ECHOCARDIOGRAPHY SERVICE
OBJECTIVES FOR ECHOCARDIOGRAPHY
IN THE McGILL CARDIOLOGY TRAINING PROGRAM

As stipulated by Royal College training requirements, residents undergo a minimum of 6 months of training in echocardiography in any of the three McGill teaching sites in echocardiography (Jewish General, MUHC-Royal Victoria or MUHC-Montreal General). Trainees have the opportunity to undergo additional elective rotations. The McGill echo laboratories are high-volume centers with state-of-the-art equipment devoted to teaching residents the knowledge and practice of (1) image acquisition, (2) image interpretation, and (3) study reporting. A large emphasis is put on image acquisition of thenormal and abnormal study of the resting trans-thoracic echocardiography.

Trainees are exposed to trans-esophageal and stress echocardiography. Our senior sonographers are devoted and experienced teachers of echocardiography with a rigorous approach to enabling residents to acquire a complete, comprehensive study, as well as understand and apply the physical principles underlying image optimization. Studies performed are usually firstly reviewed by the sonographer for teaching on acquisition and then reviewed by the Attending Physician for teaching on interpretation. An individual log of studies is kept for studies performed, interpreted and performed/interpreted by the resident.

Residents are expected to have read the Echo Manual - or other similar textbook in echocardiography - by the end of their first 3-month block of their training and have read several of the seminal papers in the field by the end of their 6-month training. Trainees are also expected to give a scholarly presentation during their 4-week rotation - the topic is decided by the Teaching Director. The overall expectation is for trainees to achievelevel II training requirements by the end of their Cardiology training.

Medical Expert

- Possesses the knowledge relevant to the physical principles and instrumentation of cardiac ultrasound
- Understands the indications, appropriateness criteria, strengths and limitations of trans-thoracic and trans-esophageal echocardiography for the normal patient and for patients with or suspected of various common cardiovascular illnesses
- Knows the normal cardiovascular anatomy – including cardiac chambers, valves and major blood vessels – as demonstrated on a complete echocardiographic study
- Understands normal and abnormal cardiac physiology, as demonstrated on a comprehensive echocardiographic study
- Interprets a complete trans-thoracic echocardiographic study including M-mode, two-dimensional, pulsed-Doppler and color-flow Doppler modalities for patients with various common cardiovascular disorders
- Uses pertinent information to synthesize various characteristic echocardiographic features into a unifying cardiovascular disorder
- Accurately correlates echocardiographic features with findings from other cardiovascular imaging modalities and/or surgical specimens

Technical Skills

- Accurately performs a tow-dimensional study from four standard transducer positions
- Applies the principles of standardization to the acquisition of echocardiographic views
- Applies the principles of Doppler in the echocardiographic hemodynamic assessment with an understanding of the advantages, limitations and applications of the various Doppler modalities (pulsed-wave Doppler, continuous-wave Doppler, color flow and tissue Doppler
- Applies the knowledge of Doppler echocardiography to specific clinical uses such as flow measurements (regurgitant volumes/fraction, intracardiac shunts), pressure gradients and valve areas (Bernoulli, continuity)
- Adapts to the indication and/or abnormalities found on a trans-thoracic study by adding 2-D and or Doppler-derived acquisitions for ensuring that all pertinent information is obtained

Communicator

- Establishes a therapeutic relationship during the examination with respect and appropriate attention to comfort
- Establishes effective relationships with peers and other health professionals. Provides and receives information
- Prepares verbal and written reports to the Attending staff and referring physician that is concise, accurate and timely

Collaborator

- Interacts effectively with attending staff cardiologist, sonographers and other health professionals by recognizing and acknowledging their roles and expertise

MCGILL UNIVERSITY ECHOCARDIOGRAPHY TRAINING GUIDE1
CCS Level 1 & Level 2 Competency

