



BC's HEART FAILURE NETWORK
Quality care for quality life.

Provincial Diagnostic Imaging Working Group

Summary Report for the Provincial Heart Failure Steering Committee

Co-Chairs

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Background

The Diagnostic Imaging Working Group (DIWG) was established under the auspices of the Provincial Heart Failure Strategy, which was formed to improve heart failure (HF) service and care across British Columbia (BC). The mandate of the DIWG was to identify optimal imaging requirements for the purpose of diagnosis and management of HF patients. The DIWG was chaired by Dr Ken Gin, with membership including cardiologists, radiologists, internists, primary care, and administrators from all health authorities. The working group reported through the Provincial Heart Failure Steering Committee to the Provincial Executive Director of Cardiac Services BC. Over the past two years the working group has met quarterly via face to face meetings with teleconference options.

Environmental Scan

The working group's first priority was to perform a diagnostic imaging environmental scan. The scan was conducted adopting methodology previously utilized in the 2005 Provincial Health Services Authority (PHSA) review of echo services conducted by Kori Kingsbury. The survey was updated to capture information regarding human resources and information that aligned with the lower mainland consolidation Magnetic Resonance Imaging (MRI) data capture information. A detailed spreadsheet was filled out by each Health Authority (Appendix 4).

It became clear that there was a wide difference in the practice of echocardiography in BC, specifically:

- 1) There are significant differences in wait times for echo across the province.
- 2) There is no general standard for turnaround time of echocardiogram reports. In some departments, the reports are computer generated; at others the reports are dictated and transcribed, resulting in significant delays in reports reaching the ordering physician.
- 3) The components of a standard echocardiogram study varied widely. For example, some labs routinely report out quantitative ejection fraction, whereas others only offer visual estimates. Some labs routinely report diastolic function and left atrial filling pressures, whereas others do not.
- 4) The ejection fraction percentage criteria was not standardized across all diagnostic/cardiology labs .e.g. criteria for mild, moderate, and severe left ventricular dysfunction vary significantly, some sites report a percent and some a percentage range.
- 5) The echocardiogram referral form generally contained incomplete information to triage the request appropriately this also did allow for easy monitoring or evaluation.

Provincial Resources Developed

As a result of the environmental scan, the DIWG decided to focus on further defining the current state, and establishing what the ideal future directions for echocardiogram services in BC should be. To facilitate this, the working group has created three echocardiogram resources to standardize practices and processes throughout BC diagnostic/cardiology imaging departments. All of the resources have been reviewed and endorsed by the health authority's diagnostic imaging physician and administrative leads; as well they have been vetted through their respective internal health authority processes. Further details are described in the Milestones section below:

- 1) Provincial echocardiogram referral form (Appendix 1).
- 2) Standard key elements for reporting of echocardiogram results (Appendix 2).
- 3) Best practice document for Heart Failure Echocardiography services in BC – adopted from the American Society of Echocardiography (Appendix 3).

The three provincial resources are meant to serve as BC best practice guidelines and should be implemented by the health authorities in a timely manner. A start date of Jan 1, 2014 should provide sufficient time for echo departments to enact the recommendations.

Provincial Echocardiogram Capacity and Wait Time analysis

To further assess the provision of echocardiogram services in BC, the DIWG collected information on echocardiogram capacity as well as wait times throughout BC. Further details are described in the Milestones section below:

- 1) ***Echocardiogram Capacity***: This included details from all sites in BC that perform echocardiograms. Information was collected regarding echocardiogram equipment, staffing, hours of operation, scan volumes, quality, and practice benchmarks (Appendix 4).
- 2) ***Wait time analysis***: Echocardiogram wait time data from all sites was collected for a 1-week period (April 16 – 23, 2012), which resulted in a total of 3,290 studies being recorded. The analysis provided insight into the wait times for inpatient and outpatient scans, by facility (Appendix 5).

MILESTONES COMPLETED

1. Standardized Provincial Echocardiogram Referral Form

This form was created to ensure all health care providers ordering an echocardiogram understand what information is needed to obtain timely access to a scan, and ensure the referral form contains enough detail to effectively triage the request. This will also assist in categorizing referrals according to the Canadian Cardiovascular Society priority benchmarks for access to echocardiography services.

The process for development began with a review of each health authority's current echocardiogram referral form. To ensure the data fields on the provincial echocardiogram referral form were guided by best practice, the DIWG reviewed the guidelines from the American Society of Echocardiography, the Canadian Cardiovascular Society, and the Canadian Society of Echocardiography. It was determined that none of the existing B.C. echocardiogram referral forms were comprehensive enough to adopt provincially. Thus, the final provincial referral form is an amalgamation of current documents, combined with recommendations from national guidelines. The referral form is contained in appendix 1 of this document.

2. Standardized Echocardiogram Final Report Data Elements

The standardized data elements for final echocardiogram reports were developed to minimize the variability in reporting across the province. Many referring physicians or nurse practitioners expressed difficulty in interpreting reports when they are requested from different hospitals within their region. For example, patients could have the same ejection fraction, but be called moderate left ventricular (LV) dysfunction at one site and severe LV dysfunction at another. To ensure consistency across all diagnostic imaging and cardiology departments, the DIWG created standard key elements that should be included on a final report. In addition, the group adopted the Canadian Cardiovascular Society's recommendations for turn-around times for when a report should be available for review by the ordering health care provider. The standard key elements for reporting are outlined in appendix 2.

3. Standardized Principles to Ensure Best Practice for Echocardiology Services in British Columbia

During the working group discussions it became apparent that not all sonographers or echocardiography physicians adhere to best practice guidelines when performing an echocardiogram study. The DIWG decided to create a best practice document, based on national standard, the American Society of Echocardiography (ASE) guidelines. These guidelines are best viewed as an all encompassing

compendium of all possible echocardiography methodologies. It was agreed that the ASE standards are too complex for routine clinical use in BC, in particular the diastology protocols. The guidelines were adapted through group consensus by echocardiology interpreting physicians involved with the DIWG and are described in the document titled *Principles to Ensure Best Practice for Heart Failure Echocardiography Services in British Columbia* (Appendix 3). This document outlines definitions for all structures within the heart, standards for vital signs prior to procedure, highlights the need for both systolic and diastolic function to be measured, minimum data elements that should be recorded, and outlines the type of echocardiogram to be performed. The DIWG notes that these principles are not intended to result in punitive consequences if diagnostic imaging departments are not able to meet them. Rather, they are intended to be a beginning point for standardization of echocardiogram clinical practice and services in BC and set the foundation to ensure patients receive the best evidence-based echocardiography care.

4. Provincial Diagnostic Imaging Capacity and Inventory

Information was collected from each facility's diagnostic imaging department, including the type of echocardiogram equipment, number of rooms, staff, hours of operation, volumes per week/month/year, number of scan interpreters, number of sonographers, current vacancies, anticipated vacancies, quality practice and benchmark standards. See appendix 4 for full details.

The number of echocardiogram machines range from 1-9 depending on the facility and expected volumes. The majority of machines are relatively new, having been purchased between 2007-2011 (anticipated life cycle of this type of equipment is 7 years or less). Not surprisingly, facilities with more than 4 machines tended to have higher volumes and shorter wait times (Appendix 6).

The majority of the imaging departments within BC have operating days Monday to Friday 8- 5 pm, with varying total hours of operation from 5-16 hours per day. Fifteen of the 35 facilities pre-book echocardiograms on weekends, and 12 facilities pre book scans in the evenings (after 5pm). This may also contribute to the shorter wait times at some facilities (Appendix 6).

There are approximately 164 FTE of sonographers across BC. Almost every department designates machines and staff specifically for echocardiograms. At the time of data collection (April 2012), there were 27 current vacancies, and 61 anticipated vacancies (retirement, maternity leave, etc) over the next

five years. Human resource availability has been a common theme identified by the facilities as their main barrier to providing timely access to echocardiograms (Appendix 6).

5. Echocardiogram Wait Time Analysis

A full description of the methodology and analysis for this work is contained in appendix 4 and 5.

