricular cavity size and function in patients with physical findings of mitral valve prolapsed.

4.2. Patients with previous diagnosis of mitral valve prolapse and changing clinical status or physical findings suggestive of progressive valvular dysfunction.

4.3. To re-evaluate patients with prior echocardiographic diagnosis but no supporting physical findings.

4.4. Reassessment (≥2 yrs) of patients with significant leaflet thickening or redundancy.

4.5. Periodic reassessment as required by severity of regurgitation (as per section 3).

5. Congenital or Inherited Cardiac Structural Disease (including Bicuspid Aortic Valve, Marfan's Syndrome, Atrial Septal Defect, Ventricular Septal Defect, Ehler's Danlos Syndrome):

5.1. Patients with known congenital or inherited structural heart disease and changing clinical status or symptoms.

5.2. Patients in whom clinical findings, the results of other investigations, or family history would suggest the presence of a congenital or Inherited Cardiac Structural Disease.

5.3. Reassessment (≥2 yrs) of asymptomatic individuals with previously diagnosed congenital or Inherited Cardiac Structural Disease.

6. Prosthetic Heart Valves:

6.1. Assessment of a newly implanted prosthetic heart valve (baseline assessment).

6.2. Reassessment (≥1 yr) in asymptomatic, hemodynamically stable patients if no known or suspected prosthetic valve dysfunction.

6.3. Assessment of a prosthetic heart valve in patients with symptoms, clinical findings or prior echocardiogram suggestive of prosthetic valve dysfunction.

7. Infective Endocarditis:

7.1. Patients in whom endocarditis is suspected clinically.

7.2. In a patient with clinically proven or suspected endocarditis to assess the severity and hemodynamic impact of valvular lesions, and to detect other high risk lesions (e.g., fistulae, abscesses).

7.3. Reassessment of patients at high risk for complications or with a change in clinical status or cardiac exam.

7.4. Reassessment in a clinically stable patient with prior echocardiographic evaluation to assess response to therapy or detect clinically silent disease progression.

8. Pericardial Disease:

8.1. Evaluation of patients with suspected pericarditis, pericardial effusion, tamponade or constriction.

8.2. Initial follow-up of patients with no change in clinical status but a pericardial effusion of suspected clinical significance.

8.3. Follow up of any pericardial effusion in patients with changing clinical status suspected related to the effusion.

8.4. Reassessment at yearly intervals in patients with moderate or large pericardial effusion.

8.5. Echocardiographic guidance of pericardiocentesis for diagnostic or therapeutic purposes.

9. Cardiac Masses:

9.1. Evaluation of patients with clinical syndromes suspicious for an underlying cardiac mass.

9.2. Follow up following surgical removal of masses/tumours, intervals to be determined by the pathology, patient clinical status and known natural history of the lesion.

9.3. Patients with malignancies when echocardiographic assessment for cardiac involvement is part of the standard disease staging process.

9.4. Evaluation of cardiac mass detected by other imaging modalities.

10. Interventional Procedures:

10.1. To assist pre and peri-procedural decision making for percutaneous interventional and electrophysiologic procedures (e.g., valvuloplasty, closure device insertion, catheter ablation, mitral valve repair).

10.2. Post-intervention baseline studies for valve function, closure device placement and stability, and ventricular remodeling (e.g., within 3 months).

10.3. Re-evaluation of patients post interventional procedure with suspected surgical complication (e.g., valvular dysfunction, closure device erosion/migration, perforation).

11. Pulmonary Diseases:

11.1. Evaluation of suspected or established pulmonary hypertension.

11.2. Reassessment of pulmonary hypertension to evaluate response to treatment.

11.3. Evaluation of suspected acute pulmonary embolism.

11.4. Reassessment after initial treatment of pulmonary embolism.

11.5. Patients being considered for lung transplantation or other surgical procedures for advanced lung disease to exclude possible cardiac disease.

11.6. Patients with known chronic lung disease and unexplained desaturation.

12. Chest Pain and Coronary Artery Disease:

12.1. Evaluation of suspected aortic dissection.

12.2. Chest pain with hemodynamic instability.

12.3. Chest pain or ischemic equivalent suggestive of underlying coronary artery disease.

12.4. Heart murmur associated with acute or recent myocardial infarction.

12.5. Assessment of infarct size and baseline LV systolic function post myocardial infarction.

12.6. Assessment of LV function post revascularization.

12.7. As a component of periodic (≥1 yr) reassessment of patients with known ischemic LV dysfunction.

12.8. Periodic (≥6 mos) reassessment of LV function to guide or modify therapy in patients with known severe ischemic LV dysfunction.