CCS Competency Level	Training Month	Training Week	Complete TTE performed		Complete TTE interpreted		Complete TEE Performed2		Complete Stress Echo performed2	
			Per week	Cumulative	Per week	Cumulative	Per week	Cumulative	Per week	Cumulative
1	1	1	*							
		2	*							
		3	*							
		4	*							
	2	5	6	6	12	12				
		6	6	12	12	24				
		7	6	18	12	36				
		8	6	24	12	48				
	3	9	6	30	12	60	2	2		
		10	6	36	12	72	2	4		
		11	6	42	12	84	2	6		
		12	6	48	12	96	2	8		
	4	13	7	55	14	110	2	10	4	4
		14	7	62	14	124	2	12	4	8
		15	7	69	14	138	2	14	4	12
		16	7	**76**	14	**152**	2	16	4	16
22	5	17	9	85	18	170	4	20	8	24
		18	9	94	18	188	4	24	8	32
		19	9	103	18	206	4	28	8	40
		20	9	112	18	224	4	32	8	48

6	21	9	121	18	242	4	36	12	60
	22	9	130	18	260	4	40	12	72
	23	10	140	20	280	5	45	14	86
	24	10	**150**	20	**300**	5	**50**	14	**100**

1 **The table above suggests a case load pace within the training period to reach the minimum of examinations recommended for achieving competency level. Higher number provides more experienced training.**

2 **Competency level 2 (Basic) is with TTE only. Numbers are also given for optional Competency level 2 (with TEE) and/or Competency level 2 (with Stress echocardiograms)**
* In the introductory month, .a significant amount of time must be spent mastering the theory of cardiovascular anatomy, physiology and hemodynamics as well as the physical principles and technical aspects of the instrumentation of ultrasound imaging. Residents are expected to perform only selected parts of a complete examination, with progression towards a complete examination for month 2.

MUHC ECHOCARDIOGRAPHY TRAINING GUIDE
Specific Objectives & Evaluation Sheet - CCS Level 1 & Level 2 Competency

WEEK 1	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	Left Parasternal Views: **2D** Long axis - LV-Aorta - LVOT (zoom view) - RV inflow - RV outflow Short axis - Aortic valve - Basal LV – Mitral valve - Mid LV - Apical LV **M-mode** - Aorta – LA - Mitral valve - RV - LV	**Left Parasternal Views** Long axis - Aortic + Mitral valve - Tricuspid valve - Pulmonic valve Short axis - Aortic valve - Mitral valve - Mid septum - apical septum			**Measurements** : - LVOT - Aorta – LA - RV - IVS – LV diastolic – PW – LV systolic **Calculations** - LVEF (uncorrected & corrected) - LV mass (ASE) - LV volume (cube & Teicholz) **Interpretation** - Wall motion & thickening. Normal, hypokinesis, akinesis, dyskinesis, aneurysm - ASE 16 & 17 segments classification - Aortic valve: cusp number, morphology, motion - Mitral valve: segment & scallop anatomy. papillary muscles. Billowing, prolapsse - Color flow imaging: aortic, pulmonic, mitral, tricuspid regurgitatio

WEEK 2	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	Apical Views - 4 chamber view - 2 chamber view - Long axis view - 5 chamber view - Para-apical short-axis	**Apical Views** - Mitral valve - Tricuspid valve - Aortic valve - Pulmonary veins	**Parasternal window** - CWD – Tricuspid valve - CWD – Pulmonic valve - PWD – RVOT **Apical window** - PWD - LVOT - CWD – Aortic valve		**Measurements** : - TR peak velocity - Pulmonic maximal systolic velocity - Pulmonic end-diastolic velocity - LVOT peak velocity and TVI - Aortic peak velocity and TVI - Aortic regurgitant halftime **Calculations** - Volumetric flow: Stroke volume & cardiac output - Bernouilli equation: Pressure gradients - Continuity equation : AVA **Interpretation** - Wall motion & thickening. Normal, hypokinesis, akinesis, dyskinesis, aneurysm - ASE 16 & 17 segments classification - Pulmonic & Aortic stenosis quantification - Pulmonary artery systolic & diastolic pressures