Although the DIWG's mandate was for HF patients specifically, it was determined to be too difficult to isolate the HF specific cases. Thus, data for all echocardiograms performed was collected, from all 36 facilities in BC that provide the service. For the purposes of this study, all pre-booked cases (those pre-scheduled 6-12 months in advance) were removed, leaving 2,768 echocardiogram cases to calculate average wait times by facility and health authority. Provincially, approximately 30% of all echocardiograms were performed on inpatients and 70 % performed on outpatients. The over-all average wait time for inpatient echocardiograms in BC was 2.5 days, and for outpatients 51.8 days. An overview of the priority level "scheduled/non-urgent" was conducted to determine the percentage of cases meeting the 30-day Canadian benchmark Medically Acceptable Wait Time (MAWT). Province wide, just 30.7% of scheduled/non-urgent outpatients had their echocardiograms completed within 30 days. Surprisingly, 7% of inpatient scheduled/non-urgent studies had a wait time of more than 30 days (Appendix 7).

There is substantial inter facility disparity in wait times for echocardiogram studies. Resources should be directed towards sites with the longest wait times to improve patient care.

Conclusion

The DIWG, with physician and administrative input from BC's health authorities created and achieved consensus on standardizing echocardiology practice in BC. Once consensus within the working group was achieved, the members vetted the documents through their respective health authority diagnostic imaging committees and feedback was incorporated into the final documents. Through implementation and utilization of the provincial referral form, key elements for echocardiogram reporting and the Provincial Principles to Ensure Best Practice for Echocardiology Services in British Columbia (BC) document, HF patients in BC will receive the best evidence based treatment and care irrespective of where they live in the province. The working group should be commended on this achievement, as it has not been an easy task to merge the disparate needs of busy community echocardiology labs and echocardiology labs from large academic centers.

Another success of the working group was collection of echocardiogram wait time data to assess variation in access times for echocardiograms across BC as well as diagnostic imaging department inventory and human resource availability. Even though the wait time data capture was just a one time snap shot it showed significant inequities in access to echocardiograms. The diagnostic imaging departments generally perform well and accommodated inpatient echocardiogram referrals within 2.5 days but the MAWT for outpatient referrals is not acceptable with an average provincial wait time of 51 days. Some facilities have outpatient wait times exceeding 100 days. Approximately 30% of all echocardiograms were performed on inpatients and 70 % performed on outpatients. Given the majority of echocardiograms are being performed on out patients and the long wait times, there needs to be some strategies implemented to improve them. Subsequent and ongoing wait time data capture is necessary to assess trends and implement improvement strategies.

Ongoing surveillance of human resource needs and longitudinal data capture will paint a clearer picture of sonographer needs within each facility and across the province. A collaborative provincial model between British Columbia Institute of Technology (BCIT) and the health authorities regarding sonographer education and job placement may assist with long term planning. A provincial sonographer task force should be established to ensure there are adequate human resources to meet the demands of the province.

With completion of the work plan, the working group feels the mandate of the provincial DIWG has been met and its primary set of goals reached. Below are the outlined recommendations from the DIWG to ensure patients in BC receive the best evidence based treatment and care, ensure practitioners adhere to best practice and to address short term and long term sonographer vacancies.

Phase II of this initiative will be to create similar standards for nuclear cardiology practice and services in BC. This process will be lead by Dr Marla Kiess and be supported by a provincial working group. Time lines for completion are currently being outlined by the provincial nuclear cardiology working group.

Recommendations

1. All health authority diagnostic imaging (cardiac imaging) departments adopt the Provincial echocardiogram referral form.
2. All health authorities diagnostic imaging (cardiac imaging) departments adopt the key elements for echocardiogram reporting.
3. All health authority cardiologists/radiologists/internists/sonographers performing echocardiograms adhere to the guidelines outlined in the Provincial Principle's to Ensure Best Practice for Echocardiology Services in British Columbia (BC).
4. All health authorities develop strategies with time lines for the implementation of the standard echocardiogram referral form and standard echocardiogram report, the DIWG recommends implementation starting January 1, 2014.
5. Health authorities use the wait time information to improve access to echocardiography care.
6. All health authorities continue to collect wait time data on a quarterly basis and forward to Cardiac Service BC (CSBC).
7. Diagnostic/cardiology imaging departments with high volumes and short wait times share their staffing models and booking models with other health authorities who have long wait times.
8. Direct resources to the facilities with the longest wait times.
9. CSBC, health authorities and BCIT form a working group to establish strategies for short term and long term sonographer education planning and work force human resource planning.
10. Educational opportunities should be made available to sonographers and physicians to allow them to upgrade skills when needed to be able to implement the above proposed changes.

Limitations

The DIWG works in an advisory capacity, and does not have the authority to impose the suggested changes. The working group also notes that the provision of echocardiogram services in BC did not consider appropriate use criteria. Adopting these criteria may shorten wait times, especially for outpatient studies. However, this is likely less of an issue in BC, as all echo studies are performed in hospital affiliated facilities (unlike Ontario and Alberta, where studies can be performed in private physician offices). The number of echo studies done per capita in BC is approximately half that of Ontario.

A common Provincial PAX system would reduce the number of duplicate studies. A shared reporting system would provide improved consistency of reports. This was felt to be outside of the scope of the working group.

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Appendix 1

Referral form

Add health authority logo

BC's ECHOCARDIOGRAM REQUISITION

- Outpatient Inpatient Unit/Ward _____
- Standard (TTE) TEE Intra-Op TEE Contrast
- Stress Bubble

APPOINTMENT

Ordered Date: _____ Time: _____
 month/day/year

Booked Date: _____ Time: _____
 month/day/year

Completed Date: _____ Time: _____
 month/day/year

Name: _____
 Address: _____
 Phone #: _____
 PHN #: _____
 DOB: _____
 In-patient unique #: _____

- Emergent (< 24 hrs) (for Out patients call physician On-call or echo department)
- Urgent/Semi-urgent (7 days)
- Scheduled/Non-urgent (30 days)
- Height _____ Weight _____
- Latex allergy No Yes
- Infections _____
 (VRE/MRSA/C-Diff)

PLEASE IDENTIFY PERTINENT CLINICAL INFORMATION AND PATIENT HISTORY [REASON FOR ORDERING ECHO]

*** REQUESTS WITHOUT CLINICAL INFORMATION WILL BE RETURNED ***

<p><input checked="" type="checkbox"/> Check all that apply</p> <p>Murmur</p> <p><input type="checkbox"/> systolic</p> <p><input type="checkbox"/> diastolic</p> <p>Aortic</p> <p><input type="checkbox"/> stenosis</p> <p><input type="checkbox"/> regurgitation</p> <p><input type="checkbox"/> bicuspid</p> <p>Mitral</p> <p><input type="checkbox"/> stenosis</p> <p><input type="checkbox"/> regurgitation</p> <p><input type="checkbox"/> prolapse</p> <p><input type="checkbox"/> repair</p> <p>Pulmonary</p> <p><input type="checkbox"/> stenosis</p> <p><input type="checkbox"/> regurgitation</p>	<p><input checked="" type="checkbox"/> Check all that apply</p> <p>Tricuspid</p> <p><input type="checkbox"/> stenosis</p> <p><input type="checkbox"/> regurgitation</p> <p>Cardiomyopathy</p> <p><input type="checkbox"/> dilated</p> <p><input type="checkbox"/> hypertrophic</p> <p><input type="checkbox"/> restrictive</p> <p>Pulmonary Hypertension</p> <p>Systemic Hypertension</p> <p>Left Ventricular Hypertrophy</p> <p>Right Ventricular function</p> <p>Heart Failure</p> <p>Left Ventricular Function</p> <p>Previous EF _____% (if known)</p> <p>Date: _____</p>	<p><input checked="" type="checkbox"/> Check all that apply</p> <p>Diastolic function</p> <p>Myocardial Infarction Date: _____</p> <p><input type="checkbox"/> anterior <input type="checkbox"/> inferior <input type="checkbox"/> unknown</p> <p>Coronary Artery Bypass Graft</p> <p>Dysrhythmia</p> <p><input type="checkbox"/> Atrial Fibrillation <input type="checkbox"/> Other</p> <p>Source of embolus <input type="checkbox"/></p> <p>Other Indications:</p> <p><input type="checkbox"/> trauma <input type="checkbox"/> chemotherapy</p> <p><input type="checkbox"/> pregnant <input type="checkbox"/> CAD</p> <p><input type="checkbox"/> pericardial disease</p> <p><input type="checkbox"/> infective endocarditis</p> <p><input type="checkbox"/> aortic aneurysm</p> <p>Symptoms</p> <p><input type="checkbox"/> Shortness of breath <input type="checkbox"/> chest pain</p> <p><input type="checkbox"/> fatigue <input type="checkbox"/> palpitations</p> <p><input type="checkbox"/> other _____</p>
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Prosthesis	Type/Manufacturer	Size	Date Implanted
Aortic			
Mitral			
Tricuspid			