13. Dyspnea, Edema and Cardiomyopathy:

13.1. Assessment of patients with suspected heart failure.

13.2. Clinically suspected cardiomyopathy.

13.3. Patients with clinically unexplained hypotension.

13.4. Assessment of baseline LV function and periodic review when using cardiotoxic drugs.

13.5. Re-evaluation of LV function in patients with documented cardiomyopathy and change in clinical status or undergoing procedures that could potentially affect function such as alcohol septal ablation or surgical myomectomy.

13.6. Reassessment of patients with known cardiomyopathy to evaluate significance of symptoms and guide therapy.

13.7. Screening of relatives potentially affected by inherited cardiomyopathy.

13.8. Reassessment (≥1 yr) of asymptomatic cardiomyopathy patients for disease progression in order to assess suitability for medical or device treatment.

14. Hypertension:

14.1. Suspected left ventricular dysfunction.

14.2. Evaluation of left ventricular hypertrophy that may influence management.

15. Thoracic Aortic Disease:

15.1. Suspected aortic dissection.

15.2. Suspected aortic rupture/trauma.

15.3. Suspected dilatation of aortic root or ascending aorta for any cause.

15.4. Evaluation patient with known aortic pathology and change in symptoms or clinical findings suggestive of progression.

15.5. Suspected or proven Marfan Syndrome or other connective tissue disorder in which aortic pathology is a potential feature.

15.6. Reassessment of asymptomatic patients with aortic aneurysm (frequency dependent on aortic dimensions and rate of progression).

15.7. Baseline and continuing reassessment (≥1 yr) of patients with prior surgical repair of aorta.

16. Neurologic or Other Possible Embolic Events:

16.1. Patient of any age with abrupt occlusion of a major peripheral or visceral artery.

16.2. Stroke or TIA in the absence of established causative pathology.

17. Arrhythmias Syncope and Palpitations:

17.1. Initial investigation of symptomatic arrhythmia.

17.2. Asymptomatic documented frequent premature atrial beats, chaotic atrial rhythm, paroxysmal or permanent atrial fibrillation or flutter, frequent ventricular premature beats, nonsustained VT, sustained VT.

17.3. Investigation of syncope of undetermined etiology.

17.4. Pre-procedural before electrophysiologic studies and procedures and before ICD or pacemaker implantation if not performed within 3 months.

17.5. Investigation of patients with LBBB, high grade AV block.

17.6. Investigation of patients with WPW pre-excitation.

17.7. Follow-up of patients with sustained tachycardia at risk for development of Cardiomyopathy.

18. Before Cardioversion:

18.1. Patients with atrial fibrillation of more than 48 hours duration requiring cardioversion and not chronically or adequately anticoagulated.

18.2. Patients for whom atrial thrombus has been demonstrated in previous study.

18.3. Precardioversion evaluation of patients who have previous echocardiographic evidence of structural heart disease.

19. Suspected Structural Heart Disease:

19.1. Where an investigation suggests possible structural heart disease and an echocardiographic study has not been previously performed or the finding has not been previously identified.

20. Indications for Transesophageal Echo:

20.1. Non-diagnostic transthoracic study, either due to technical limitations or failure to fully characterize a potentially significant finding.

20.2. Assessment of structure and function of cardiac valves to assess feasibility of surgery or catheter-based intervention.

20.3. Patient selection, guidance and monitoring of interventional procedures including but not limited to device closure of intra-cardiac shunt and radio-frequency ablation.

20.4. Detection of cardiac source of embolus in the absence of established causative pathology.

20.5. Evaluation of patients with suspected aortic dissection or aortic disease not fully evaluated by other imaging modalities.

20.6. Detection of atrial thrombus in patients prior to cardioversion or interventional procedures.

20.7. Moderate or high risk for endocarditis when TTE is negative or inconclusive.

20.8. Detection of valvular and peri-valvular complications in high risk endocarditis patients such as patients with staphylococcal bacteremia.

21. Indications for Stress Echo:

21.1. Typical or atypical chest pain or ischemic equivalent syndrome.

21.2. Possible ACS with non-diagnostic ECG changes and negative or borderline significant troponin levels.

21.3. History of Congestive Heart Failure.

21.4. Known LV systolic dysfunction of unclear etiology.

21.5. Significant ventricular arrhythmia.

21.6. Syncope of unclear etiology.

21.7. Borderline or high troponin levels in a setting other than ACS.

21.8. Significant cerebrovascular or peripheral atherosclerosis.

21.9. Re-evaluation (≥1 yr) in patients with significant cerebrovascular or peripheral atherosclerosis.

21.10. Equivocal or non-diagnostic results from other stress modalities.

21.11. Initial evaluation of patients at intermediate or high global CAD risk.

21.12. Periodic (≥2 yrs) re-evaluation of patients with intermediate or high global CAD Risk.

21.13. New or worsening chest pain or ischemic equivalent.

21.14. Post MI or ACS for risk stratification (within 3 months).

21.15. Viability in patients with known significant LV dysfunction post re-vascularization.

21.16. Periodic (≥1 yr) re-evaluation of stable patients with known CAD (previous coronary angiography, CTA/EBCT, MI, ACS or abnormal stress imaging).

