

Saudi Council for Health Specialties

SAUDI BOARD OF INTERNAL MEDICINE

الهيئة السعودية للتخصصات الصحية
Saudi Commission for Health Specialties



Prince Sultan Cardiac Center (PSCC)

Adult Echocardiography

Training Program

1434 / 2013

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I- Introduction

Echocardiography has evolved over the years and becomes today the backbone of all cardiac imaging modalities. Its diagnostic ability of different cardiovascular diseases is well recognized, and has obviated the need for invasive diagnostic methodology. The use of echocardiography is vital in determining the nature of the cardiovascular pathology as well as to determine the timing of therapeutic intervention and surgery. Additionally, echocardiography is essential for follow-up of patients to monitor the outcome of such therapies. Moreover, Echocardiography is a strong prognostic modality in predicting the clinical outcome of different cardiovascular disorders.

Since echocardiography is a very specialized form of ultrasound, it is mandatory to be performed and interpreted by specially trained personnel. This includes special training of sonographers as well as echocardiologists. Echocardiography should not be performed or interpreted until the candidate acquires different levels of training which they will attain during their general cardiology training program. To be an echo-cardiologist, further specialty training has to be obtained after completing the fellowship training program. Since no organized training program for echocardiography presently exists in Saudi Arabia, we intend to propose this training program for fellows who are interested to specialize in the field of echocardiography.

Objectives of training:

This program is aimed to provide:

- Basic knowledge of cardiac anatomy, physiology, as well as normal development and embryology of the cardiovascular system.
- Understanding basic physics of different echocardiographic imaging modes
- Echocardiographic recognition of various acquired and adult congenital heart diseases,
 - Learn clinical applications of echocardiography
 - Understand the strengths and limitations of echocardiography
 - Performance, and interpretation of complete transthoracic echocardiography
 - Performance and interpretation of transesophageal echocardiography
 - Performance and interpretation of stress echocardiography
 - Performance and interpretation of contrast echocardiography
 - Introduction to specialized echo techniques: Tissue Doppler, speckle tracking, 3-D echocardiography, and intracardiac echocardiography

Candidate requirements:

- 1- To be a graduate of cardiology training program
- 2- Achieved level 2 of training in echocardiography
- 3- To be fully committed to the training program
- 4- Be licensed to practice medicine in Saudi Arabia.
- 5- Provide written permission form his/her sponsoring institution allowing participation in full time training for the whole program period (1 year).
- 6- Signature of obligation to abide by the rules and regulations of the Training Program and the Saudi Board,
- 7- Pass successfully the interview.
- 8- Provide three letters of recommendation from consultants with whom the candidate has recently worked with.
- 9- Registration as a trainee at the Saudi Council for Health Specialties.

- 10- Training is a full time commitment; trainees shall be enrolled in continuous full time training for the whole period of the program (1 year).
- 11- Training is to be conducted in institutions accredited for training by the Saudi council.
- 12- Trainees shall abide by training regulations and obligations set by the Saudi council.

Structure of the Training Program:

The duration of the fellowship program will be 12 months which is divided in several rotations as following:

- 1- 3 months in performing and interpreting transthoracic echocardiography (Should perform and interpret minimum of 250 studies)
- 2- 1.5 months in performing and interpreting Transesophageal echocardiography (should perform minimum of 50 studies).
- 3- 1 month in interpreting different modalities of stress echocardiography (should perform minimum of 25 studies)
- 4- 1.5 months in performing and interpreting perioperative Transesophageal echocardiography (Should perform at least 50 case)
- 5- 1 month rotation in congenital echo laboratory (minimum cases interpreted of 50)
- 6- 1.5 months in 3-D transtoracic as well as 3-D transesophageal echocardiography, contrast echo, tissue Doppler, and speckle tracking echocardiography
- 7- 1.5 months intracardiac echocardiography, intravascular ultrasound, and carotid ultrasound.
- 8- 1 months research

Echocardiology specialty fellowship: complete Level III training as well as participate in research and scholarly activities. This track targets those trainees that seek advanced training in echocardiography.

Duration: Twelve months (12 months cumulative)

Candidates should have at least Level II training when applying for this position.

Training Format: Candidate should fulfill the rotation requirements mentioned above in the fellowship curriculum. Specialty training areas include:

Stress echo

Transesophageal echo, intraoperative TEE

Research studies

Adult congenital echocardiography

Digital imaging/communications

Transthoracic Echocardiography:

Trainee will obtain knowledge in ultrasound physics and use of instrumentation, anatomy, physiology, and pathology of the heart and great vessels.