Congenital Defect: (attach operative report)

Other History:

Attending Physician _____ Signature _____

MSC # _____ Phone # _____ Page # _____

Copies to: Preliminary Report with Patient

Final BC's echo requisition; September 18, 2013

Benchmarks (will be added to the back of the referral form)

Benchmark Wait times for Accessing Echocardiography

Urgency Category	Recommended wait time	Defined by: Examples
Emergent	<24 hrs	Hemodynamically unstable patients with suspected certain cardiovascular conditions (eg. pericardial effusion with tamponade, mechanical complications, post myocardial infarction)
Urgent/semi urgent	Within 7 days	Critically ill patients who do not meet the definition of emergent and patients with a condition that could deteriorate rapidly (eg, symptomatic aortic stenosis)
Scheduled/Non urgent	Within 30 days	All patients who do not fall into the previous categories (eg, assessment of murmurs in asymptomatic individuals, assessment of left ventricle mass)

Adapted from: 2008, CCS Wait time benchmarks: Treating the Right Patient at the Right Time: Access to Echocardiography in Canada

**British Columbian's (BC) Key Elements for Reporting Demographics and Results
On an Echocardiography Final Report**

Reporting Demographics

1. Area on right side of report for patient information
 - a. Patients first, middle & last name
 - b. Unique identifier (hospital # or PHN#)
 - c. Date of birth
2. Identification as:
 - a. In-patient
 - b. Out-patient
3. Height
4. Weight
5. Referring physician identifier
6. Interpreting physician identifier
7. Collect but do not put in the final report
 - a. Date study ordered
 - b. Date study performed
 - c. Date study interpreted
8. Report transcribed
9. Report verified
10. Location study performed (what site)
11. Initials of sonographer performing scan
12. Descriptor of study quality (eg. good, fair, poor)

Clinical findings

1. **When applicable** all structures should be characterized by size (volume), function and measurement
 - Left atrium, Left ventricle
 - If visually abnormal, quantitative EF should be performed and reported when image quality sufficient.
 - Right atrium, Right ventricle
 - Aortic valve, Mitral valve, Tricuspid valve, Pulmonic valve
 - Pericardium, Aorta
 - Pulmonary artery
 - Inferior vena cava
 - Pulmonary veins
 - Interatrial septum
 - Interventricular septum

- Pericardial effusion (mention only if there is one)
- Diastolic function should be reported in all cases of suspected heart failure in patients with sinus rhythm. In Atrial fibrillation filling pressures reported as elevated when mitral DT < 150 msec or E/e' ≥ 13-15
- For Paced rhythm, diastolic function and filling pressures should be reported as indeterminate.

2. Conclusion/Summary statement :

- Their relevance to the diagnosis
- Quantitative values where applicable
- Should identify the salient findings, any abnormalities that are correlated to the reason the study was requested.
- Descriptor for the values and comparison with previous echo values

Final reports: (Adopted from CCS and ASE)

1. Emergent/Stat final echo report ideally should be available to review within 24 hours.
2. Non-urgent/routine the final echo report ideally should be available to review within 48hrs.
3. Final reports ideally should be processed and forwarded to the most responsible physician within 7 days from the time the test was interpreted.
4. Each hospital should have a policy for reporting critical values and a method to communicate these findings to the referring physician.

**Principles to Ensure Best Practice For
Heart Failure Echocardiography Services in British Columbia (BC)**

1. Sonographers

Recommendation: Prefer sonographers to have extra training in cardiac ultrasound prior to being hired into the department.

2. All hospital Echocardiography referral forms must contain the provincially identified key elements for an Echocardiography referral form OR a hospital may adopt the Standardized Provincial Echocardiography referral form.

3. Adopt the American Society Echocardiography (ASE) definitions for:

- Right Atrium
- Right Ventricle Wall Thickness
- Right Ventricular Outflow Tract
- Right Ventricle Dimensions
- Right Ventricle Systolic Function
- Right Atrial Pressure
- Peak Systolic Pulmonary Pressure
- Left Atrial Volume
- Left Ventricle Dimensions and Mass
- Left Ventricle Ejection Fraction

4. Prior to procedure patients:

- Height and weight must be documented
- BSA should be calculated
- Heart rate, heart rhythm and blood pressure should be documented
- Blood pressure measurement may be particularly useful in patients with mitral regurgitation or heart failure

5. Both systolic and diastolic *function* should be measured, documented and *reported* especially when the indication includes heart failure, shortness of breath, hypertension, left ventricular function.

6. A comprehensive 2 dimension and M mode, doppler study should be performed in order to determine the mechanism of congestive symptoms. This should include an assessment of the left and right heart function, size, volume, left sided filling pressure (diastolic function),

right atrial pressure, pulmonary artery pressure, valves and pericardium. Details on recommendations for measuring and reference values are outlined in Appendix 1a.

7. Minimum data elements that should be measure

- Quantification of all measurements
- Left Ventricular (LV) dimensions
 - Septal and posterior wall thickness
 - Indexed LVIDd
 - Indexed LV End Diastolic Volume (LVEDV)
 - LV Mass
 - Qualitative Function
 - LV cavity at end diastole and end systole
- Quantitative Ejection Fraction should be performed when possible provided image quality is adequate. If visual estimate of the LVEF is abnormal then quantitative EF is mandatory, when image quality is adequate. It is also recommended that LVEF quantification using the Modified Simpson' or 3D method be employed. The visual EF and quantitative EF should correspond.

Reference Values for LV EF

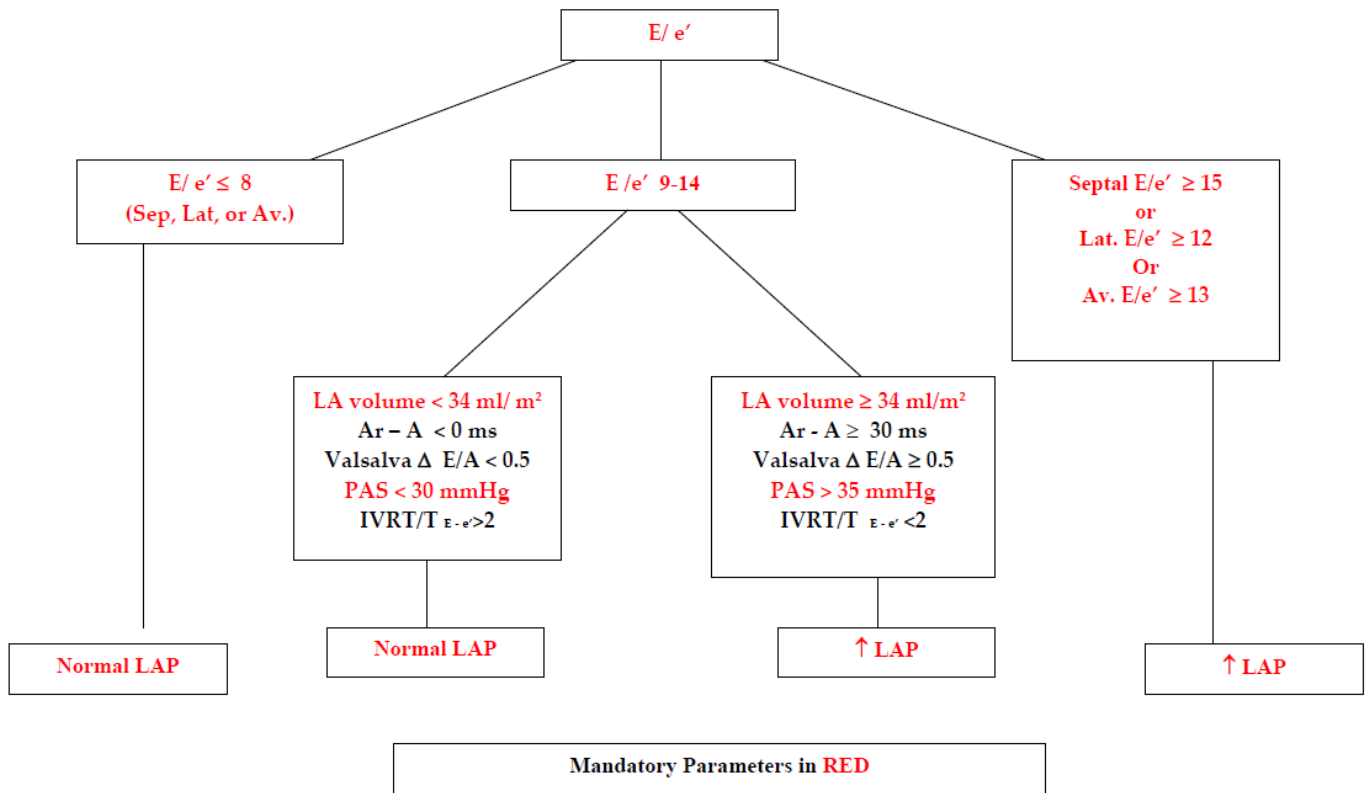
Ejection Fraction (%) per gender	Normal	Mild Dysfunction	Moderate Dysfunction	Severe Dysfunction
Male	52-72 %	41-51 %	30-40 %	< 30 %
Female	54-74 %	41-53 %	30-40 %	< 30 %