WEEK 3	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	Subcostal Views - Long axis 4 chamber view - Atrial septum zoom - Short axis view Atrial septum – aortic valve LV basal LV mid LV apical IVC – hepatic veins	**Subcostal Views** - ASD – PFO - Tricuspid valve - Hepatic vein flow	**Apical window** PWD – MV inflow CWD – MV inflow & MR PWD – Pulmonary veins PWD – RV inflow CWD – TV inflow & TR		**Measurements** : - MV annulus orthogonal dimensions (Apical 4 chamber & 2 chamber views) - MV inflow : E, A velocity, deceleration time, IVRT - MR Peak velocity, TVI - Pulmonary veins S,D, AR velocities **Calculations** : - MVA (continuity equation, pressure halftime method) - LV dP/dt **Interpretation** - Mitral & tricuspid valve stenosis

	Abdominal aorta				quantification (valve area & pressure gradient) - BVR Mitral score

WEEK 4	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	Suprasternal Views - Aortic arch & desc aorta - Crab (LA–Pulm veins) - R supraclavicular view	**Suprasternal Views** -Descending aorta - Ascending aorta R supraclavicular view - Superior vena cava	**Subcostal window** - PWD Abdominal aorta - PWD Hepatic veins **Suprasternal window** - PWD Descending aorta - CWD Ascending aorta - PWD Superior vena cava	**Apical Views** - MV septal annulus - MV lateral annulus	**Measurements** : - Hepatic veins & SVC: S, SR, D, AR velocities - Descending aorta: end-diastolic regurgitant velocity - Ascending aorta: Peak velocity & TVI - Tissue Doppler: s, e, a velocities **Interpretation** : - RA pressure estimation - LV & RV diastolic function

WEEK 5	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	Subcostal views - M-mode IVC - M-mode atrial septum **Right Parasternal Views** - Ascending aorta	PISA - Mitral regurgitation	**Apical window** - PWD LVOT with respirometry **Pedhoff** **Apical window** - Aortic valve		**Measurements** : - PISA radius - IVC diameter with respiratory phases - Atrial septum displacement **Interpretation** : - Mitral regurgitation quantification with PISA method - Mitral regurgitation quantification with continuity equation - Mitral regurgitation estimation with color flow imaging **Communication :** - Write preliminary reports of echocardiographic studies

WEEK 6	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
			Apical window - PWD MV with respirometry **Pedhoff** **Apical window** - Mitral valve		**Measurements:** - Area-Length & Simpson's biplane method of disc LV Volumes & EF measurement - Mitral regurgitation jet area - vena contracta **Interpretation** - Mitral regurgitation mechanism (Carpentier – Duran & other classifications) - Mitral regurgitation overall quantification (summary)

WEEK 7	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: - Patient preparation, - Safety monitoring, - Basic probe manipulation (off patient)		**Apical window** - PWD P veins with respirometry **Pedhoff** **Apical Window** - Tricuspid valve		**Measurements:** - Mitral valve area short-axis planimetry **Interpretation** - Aortic regurgitation quantification with Jet width & Short axis area - Aortic regurgitation quantification with continuity equation - Aortic regurgitation quantification with pressure halftime method - Aortic regurgitation quantification with PISA method - Aortic regurgitation quantification with vena contracta

WEEK	Technical				Interpretation

8	Performance				
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE Training - Local anesthesia - Conscious Sedation - Probe cleaning & storage		**Apical window** - PWD TV with respirometry **Pedhoff Suprasternal window** - Aortic valve		**Measurements:** - Aortic valve area short-axis planimetry **Interpretation** - Low output – low gradient aortic stenosis - Aortic supra & subvalvular fixed stenosis - LVOT & mid-cavity dynamic obstruction

WEEK 9	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: - Patient intubation - Basic probe manipulation (in patient) **Stress Echo Training** Pharmacologic stress - Patient preparation, - Safety monitoring - Image acquisition @ Rest		**Subcostal window** - PWD Hep Veins with respirometry **Pedhoff Subcostal Window** - Aortic valve - Tricuspid valve		**Interpretation** - Evaluation of bioprosthesis & mechanical valvular prosthesis morphology - Quantification of prosthetic valve area & pressure gradient - Notion of patient-prosthesis mismatch