Basic Knowledge of Ultrasound Physics.

Echocardiographic imaging and Doppler systems generate ultrasound signals that follow the laws of physics. Appropriate utilization of these instruments and interpretation of the data generated require an understanding of the fundamental principles of ultrasound physics and how they relate to the images produced and the spectral and color Doppler information.

This understanding is considered to be an important requirement for clinical competence in all modalities of echocardiography.

Technical Aspects of the Examination.

An essential component of the diagnostic accuracy of echocardiography is the skill and experience of the individual responsible for image and data acquisition. Technical skills related to echocardiographic data acquisition may be divided into two important skill sets: transducer manipulation and ultrasound system adjustments. Perhaps the most difficult and

underestimated skill set to master is transducer manipulation, which is critical to obtaining optimal image quality in standard tomographic imaging planes, and optimal Doppler flow velocity signals. This is true regardless of the type of transducer utilized (i.e., transthoracic, transesophageal, or intravascular). The second set of technical skills includes appropriate knowledge of ultrasound instrument settings such as transducer frequency, use of harmonics, mechanical index, depth, gain, time-gain-compensation, dynamic range, filtering, velocity scale manipulations, and display of received signals.

Anatomy and Physiology.

Echocardiography is a powerful diagnostic tool that provides immediate access for the evaluation of cardiac and vascular structures and assessment of heart function. Intrinsic to a competent echocardiographic examination is a thorough understanding of the anatomy and physiology of the heart and great vessels. Two-dimensional imaging can accurately quantify cardiac chamber sizes, wall thickness, ventricular function, alular anatomy, and great vessel size. Pulsed, continuous-wave, and color-flow Doppler echocardiography, especially when Combined with two-dimensional imaging, can be used to quantify blood flow velocities and calculate blood flow; assess intracranial pressures and homodynamic; and detect And quantify stenosis, regurgitation, and other abnormal flow states. Documentation of normal and abnormal cardiac anatomy and physiology must be accomplished by the individual performing the examination.

Recognition of Simple and Complex Pathology.

The ability to recognize both simple and complex pathology of the heart and great vessels is required for competence in echocardiography. A fundamental knowledge of cardiac pathology is required during data acquisition to tailor the examination appropriately and maximize demonstration of the abnormalities present. This includes the ability to modify standard imaging planes and optimize the Doppler beam angle of incidence to achieve this goal. In addition, an extensive knowledge of pathology and pathophysiology is required to interpret recorded echocardiographic data.

Basic Cognitive Skills Required for Competence

in Echocardiography

- Knowledge of physical principles of echocardiographic image formation and blood flow velocity measurements.
 - Knowledge of instrument settings required to obtain an optimal image.
 - Knowledge of normal cardiac anatomy.
 - Knowledge of pathologic changes in cardiac anatomy due to acquired and CHD.
 - Knowledge of fluid dynamics of normal blood flow.
 - Knowledge of pathological changes in blood flow due to acquired heart disease and congenital heart disease (CHD).
- CHD _.

Cognitive Skills Required for Competence in Adult Transthoracic Echocardiography

- Basic knowledge outlined above.
- Knowledge of appropriate indications for echocardiography.
- Knowledge of the differential diagnostic problem in each case and the echocardiographic techniques required to investigate these possibilities.
- Knowledge of appropriate transducer manipulation.
- Knowledge of cardiac auscultation and electrocardiography for correlation with results of the echocardiogram.
- Ability to distinguish an adequate from an inadequate echocardiographic examination.

- Knowledge of appropriate semi-quantitative and quantitative measurement techniques and ability to distinguish adequate from inadequate quantitation.
- Ability to communicate results of the examination to the patient, medical record, and other physicians.
- Knowledge of alternatives to echocardiography.

Transesophageal Echocardiography

This will include observational periods intended to familiarize the trainee with TEE anatomy, the process of the procedure and the strengths and limitations of TEE.

This training will include all levels of interaction with the TEE examination, including intubation, handling the scope, interpretation of the TEE findings and communication of results. Trainees must perform esophageal intubations (using a diagnostic TEE probe) under the tutelage of an experienced physician with advanced skills in TEE or under the supervision of an experienced endoscopist.