*** Contrast opacification should be considered in cases of poor image quality or where there are concerns regarding the possible presence left ventricular thrombus**

- Left Atrium (LA) dimensions
 - Basal Minor Axis Dimension
 - Volumes
 - Qualitative Function
- Right Ventricle (RV) dimensions
 - Volume

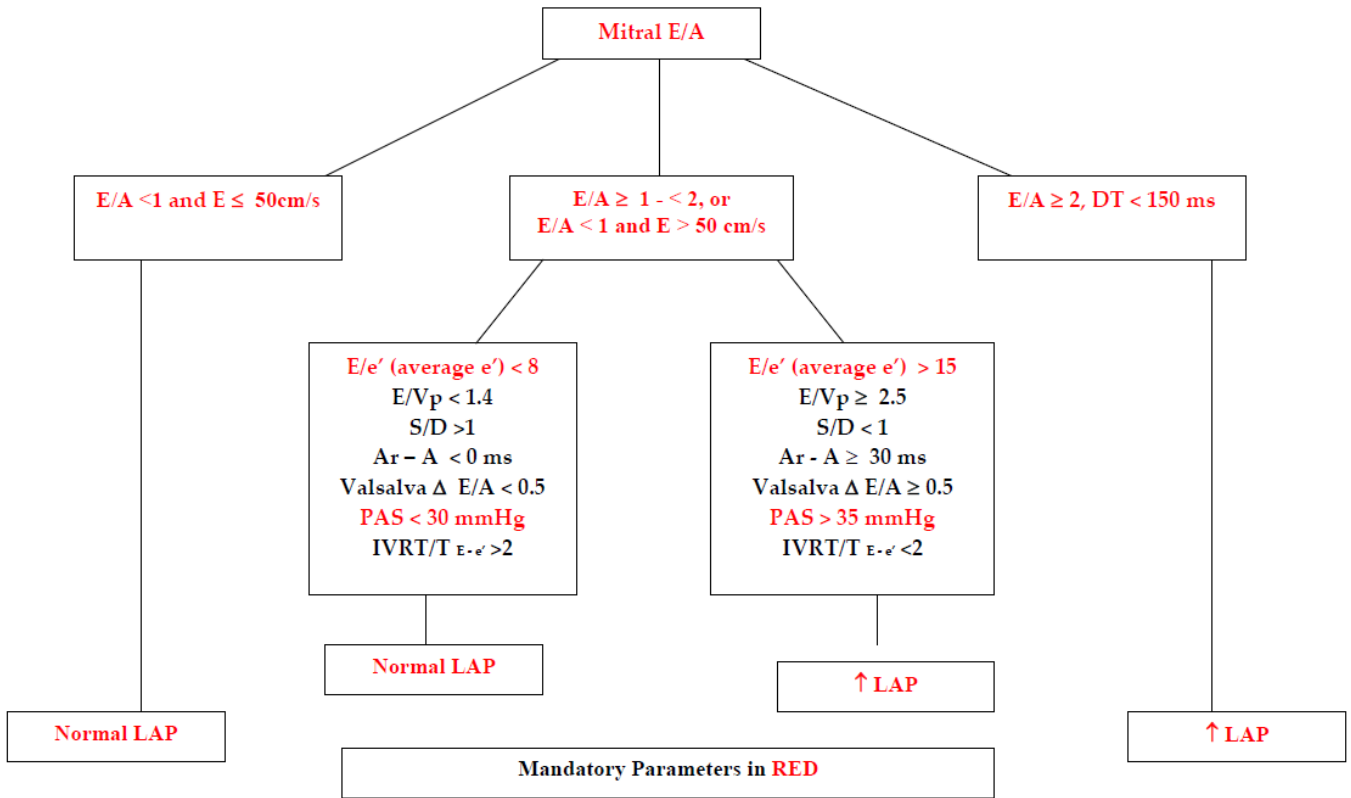
- Wall thickness
- Systolic function
- Outflow tract
- Tricuspid annular plane systolic excursion
- Right Atrium
 - Minor Axis Dimension Area
 - Pressures
- Hemodynamics
 - Right Atrial Pressure
 - Systolic Pulmonary Pressure
- Diastolic Parameters
 - Mitral E/A
 - Mitral decel Time
 - Septal e'
 - Lateral e'
 - E/e' Septal, E/e' lateral, E/e' average
 - Valsalva and response
 - LA volume
 - PA systolic pressure
 - Optional
 - i. Ar-A
 - ii. E/VP
 - iii. IVRT
 - iv. Pulmonary vein

Diastolic Dysfunction: Estimation of Left Ventricular Filling Pressures in Patients with Normal EF



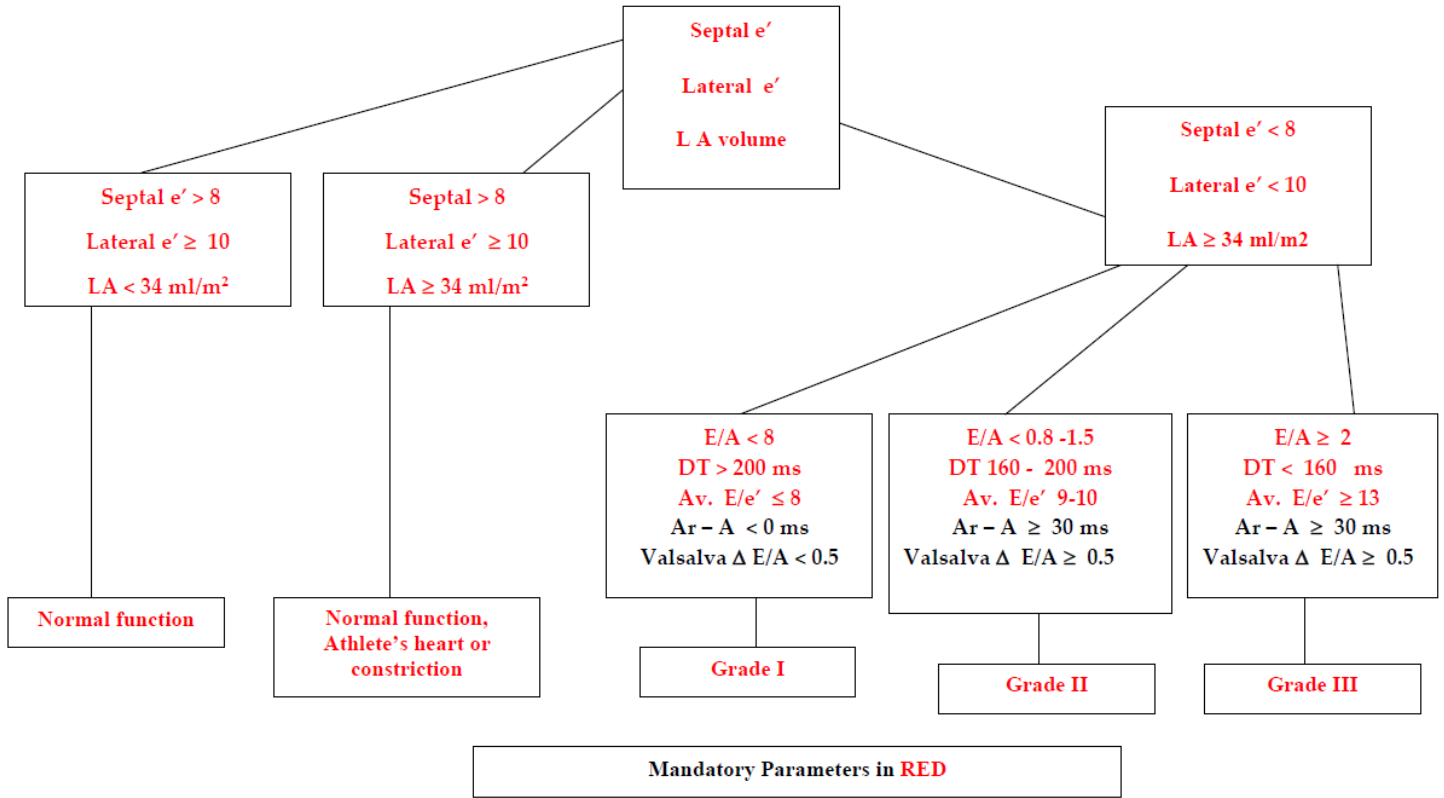
- Diastolic function will be reported as indeterminate when paced.
- In Atrial fibrillation diastolic function reported as indeterminate when Average E/e > 13, increased left atrial pressure is present
- Diastolic function should be reported as indeterminate in the presence of severe mitral annular calcification (MAC) prosthetic mitral valve