WEEK 10	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: Mid-esophageal views 45° AoV – TV-PV SAX 135° Ao valve LAX	**TEE training:** Mid-esophageal views	**R supraclavicular window** - PWD SVC with respirometry		**Interpretation** - Mitral valve repair / annuloplasty evaluation - Duke criteria for

	Stress Echo Training Pharmacologic stress - Image acquisition with pharmacologic stress	45° AoV – TV-PV SAX 135° Ao valve LAX			endocarditis - Vegetation mobility score

WEEK 11	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: Mid-esophageal views 60° LAA – LUPV-LLPV 90-135°LAA (cauliflower) 60° RUPV-RMPV-RLPV **Stress Echo Training** Pharmacologic stress - Image acquisition with pharmacologic stress	**TEE training:** Mid-esophageal views 60° LAA – LUPV- LLPV 60° RUPV-RMPV-RLPV	**Pedhoff Right parasternal window** - Aortic valve **TEE training** - PWD LUPV - RUPV - PWD LAA		**Interpretation** Intracavitary Contents: - Thrombus - Tumors - Vegetations - Man-made objects: Catheters (PICC line, Swan ganz, IABP), wires (PPM, ICD)

WEEK 12	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: Mid-esophageal views 0° LV – 4 chamber view 60° LV – 2 chamber view 135° LV = Long axis view **Stress Echo Training** Pharmacologic stress - Image acquisition with pharmacologic stress		Apical window - PWD Intracavitary grad - CWD intracavitary grad at rest & with Valsalva maneuver **Stress Echo Training** Pharmacologic stress - PWD - LVOT - CWD – Aortic valve		**Interpretation** - Pericardial effusion - Pericardial tamponnade - Pericardial constriction

WEEK 13	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training Mid-esophageal views 0° - MV 45-60° - MV 60-90° - MV 90-135° - MV **Stress Echo Training** Exercise stress - Image acquisition @ Rest	**TEE training** Mid-esophageal views 0° - MV 45-60° - MV 60-90° - MV 90-135° - MV			**Interpretation** - Dilated cardiomyopathy evaluation

WEEK 14	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: Mid-esophageal views 45° - atrial septum 100° - atrial septum bicaval view **Stress Echo Training** Exercise stress - Image acquisition with or post-exercise	**TEE training:** Mid-esophageal views 45° - atrial septum 100° - atrial septum bicaval view			**Interpretation** - Hypertrophic cardiomyopathy evaluation - Infiltrative / restrictive cardiomyopathy evaluation

WEEK 15	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: High-esophageal views 0° - Asc aorta, SVC RPA 100° - Asc aorta longitudinal view **Stress Echo Training**	**TEE training:** High-esophageal views 0° - Asc aorta, SVC RPA 100° - Asc aorta			**Interpretation** - Aortic atherosclerosis – grading classification - Aortic aneurysm - Aortic dissection & hematoma

	Exercise stress - Image acquisition with or post-exercise	longitudinal view			

WEEK 16	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: Transgastric views 0° - Basal LV – MV 0° - Mid LV – pap muscles 0° - Apical LV **Stress Echo Training** Exercise stress - Image acquisition with or post-exercise	**TEE training:** Transgastric views 0° - Basal LV – MV 0° - Mid LV – pap muscles 0° - Apical LV			**Interpretation** - Coarctation **Communication** - Write complete preliminary reports of echocardiographic studies

WEEK 17	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: Tansgastric views 90° - LV-MV long-axis 110° - LV–LVOT view 60-90° - RV-TV long axis **Stress Echo Training** Exercise stress - Image acquisition with or post-exercise	**TEE training:** Tansgastric views 90° - LV-MV long-axis 110° - LV–LVOT view 60-90° - RV-TV long axis	**TEE training:** Tansgastric views 110° - PWD LVOT 110° - CWD Ao valve 60-90° PWD RVOT 60-90° CWD PV		**Interpretation** - Atrial septal morphology. Atrial septal defect classification - Shunt quantitative evaluation (Qp:Qs) - Cor triatraitum dexter & sinister **Communication** - Write complete preliminary reports of echocardiographic studies