Cognitive and Technical Skills Required for Competence in TEE

Cognitive Skills

- Basic knowledge outlined under transthoracic echocardiography.
- Knowledge of the appropriate indications, contraindications, and risks of TEE.
- Understanding of the differential diagnostic considerations in each clinical case.
- Knowledge of infection control measures and electrical safety issues related to the use of TEE.
- Understanding of conscious sedation, including the actions, side effects

and risks of sedative drugs, and cardiorespiratory monitoring.

- Knowledge of normal cardiovascular anatomy, as visualized tomographically by TEE.
- Knowledge of alterations in cardiovascular anatomy that result from acquired and congenital heart diseases and of their appearance on TEE.
- Understanding of component techniques for transthoracic echocardiography and for TEE, including when to use these methods to investigate specific clinical questions.
- Ability to distinguish adequate from inadequate echocardiographic data, and to distinguish an adequate from an inadequate TEE examination.
- Knowledge of other cardiovascular diagnostic methods for correlation with TEE findings.
- Ability to communicate examination results to the patient, other health care professionals, and medical record.

Technical Skills

- Proficiency in using conscious sedation safely and effectively.
- Proficiency in performing a complete transthoracic echocardiographic examination, using all echocardiographic modalities relevant to the case.
- Proficiency in safely passing the TEE transducer into the esophagus and stomach, and in adjusting probe position to obtain the necessary tomographic images and Doppler data.
- Proficiency in operating correctly the ultrasonographic instrument, including all controls affecting the quality of the data displayed.
- Proficiency in recognizing abnormalities of cardiac structure and function as detected from the transesophageal and transgastric windows, in distinguishing normal from abnormal findings, and in recognizing artifacts.

- Proficiency in performing qualitative and quantitative analyses of the echocardiographic data.
- Proficiency in producing a cogent written report of the echocardiographic findings and their clinical implications.

Perioperative echocardiography

The trainee will spend most of his time during this rotation in the operating room, and observe and perform perioperative transesophageal echocardiography under the supervision of staff echocardiologist assigned to the OR.

Cognitive and Technical Skills Needed to Perform

Perioperative Echocardiography at a Basic Level

Cognitive Skills

- Basic knowledge outlined under transthoracic echocardiography.
- Knowledge of the equipment handling, infection control, and electrical safety recommendations associated with the use of TEE.
- Knowledge of the indications and the absolute and relative contraindications to the use of TEE.
- General knowledge of appropriate alternative diagnostic modalities, especially transthoracic and epicardial echocardiography.
- Knowledge of the normal cardiovascular anatomy as visualized by TEE.
- Knowledge of commonly encountered blood flow velocity profiles as measured by Doppler echocardiography.
- Detailed knowledge of the echocardiographic presentations of myocardial ischemia and infarction.
- Detailed knowledge of the echocardiographic presentations of normal and abnormal ventricular function.
- Detailed knowledge of the physiology and TEE presentation of air embolization.

- Knowledge of native valvular anatomy and function, as displayed by TEE.
- Knowledge of the major TEE manifestations of valve lesions and of the TEE techniques available for assessing lesion severity.
- Knowledge of the principal TEE manifestations of cardiac masses, thrombi, and emboli; cardiomyopathies; pericardial effusions and lesions of the great vessels.

Technical Skills

- Ability to operate the ultrasound machine, including controls affecting the quality of the displayed data.
- Ability to perform a TEE probe insertion safely in the anesthetized, intubated patient.
- Ability to perform a basic TEE examination.
- Ability to recognize major echocardiographic changes associated with myocardial ischemia and infarction.
- Ability to detect qualitative changes in ventricular function and hemodynamic status.
- Ability to recognize echocardiographic manifestations of air embolization.
- Ability to visualize cardiac valves in multiple views and recognize gross valvular lesions and dysfunction.
- Ability to recognize large intracardiac masses and thrombi.
- Ability to detect large pericardial effusions.
- Ability to recognize common artifacts and pitfalls in TEE examinations.
- Ability to communicate the results of a TEE examination to patients and other health care professionals and to summarize these results cogently in the medical record.