Diastolic Dysfunction: Estimation of Left Ventricular Filling Pressures in Patients with Depressed EF



- Diastolic function will be reported as indeterminate when paced.
- In Atrial fibrillation diastolic function reported as indeterminate when Average E/e > 13, increased left atrial pressure is present
- Diastolic function should be reported as indeterminate in the presence of severe mitral annular calcification (MAC) prosthetic mitral valve

Practical Approach to Grade Diastolic Dysfunction



- Diastolic function will be reported as indeterminate when paced.
- In Atrial fibrillation diastolic function reported as indeterminate when Average E/e >13, increased left atrial pressure is present
- Diastolic function should be reported as indeterminate in the presence of severe mitral annular calcification (MAC) prosthetic mitral valve

8. Minimum data elements should be indicated in the final report.

- Must include patient demographics, echocardiographic findings and summary. See Appendix 2 for narrative that should go in the summary
- Each of the below structures should be characterized by size (volume), function and measurement
 - Left ventricle
 - Left atrium
 - Right atrium
 - Right ventricle
 - Aortic valve
 - Mitral valve
 - Tricuspid valve
 - Pulmonic valve
 - Pericardium
 - Aorta
 - Pulmonary artery
 - Inferior vena cava
 - Pulmonary veins
 - Interatrial septum
 - Interventricular septum

9. Diastolic function should be reported in all cases of suspected heart failure in patients with sinus rhythm. In Atrial fibrillation filling pressures reported as elevated when mitral DT 150 msec or E/e' \geq 13-15. Diastolic function should be reported as indeterminate in the presence of severe mitral annular calcification (MAC) prosthetic mitral valve

10. Emergent/Stat final echo report ideally should be available to review within 24 hours.

11. Non-urgent/routine final echo report ideally should be available to review within 48 hours.

12. Final report should be processed and forwarded to the most responsible physician within 7 days from the time the test was interpreted.

13. Each hospital should have a policy for reporting critical values and a method to communicate these findings to the referring physician.

14. All health authorities must strive to meet the Canadian Cardiovascular Society Echocardiography accessibility recommendation guideline for:

- Emergent:
 - i. Defined by: a patient being: hemodynamically unstable with suspected certain cardiovascular conditions (eg, pericardial effusion with tamponade, mechanical complications, post-myocardial infarction)
 - ii. The maximum medically accepted wait time for emergent echocardiograms is < 24hrs
- Urgent/Semi-Urgent:
 - i. Defined by: critically ill patients who do not meet the definition of emergent and patients with a condition that could deteriorate rapidly (eg, symptomatic aortic stenosis)
 - ii. The maximum medically accepted wait time for urgent/ semi urgent echocardiogram is 7 days
- Scheduled/non-Urgent:
 - i. Defined by: all patients who do not fall into the previous categories (eg, assessment of murmurs in asymptomatic individuals, assessment of left ventricle mass)
 - ii. The maximum medically accepted wait time for scheduled/non urgent echocardiogram is 30 days.

Position Statement

The Heart Failure Diagnostic Imaging Working Group believes the American Society of Echocardiography (ASE) guidelines are too complex for routine clinical practice in British Columbia [in particular the diastology protocols]. Therefore, they were adapted by Jonathan Tang and Ellamae Stadnick and the *Principles to Ensure Best Practice for Heart Failure Echocardiography Services in British Columbia* document will set the standard for Echocardiology Service in British Columbia (BC).

The Heart Failure Diagnostic Imaging Group supports hospitals that are unable to meet standards because of human resource and/or equipment issues. The Imaging Group will consider setting up traveling clinics to remote locations in the province to facilitate optimum echocardiography service.

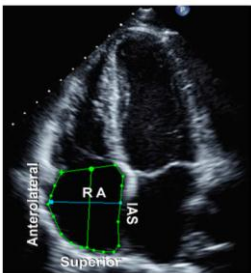
Echocardiographic Assessment of Heart Failure

Recommendations for measuring and reference values for the following:

- Right Atrium
- Right Ventricle Wall Thickness
- Right Ventricular Outflow Tract
- Right Ventricle Dimensions
- Right Ventricle Systolic Function
- Right Atrial Pressure
- Peak Systolic Pulmonary Pressure
- Left Atrial Volume
- Left Ventricle Dimensions and Mass
- Left Ventricle Ejection Fraction

Right Atrium

- How To:*
- Obtain apical-4 chamber, optimizing view of the right atrium (RA)
 - Freeze image at the end of ventricular systole when the atrial dimensions are largest, prior to tricuspid valve opening
 - Minor axis is measured from the mid- RA free wall to the interatrial septum
 - Major axis is measured from the TV annulus to the superior RA wall
 - Area is measured by tracing the RA being sure not to include the IVC



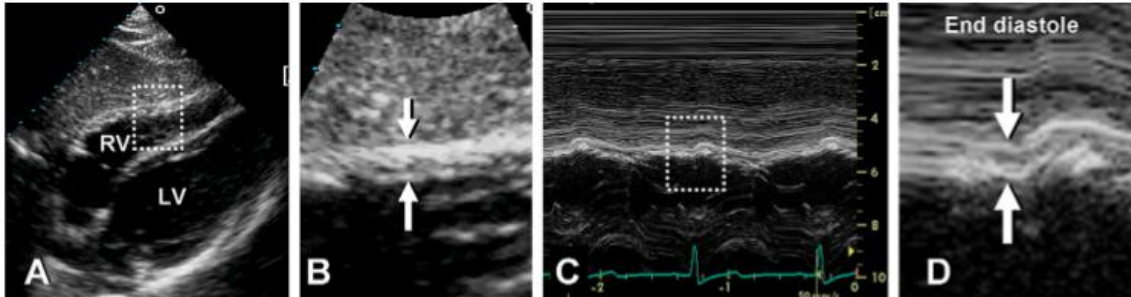
Normal Values: Minor Axis ≤ 44 mm
Major Axis ≤ 53 mm
Area ≤ 18 cm²

Pitfalls: - Normal values indexed for body surface area are not available

Right Ventricle

Right Ventricle Wall Thickness

- How To:*
- Obtain a subcostal view of the right ventricle (RV)
 - Place M-mode cursor through the RV
 - Measure RV wall thickness at end-diastole (onset of QRS) when it is the thinnest

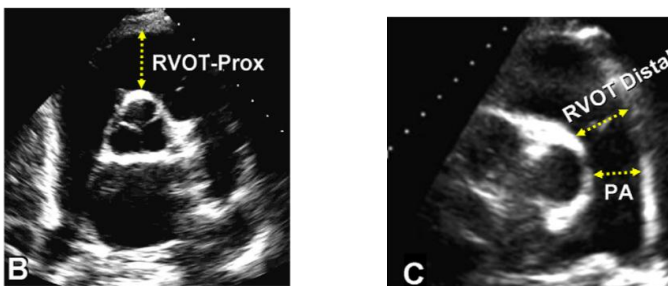


Normal Value: ≤ 5 mm

- Tips:*
- Zoom on image to decrease measurement error
 - Careful to avoid measuring epicardial fat

Right Ventricular Outflow Tract (RVOT)