WEEK 18	Technical Performance				Interpretation
	2D & M-mode	Color Flow	PWD / CWD	Tissue	

		Imaging		Doppler	
	TEE training: Transgastric views 90° - IVC-Hep veins **Stress Echo Training** Exercise stress - Image acquisition with or post-exercise	**TEE training:** Transgastric views 90° - IVC-Hep veins	**TEE training:** Transgastric views 90° - PWD Hep veins		**Interpretation** - Ventricular septal morphology. Ventricular septal defect classification - Shunt quantitative evaluation (Qp:Qs) **Communication** - Write complete preliminary reports of echocardiographic studies

WEEK 19	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: Transgastric views 0 & 90° abdominal aorta Midesophageal views 0 & 90° desc thoracic aorta **Stress Echo Training** Exercise stress - Image acquisition with or post-exercise	**TEE training**: Transgastric views 0 & 90° abdominal aorta Midesophageal views 0 & 90° desc thoracic aorta				**Interpretation** - Ebstein's anomaly Evaluation **Communication** - Write complete preliminary reports of echocardiographic studies

WEEK 20	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: High esophageal views 0° Desc & transverse aorta 90° Transverse & Asc aorta arch vessels (RBA, LCCA, LSCA) **Stress Echo**	**TEE training:** High esophageal views 0° Desc & transverse aorta 90° Transverse & Asc aorta arch vessels (RBA, LCCA, LSCA)	**Stress Echo Training** Exercise stress - CWD TV (PAPs) with or post-exercise			**Interpretation** - Tetralogy of Fallot evaluation **Communication** - Write complete preliminary reports of echocardiographic studies

	Training Exercise stress - Image acquisition with or post- exercise				

WEEK 21	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: High esophageal views 90° MPA-PV **Stress Echo Training** Exercise stress - Image acquisition with or post-exercise	**TEE training:** High esophageal views 90° MPA-PV	**TEE training:** High esophageal views 90° CWD PV		**Interpretation** - Persistant left superior vena cava **Communication** - Write & sign off final reports of echocardiographic studies **Manager** - Supervise & Review cardiac sonographer's studies

WEEK 22	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	TEE training: Pulmonary vein anatomy RUPV-RMPV-RLPV LUPV-LLPV At 0° & 45-90° **Stress Echo Training** Exercise stress - Image acquisition with or post-exercise	**TEE training:** Pulmonary vein anatomy RUPV-RMPV-RLPV LUPV-LLPV At 0° & 45-90°			**Interpretion** - Cleft mitral valve - Anomalous pulmonary venous connections **Communication** - Write & sign off final reports of echocardiographic studies **Manager** - Supervise & Review cardiac sonographer's studies

WEEK 23	Technical Performance				Interpretation
	2D & M-mode	Color Flow	PWD / CWD	Tissue	

		Imaging		Doppler	
	TEE training: Deep transgastric views 0° LVOT **Stress Echo Training** Exercise stress - Image acquisition with or post-exercise	**TEE training:** Deep transgastric views 0° LVOT	**TEE training:** Deep transgastric views 0° CWD Aortic valve		**Interpretation** - Patent ductus arteriosus **Communication** - Write & sign off final reports of echocardiographic studies **Manager** - Supervise & Review cardiac sonographer's studies

WEEK 24	Technical Performance				Interpretation
	2D & M-mode	Color Flow Imaging	PWD / CWD	Tissue Doppler	
	Stress Echo Training Exercise stress - Image acquisition with or post-exercise				**Interpretation** - Transposition of the great arteries **Communication** - Write & sign off final reports of echocardiographic studies **Manager** - Supervise & Review cardiac sonographer's studies