Skills Necessary to Perform Perioperative

Echocardiography at the Advanced Level

Cognitive Skills

- All the cognitive skills defined for the basic level.
- Knowledge of the principles and methodology of quantitative echocardiography.
- Detailed knowledge of native valvular anatomy and function. Knowledge of prosthetic valvular structure and function. Detailed knowledge of the echocardiographic manifestations of valve lesions and dysfunction.
- Knowledge of the echocardiographic manifestations of CHD*.
- Detailed knowledge of echocardiographic manifestations of pathologic conditions of the heart and great vessels (such as cardiac aneurysms, hypertrophic cardiomyopathy, endocarditis, intracardiac masses, cardioembolic sources, aortic aneurysms and dissections, pericardial disorders, and post-surgical changes).
- Detailed knowledge of other cardiovascular diagnostic methods for correlation with TEE findings.

Technical Skills

- All the technical skills defined for the basic level.
- Ability to perform a complete TEE examination.
- Ability to quantify subtle echocardiographic changes associated with myocardial ischemia and infarction.
- Ability to utilize TEE to quantify ventricular function and hemodynamics.
- Ability to utilize TEE to evaluate and quantify the function of all cardiac valves including prosthetic valves (e.g., measurement of

pressure gradients and valve areas, regurgitant jet area, effective regurgitant orifice area). Ability to assess surgical intervention on cardiac valvular function.

- Ability to utilize TEE to evaluate congenital heart lesions. Ability to assess surgical intervention in CHD*.
- Ability to detect and assess the functional consequences of pathologic conditions of the heart and great vessels (such as cardiac aneurysms, hypertrophic cardiomyopathy, endocarditis, intracardiac masses, cardioembolic sources, aortic aneurysms and dissections, and pericardial disorders). Ability to evaluate surgical intervention in these conditions if applicable.
- Ability to monitor placement and function of mechanical circulatory assistance devices.

Stress Echocardiography

Trainees exposure will include all levels of interaction with the exercise and pharmacological stress examinations. The trainee will achieve competency in administration of pharmacological stress agents, generally by supervising a total of 100 dobutamine stress studies. The trainee will become an expert interpreter of regional wall motion assessment and familiar with the administration of contrast agents for the purpose of endocardial border definition. The trainee will also achieve competency in interpretation of stress valvular hemodynamics, generation of reports and communication of test results with the referring clinician. ASE, ACC and AHA have recommended a minimum of 100 stress studies during training. Training in the actual acquisition of the stress images is not required, but is encouraged on an individual basis.

Cognitive Skills Required for Performance and Interpretation of Stress Echocardiography

Performance

- Basic knowledge outlined under transthoracic echocardiography.
- Skills for supervision of standard exercise testing, including

competence in cardiopulmonary resuscitation and successful completion of an American Heart Association-sponsored course in cardiopulmonary resuscitation and renewal on a regular basis.

- Knowledge of the indications and limitations of exercise echocardiography.
- Knowledge of the different types of pharmacologic stress agents, including advantages and disadvantages of the different agents.
- Knowledge of the indications for pharmacologic stress echocardiography.
- Knowledge of limitations and contraindications of pharmacologic stress echocardiography with different types of pharmacological stress agents.
- Knowledge of pharmacokinetics and physiologic responses of the different pharmacologic stress agents.
- Knowledge of the side effects of different pharmacologic agents and how to manage them.
- Knowledge of the complications of different pharmacologic stress agents and how to manage them.
- Knowledge of cardiovascular drugs and their effects on responses to pharmacological stress.
- Knowledge of electrocardiography and changes that may occur in response to pharmacologic stress.
- Knowledge of the end points of pharmacologic stress echocardiography and indications for termination of a stress echocardiographic examination.
- Knowledge of the sensitivity, specificity, and diagnostic accuracy of pharmacologic stress echocardiographic testing in different patient populations.
- Ability to apply Doppler data to the physiologic changes that occur during pharmacologic stress.

Image Interpretation

- Basic interpretative skills.
- Ability to identify left ventricular wall segments and recognize wall motion abnormalities at rest and during stress.
- Knowledge of common pitfalls in the interpretation of digitally acquired images, such as arrhythmias, improper capture, and foreshortening of left ventricular cavity.
- Knowledge of coronary anatomy and relationship to echocardiographic findings.
- Knowledge of the relationship of imaging results to the presence or absence of myocardial viability.
- Knowledge of specificity, sensitivity, and diagnostic accuracy of stress echocardiographic testing in different patient populations.
- Knowledge of conditions and circumstances that can cause falsepositive, indeterminate, or false-negative test results.
- Ability to apply Doppler data to the physiologic changes that

Congenital Echocardiography

The trainee will rotate in the congenital echo lab under the supervision of adult congenital echocardiologist and will be exposed to patients with adult congenital heart diseases.