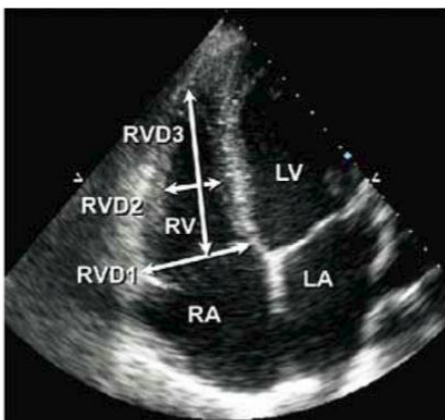
- How To:*
- Obtain a parasternal short axis view
 - Measurements are made at end diastole
 - The proximal RVOT is measured from the inner edge of the anterior RV wall to the inner edge of the aortic valve
 - The distal RVOT is measured at the level of the pulmonary valve



Normal Values: Proximal RVOT 35 mm
Distal RVOT 27 mm

Right Ventricle 2D

- How To:*
- Obtain an apical-4 chamber view focused on the RV
 - The true LV apex should be included along with the tricuspid and mitral valves
 - The left ventricular outflow tract (LVOT) should not be visible
 - Adjust transducer to obtain the largest RV dimension
 - Measurements are obtained at end-diastole
 - Measure the base of the RV from the inner edge of the interventricular septum to the inner edge of the lateral wall of the RV
 1. Qualitatively the RV should not appear larger than the LV and it should not share the apex; either of these indicate either RV enlargement or an under filled LV



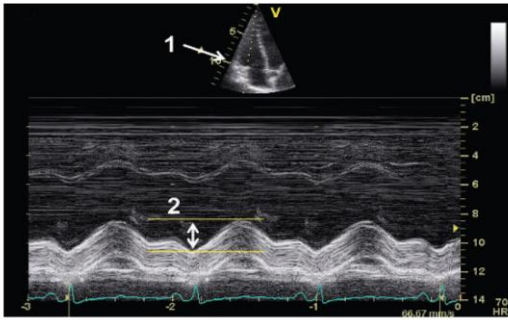
Normal Value: Basal Width ≤ 42 mm

- Pitfalls:*
- Normal values indexed for body surface area are not available
 - Large sources of error are possible if 4-chamber view is not optimized to assess the RV

Right Ventricle Systolic Function

A. Tricuspid Annular Plane Systolic Excursion (TAPSE)

- How To:*
- Obtain an apical-4 chamber view optimized to assess the RV
 - Place M-Mode cursor through the lateral tricuspid annulus
 - Measure the maximal longitudinal distance from end-diastole to peak systole

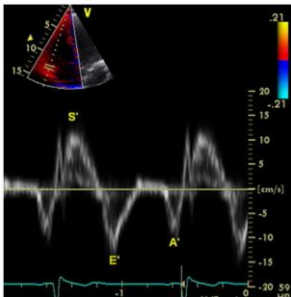


Normal Value: ≥ 16 mm

- Pitfalls:*
- TAPSE assesses longitudinal shortening and will not identify systolic dysfunction not involving the RV base

B. Pulse-Wave Tricuspid Valve Annulus Velocity

- How To:*
- Obtain an apical-4 chamber view optimized to assess the RV
 - Place PW Doppler on the basal RV free wall
 - The systolic wave is referred to as S'

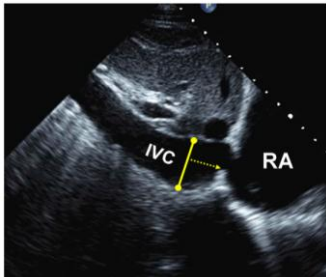


Normal Value: ≥ 10 cm/sec

- Pitfalls:*
- This measurement is not validated in the elderly

Right Atrial Pressure

- How To:*
- Obtain a sub-costal view of the inferior vena cava (IVC)
 - Measure diameter at end expiration
 - Measurements are made 0.5-3 cm proximal to the RA ostium and proximal to the junction of the hepatic veins
 - Measure collapse with patient 'sniffing' or upon deep inspiration



Normal Values:

- IVC ≤ 2.1 cm with inspiratory collapse $> 50\%$: 3 mmHg
- IVC > 2.1 cm with inspiratory collapse $< 50\%$: 15 mmHg

Tips:

- If neither category above applies estimate RAP at 8 mmHg and look for secondary indices of elevated RAP such as diastolic dominant hepatic vein flow, tricuspid E/E' > 6 or a restrictive right sided inflow pattern
- RAP measurements are not validated in ventilated patients
- IVC may be dilated in athletes (normal variant)

Pulmonary Artery Pressure

- How To:*
- In the absence of RVOT or pulmonary stenosis:
$$RVSP = 4v^2 + RAP$$

(v = peak tricuspid regurgitation velocity)
 - Obtain the peak tricuspid regurgitation velocity by aligning Doppler signal parallel to the regurgitant jet in multiple views
 - May not be accurate with severe tricuspid regurgitation
 - Contrast (saline) may be used to enhance TR jet envelopes

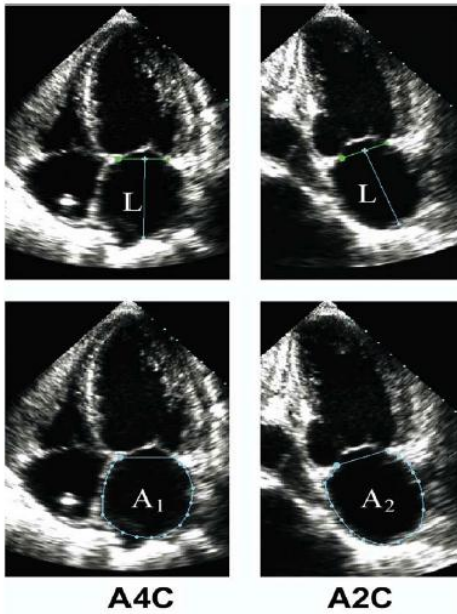
Normal Value: < 35 mmHg (assuming normal RAP)

Left Atrial Volume

- How To:*
- Area Length Method
 - Obtain apical-2 and apical-4 chamber views
 - Measure area in both views (avoid appendage and pulmonary veins)
 - Measure length in both views from back wall to level of mitral annulus

$$\text{Left Atrial Volume} = \frac{8}{3} \Pi [(A_1)(A_2)/(L)]$$

(L) is the shortest of either the A4C or A2C lengths



Normal Value: $22 \pm 6 \text{ ml/m}^2$

Left Ventricle

LV 2D Dimensions and Mass:

- How To:*
- Linear Method
 - Obtain parasternal long axis view
 - Measure the interventricular septum (SWT), posterior wall (PWT) and left ventricular internal dimension (LVID) at end diastole at the midcavitary region at the level of the chordae above the papillary muscles (level of mitral valve leaflet tips)
 - Left ventricular systolic dimension should be measured at the same
 - Either M-mode or 2D measurements have been validated (M-Mode measurements should be made perpendicular to the long axis)

$$\text{LV mass} = 0.8 \times \{ 1.04 [(\text{LVIDd} + \text{PWTd} + \text{SWTd})^3 - (\text{LVIDd})^3] \} + 0.6 \text{ g}$$

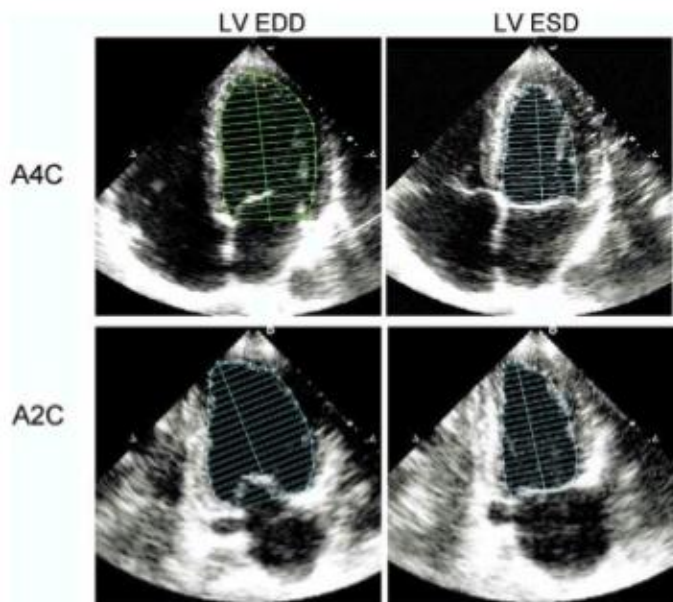
<i>Normal Values:</i>	<u>Women</u>	<u>Men</u>
Mass	< 95 g/m ²	< 115 g/m ²
LVIDd	39 – 53 mm	42-59 mm
LVIDdi	24 – 32 mm/m ²	22-31 mm/m ²