21.17. For physiologic assessment and/or symptom correlation in patients with moderate or severe Aortic Stenosis, Mitral Stenosis, Mitral Regurgitation, Aortic Regurgitation, Hypertrophic Cardiomyopathy.

21.18. Assessment of established or latent pulmonary hypertension.

Appendix C:
Summary of Standards

The Echocardiographic Examination

E1 Established Protocols
E2 Required Imaging Components
E3 Required Doppler Components
E4 Standard Measurements
E5 Additional Information

The Stress Echocardiographic Examination

ES1 Established Protocols
ES2 Established Protocols for the Screening Examination
ES3 Required Imaging Components
ES4 Important Considerations

The Transesophageal Echocardiographic Examination

ET1 Established Protocols
ET2 Required Imaging Components
ET3 Required Doppler Components

Echocardiographic Facilities, Equipment, Standard Operating Procedures

F1 Examining Room Requirements
F2 Imaging System Requirements
F3 Maintenance Requirements
F4 Ordering of Echo Studies
F5 Providing Sufficient Time for Examinations
F6 Timeframes for Reporting
F7 Storage of Echo Examination Data
F8 Record Storage and Availability
F9 Communication of High Risk Findings
F10 Infection Prevention and Control
FS1 Personnel for Stress Studies
FS2 Informed Consent for Stress Studies
FS3 Space Requirements for Stress Studies
FS4 Facilities for Observation and Recovery of Patients
FS5 Equipment Requirements for Stress Studies
FS6 Laboratory Requirements for Stress Studies
FT1 Personnel for Transesophageal Studies
FT2 Informed Consent for Transesophageal Studies
FT3 Equipment for Transesophageal Studies
FT4 Space Requirements for Transesophageal Studies
FT5 Laboratory Requirements for Transesophageal Studies
FT6 Cleaning and Maintenance of Transesophageal Probes
FT7 Facilities for Observation and Recovery of Patients

The Report

R1 Content of Echo Reports
R2 Content Relevant to Presenting Problem
R3 Assessment of Study Quality and Limitations
R4 Amended Reports
R5 Requirement for Conclusions
R6 Reporting of Urgent Findings

Personnel

P1 Medical Director Requirement and Qualifications
P2 Medical Director Responsibilities
P3 CME Requirements for Medical Director
P4 Technical Director Requirement and Qualification
P5 Technical Director Responsibilities
P6 CME Requirements for Technical Director
P7 Medical Staff Qualifications
P8 Medical Staff Responsibilities
P9 CME Requirements of Medical Staff
P10 Technical Staff Qualifications
P11 Technical Staff Responsibilities
P12 CME Requirements for Technical Staff

Indications

I1 Documentation of Indication for all Referrals
I2 Mechanisms to Process Studies Order Without a Stated Indication
I3 Tracking of Indications

Quality Assurance

Q1 Examination Completeness and Quality
Q2 Study Interpretation
Q3 Laboratory Operation
Q4 External Review
Q5 Validation of Finding
Q6 Rounds and Conferences

References

American Society of Echocardiography

www.asecho.org

Canadian Society of Echocardiography

www.csecho.ca

College of Physicians and Surgeons of Ontario

http://www.cpso.on.ca/policies-publications/policy/medical-records

Ontario Ministry of Health and Long - Term Care

http://www.health.gov.on.ca/en/common/ministry/publications/reports/phipa/phipa_mn.aspx

http://www.health.gov.on.ca/en/common/ministry/publications/reports/phipa/compendium.pdf

http://www.health.gov.on.ca/en/common/ministry/publications/reports/phipa/bill_159.pdf

Provincial Infectious Diseases Advisory Committee (PIDAC)

Infection Prevention and Control: Out-of-Hospital Premises (OHP) and Independent Health Facilities (IHF)

Public Health Ontario

http://www.publichealthontario.ca/en/eRepository/IPAC_CPSO_Out-of-Hospital_Premises_Indep_Facilities_April_2014.pdf

http://www.publichealthontario.ca/en/BrowseByTopic/InfectiousDiseases/PIDAC/Pages/PIDAC_Documents.aspx#.VJG_l9LF9u0

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