Cognitive Skills Required for Performance and Interpretation of Echocardiography in Patients With Complex CHD

For the Adult Patient

- Basic knowledge outlined under transthoracic echocardiography.

- Understanding of the limitations of the echocardiogram in the adult.
- Knowledge of the anatomical and physiologic spectrum of CHD and its manifestations in the adult.
- Knowledge of the spectrum of surgical palliation and surgical repair for CHD and its manifestations on the adult echocardiogram.
- Knowledge of the spectrum of catheter based interventions for CHD and its manifestations in the adult echocardiogram.
- Knowledge of the impact of acquired heart disease on the physiology of the underlying congenital lesion.

Intracardiac and Intravascular Ultrasound

Trainees will be introduced to these invasive echo imaging techniques in the cath and EP labs. They will learn their basic function, operation, manipulation of the catheter and image interpretation and correlation with fluoroscopy. The candidates will work with the invasive echocardiologist who will perform these imaging modalities in conjunction with the invasive cardiologist and electrophysiologist. .

Contrast Echocardiography

Intravenous contrast agents are available for enhancing endocardial border delineation and improving the Doppler signal. The use of contrast with harmonic imaging provides opacification of the left ventricular cavity and improved endocardial border detection. The

technique is especially useful in obese patients and those with lung disease. Stress echocardiography examinations can be challenging, and a short acquisition time is essential in delineating regional wall motion abnormalities induced by peak exercise. The use of contrast can improve the ability to obtain diagnostic information and/or increase diagnostic accuracy. The ASE Task Force on Contrast Echocardiography states that “Intravenous contrast agents demonstrate substantial value in the difficult-to-image patient with comorbid conditions that limit an ultrasound evaluation of the heart” (21). Future applications may include the evaluation of myocardial perfusion at rest or during exercise or

Trainee will learn the application of contrast for endocardial delineation and an introduction to myocardial perfusion during stress echocardiography.

New imaging modalities

Trainee will be introduced to the new imaging modalities of annotative myocardial velocity and strain/strain rate imaging.

Three- Dimensional echocardiography

Trainee will be exposed to the utilization of the new real time three- dimensional echocardiography. They will learn the imaging format and the machine settings, and importantly they will understand the cardiac anatomy as it appears on 3-D imaging. The trainee will learn the use of the newly introduced 3-D TEE real time imaging and its application in different cardiovascular disorders.

Research

Every trainee will be required to conduct or participate in a research project during his training period, and this is considered essential for completion of his training.

VACATIONS, HOLIDAYS AND ON-CALL

1. Fellows are entitled for four weeks vacation annually and a maximum of 10 days for both Eid holidays and emergency leave.
2. Sick and maternity leave shall be compensated for during or at the end of training.
3. On call duty shall be an average of one every three to four nights (minimum of 7 calls per month, 24 hours per call). Fellows are expected to perform regular duty the day after call and ensure continuity of care for their patients.

EVALUATION

- A. During the year, performance will be monitored and assessed with a written report from the Consultant in-charge of each area of training.
- B. The candidate will be assessed by the regional supervisory committee at the end of the year with an exam which may include a written or clinical component or both. If the candidate passes the evaluation, then he will be promoted to the next level. If the candidate however fails the evaluation, he will continue with the training program on the same level and will be allowed 2 attempts within the next year of the training program. Should the candidate still fail, he will then be dismissed from the program.
- C. Final Examination includes:

- a. Written examination;
 1. MCQ
 2. Short Essay Questions
 3. Clinical data interpretation

Candidates who fail the examination are allowed to reset for the exam as specified in the SCFHS by-laws.

- b. Oral

All exams are subject to the rules specified in the SCFHS

CERTIFICATION

Upon completion of the required training and passing the final examination, the certificate of COMPETANCY in Adult Cardiac Echocardiography will be conferred upon the candidate.

Training Center Requirements

- 1- The center should have a cardiology training program recognized by the Saudi council.
- 2- There should be at least 4 staff non invasive cardiologist dedicated to perform and interpret echocardiography.
- 3- The echo lab should perform at least 6000 study per year.
- 4- The echo lab should be able to perform complete transthoracic echocardiography, transesophageal echocardiography, stress echocardiography, and periopertaive echocardiography. In addition to performance of 3-D echo, contrast, tissue Doppler, and intracardiac echocardiography.