- Pitfalls:*
- The mass calculation assumes a prolate ellipse geometry for the left ventricle, and will not be accurate as the LV dilates and assumes a spherical structure
 - The mass calculation will not be accurate if there is asymmetric septal hypertrophy
 - Small discrepancies in measurements will result in large errors as the values are cubed in the calculation

LV Ejection Fraction:

- How To:*
- Quantitative assessment should correspond with qualitative visual estimate
 - Quantitative 2D Method (Modified Simpson's Rule)
 - End systolic (ESV) and diastolic (EDV) volumes are measured in both the apical 4 and 2 chamber views
 - Requires adequate visualization of the endocardium
 - Basal border should be drawn as a straight line between the lateral and septal leaflet insertion points in the mitral annulus
 - Papillary muscles should be included in the volume

$$\text{Ejection Fraction} = (\text{EDV} - \text{ESV}) / \text{EDV}$$



Reference Values of Ejection Fraction:

Normal:	≥ 55 %
Mild Dysfunction:	45 – 54 %
Moderately Dysfunction:	30 – 44 %
Severe Dysfunction:	< 30%

Appendix 4

ECHO Capacity for Provincial Heart Failure Strategy - Diagnostic Imaging Working Group			
HA	Question	Answer	comments
Hospital / Facility Name			
ECHO	List all the referral hospitals to the above ECHO site [in the comments section]		
	Number of machines?		
	Make and model of machine 1		
	Year purchased of machine 1		
	Make and model of machine 2 (if applicable)		
	Year purchased of machine 2 (if applicable)		
	Make and model of machine 3 (if applicable)		
	Year purchased of machine 3 (if applicable)		
	Make and model of machine 4 (if applicable)		
	Year purchased of machine 4 (if applicable)		
	Make and model of machine 5 (if applicable)		
	Year purchased of machine 5 (if applicable)		
	Make and model of machine 6 (if applicable)		
	Year purchased of machine 6 (if applicable)		
	Make and model of machine 7 (if applicable)		
	Year purchased of machine 7 (if applicable)		
	Make and model of machine 8 (if applicable)		
	Year purchased of machine 8 (if applicable)		
	Do you feel you have sufficient machines to meet the benchmark for echo booking		
	If NO how many more do you feel you require?		
	Would a mobile echo unit (machine and tech) be helpful to your health authority		
	Which of your communities would benefit from this service (please specify)		
	Total number of sonographers?		
	Total number of FTEs for sonographers?		
	Total number of sonographers designated specifically for echo?		
	Total number of sonographer FTEs designated specifically for echo?		
	Average number of sonographers scheduled each day?		
	Average available lab hours per day?		
	Do you prebook scans on weekends?		
	Do you prebook scans M-F after 1700?		
	Total number of all scans per day (M-F and after 1700)		
	Average number of scans per week		
	Average number of scans per month		
	Total number of scans done last year (2011)?		
	Is lab digital or videotape?		
	Reading (interpreting system used)		
	Is qualitative EF <i>done</i> on your echo patients?		
	If yes, indicate approximately how often EF is done? (%)		
	Is qualitative EF <i>reported</i> on your echo patients?		
	If yes, indicate approximately how often EF is reported (%)		
	Does Lab have ability to assess diastolic function?		
	Is diastolic function <i>done</i> on your echo patients?		
	If yes, indicate approximately how often this is done (%)		
	Is diastolic function <i>reported</i> on your echo patients?		
	If yes, indicate approximately how often this is reported (%)		
Is the site a catchment center for a Heart Function Clinic (HFC) centre?			
Approximate number of cases referred for LV function in 2011 (if unknown, enter -1)			
Approximate number of cases referred for HF in 2011 (if unknown, enter -1)			
Approximate number of cases referred for dyspnea (SOB) in 2011 (if unknown, enter -1)			
How many echo interpreters do you have available for your site?			
How many of your echo interpreters are radiologists			
How many of your echo interpreters are cardiologists			
How many of your echo interpreters are internists			
Do you have sufficient echo interpreters at your site to meet your <i>reporting</i> benchmarks of: the final report for an emergent/stat echo should be available to review within 24 hours?			
Do you have sufficient echo interpreters at your site to meet your <i>reporting</i> benchmark of: the final report for a nonurgent/routine echo should be available to review within 48 hours?			
Do you have sufficient echo interpreters at your site to meet your <i>reporting</i> benchmarks of: the final report should be processed and forwarded to the most responsible physician and other delegates within 7 days from the time the test was interpreted ?			
HR	Current number of sonographer vacancies		
	Of existing vacancies how many meet the definition of difficult to fill (vacancy posted > 90 days)		
	Anticipated permanent vacancies next year (retirements, unfilled vacancies)		
	Anticipated permanent vacancies next 2 – 5 years (retirement)		
	Number # of sonographers eligible for retirement (55+) in the next 1-5 years?		
Percent (%) of sonographers eligible for retirement (55+) in the next 1-5 years?			
Access to Care	What is your major barrier to providing timely access to echocardiography tests?		
	Other barriers (please specify)		

Appendix 5

Data Elements: The following detailed data were collected:

ITEM	DATA COLLECTED
1. Health Authority	IH (Interior Health) NH (Northern Health) VIHA (Vancouver Island Health Authority) FH (Fraser Health) VCH (Vancouver Coastal Health) PHC (Providence Health) BCCH (BC Children's Hospital)
2. Site / Facility	Name of facility
3. Designation	Inpatient, Outpatient
4. Ordering Physician Specialty	Cardiologist, Cardiac Surgeon, Internist, Neurologist, GP, Other (specify)
5. Physician Name	Name of ordering physician
6. Priority level of echocardiogram (see definitions)	Emergent Urgent/ Semi-urgent Scheduled/non-urgent Pre-booked Unknown/not specified
7. Date echocardiogram was ordered	Date (dd/mm/yyyy)
8. Date requisition form was entered	Date (dd/mm/yyyy)
9. Date echocardiogram was conducted	Date (dd/mm/yyyy)

Appendix 6

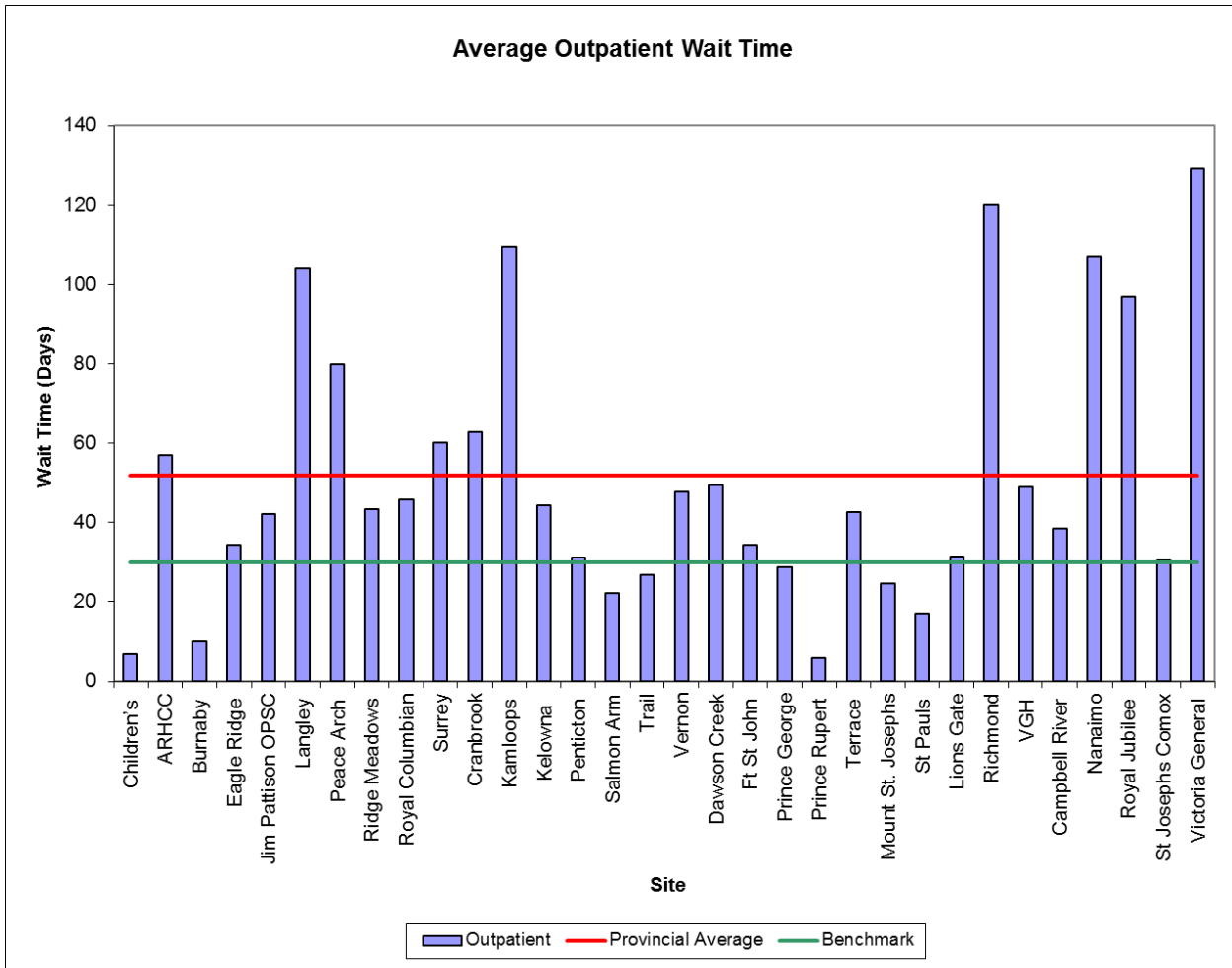
Health Authority	Facility	Total echocardiograms done in the data collection period	Out pt wait times (days)	No. Machines	Sono FTE	Sono FTE dedicated to Echo	Average lab hours/day	Prebook scans on weekend	Prebook scans M-F after 1700	Current sono vacancies	Anticipated vacancies	% sono eligible for retirement in 1-5 years
Fraser Health	Abbotsford	137	56.9	4	8.8		10	Yes	No	4	2	0.0%
	Burnaby	96	10.0	2	8	2	9.5	Yes	No	0	na	15.0%
	Eagle Ridge	29	34.3	1	1	1	7.2	Yes	No	1	1	0.0%
	JP in surrey	137	42.1	3	5.825	5.825	10	Yes	No	0	1	10.0%
	Langley	50	104.0	1	5.4	1.4	9	Yes	Yes	0	2	0.0%
	Peace Arch	51	79.8	1	1.78	1.78	10	No	No	0	1.78	100.0%
	Royal Columbian	265	45.8	5	6.6	6.6	9	Yes	Yes	2	2	25.0%
	Ridge Meadows	55	43.3	1	1.2	1.2	8	Yes	wed	0	0	0.0%
	Surrey Memorial	115	60.2	6	12	5.8	9	No	No	4.75	6.75	14.0%
Northern Health	University Hospital of Northern BC	68	28.8	1	1.6	0	9	no	no	0	0	0
	GR Baker Memorial (Quesnel)	17	No designation identified	3	3.7	0	26.6	no	no	0	1	25.0%
	Dawson Creek & District	8	49.5	3	2.2	0	8.5	no	no	2	2	25.0%
	Smithers	1	341	1	1.6	.8	9.1	yes	yes	0	0	100.0%
	Fort St. John Hospital & Health Centre	37	34.4	3	2	1	14.4	no	no	1	1	0.0%
	Prince Rupert Regional	7	5.8	2	1.2	0	7	no	no	0	0.6	100.0%
	Mills Memorial (Terrace)	49	42.7	1	0	0	0	No	Yes	0	not filled	0.0%
Interior Health	Penticton	39	31.1	2	3	3	15	No	Yes	0	0	100.0%
	Vernon Jubilee	78	47.7	2	5	0	7.5	no	No	2	3	25.0%
	Kootenay Boundary Regional (Trail)	4	26.8	2	0.8	.5	5	no	no	1	2	0.0%
	East Kootenay Regional (Cranbrook)	37	62.7	1	4.9	.8	6	no	no	1	1	40.0%
	Kelowna General	209	44.2	5	7.66	7.66	11.5	yes	no	0	1	11.0%
	Royal Inland (Kamloops)	65	109.6	2	11.5	2	8	no	no	1.2	4.4	1.3%
	Nelson	9	No designation identified	1	1.6	.8	9.1	yes	yes	0	not filled in	50.0%
Provident	St. Paul's	151	17	9	8.2	6	12	No	Yes	1	2	10.0%

ce	Mt St Josephs	42	24.7	Non info	No info	No info	No info	No info	No info	No info	No info	No info
Vancouver Coastal Health	Vancouver General	326	49	8	10.5	10.5	11.5	Yes	Yes	1	3	20.0%
	Lions Gate	85	31.4	7	10	3.5	28	yes	yes	1	5	50.0%
	Richmond	41	120.1	2	5.6	1.5	9.25	yes	yes	1	3	30.0%
Vancouver Island Health	Nanaimo Regional General	76	107.2	3	9	2.6	10	yes	no	1.5	5.5	33%
	Victoria General	64	129.4	8	10.5	10.5	11.5	Yes	Yes	1	3	20.0%
	Royal Jubilee	171	97	9	10.5	10.5	10	yes	yes	2	3	15%
	Victoria General peds	22	-	1	1	not filled in	8	no	no	0	0	0%
	St. Joseph's General	43	30.5	2	not filled in	not filled in	8	not filled in	not filled in	0	2	33%
	Campbell River & District	51	38.4	2	6	2	8	no	not filled in	0	1	17%

Appendix 7 Table:

All Cases					
		Inpatient		Outpatient	
Health Authority	Site	No. Cases	Wait Time	No. Cases	Wait Time
PHSA	Children's	53	0.0	53	6.8
PHSA Total		53	0.0	53	6.8
Fraser Health	ARHCC	51	1.5	86	56.9
	Burnaby	23	1.4	73	10.0
	Eagle Ridge	15	5.1	14	34.3
	Jim Pattison OPSC	-	-	137	42.1
	Langley	14	14.8	36	104.0
	Peace Arch	10	27.8	41	79.8
	Ridge Meadows	10	1.0	45	43.3
	Royal Columbian	99	1.9	166	45.8
Surrey	66	1.9	49	60.2	
FHA Total		288	3.5	647	48.5
Interior Health	Cranbrook	6	0.8	31	62.7
	Kamloops	29	2.3	36	109.6
	Kelowna	41	1.0	168	44.2
	Nelson	9 total for all cases	Unable to analyze as site did not specify designation	-	Unable to analyze as site did not specify designation
	Penticton	16	1.4	23	31.1
	Salmon Arm	4	1.0	20	22.2
	Trail	-	-	4	26.8
	Vernon	19	1.9	59	47.7
IHA Total		115	1.5	341	51.0
Northern Health	Dawson Creek	2	0.0	6	49.5
	Ft St John	8	2.9	29	34.4
	Prince George	11	4.0	56	28.8
	Prince Rupert	1	1.0	6	5.8
	Smithers	-	-	1	341.0
	Terrace	7	40.3	42	42.7
	Quesnel	17 total for all cases	Unable to analyze as site did not specify designation	-	Unable to analyze as site did not specify designation
NHA Total		29	12.1	140	36.3
Providence Health	Mount St. Josephs	15	4.9	27	24.7
	St Pauls	57	1.5	94	17.0
PHC Total		72	2.2	121	18.7
Vancouver Coastal Health	Lions Gate	36	0.8	49	31.4
	Richmond	19	1.6	22	120.1
	VGH	69	2.0	257	49.0
VCHA Total		124	1.6	328	51.2
Vancouver Island Health	Campbell River	9	2.8	42	38.4
	Nanaimo	8	1.1	68	107.2
	Royal Jubilee	61	1.1	110	97.0
	St Josephs Comox	12	0.0	31	30.5
	Victoria General	16	0.0	48	129.4
VIHA Total		106	1.0	299	89.4
Provincial Total		787	2.5	1929	51.8

Graph:



Graph was calculated to the 90th percentile so Smithers 341 days wait time for the 1 echo was removed