Introducing the Training Guidelines for Interventional Echo: COMPETENCIES DEFINED

We are delighted to introduce the American Society of Echocardiography (ASE) Recommendations for Special Competency in Echocardiographic Guidance of Structural Heart Disease (SHD) Interventions, published this month in the *Journal of the American Society of Echocardiography*.[1] This important document outlines the requirements, training pathways, and general and procedure-specific competencies for formalized training in interventional echocardiography (IE) and the achievement of level III IE training.



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A historical perspective of training in IE and SHD imaging

The term interventional echocardiographer (IE) was first coined in 2009 to describe an imager with specific knowledge and skills in all aspects of SHD as an integral part of the multidisciplinary "heart team" with specific tasks in the overall path of care, including the imaging guidance of transcatheter heart interventions. Historically, the skills required to achieve competency in IE were acquired on a "learn as you go" basis through on-the-job training and proctoring by more experienced echocardiographers which were available to few individuals. However, there is an increasing need for competent IE imagers in an era of rapidly evolving and expanding SHD therapies and devices, heart team-based decision-making, and the required participation of a dedicated imager in specific interventions.

The fundamental competencies for cardiology training have been defined by the American College of Cardiology (ACC) as part of the Core Cardiovascular Training Statements (COCATS). Criteria for the echocardiography portion of cardiology training were outlined in the COCATS 4 Task Force 5 document published in 2015 in collaboration with ASE.[2] In 2019, ASE published an Advanced Training Statement (ATS) on echocardiography that identified specific competencies required to achieve level III echocardiography training, recommended additional dedicated training after general cardiology fellowship, and proposed minimum procedural numbers for the development of level III echocardiography competencies for additional, optional special cardiovascular ultrasound procedures.[3] That same year, recognizing that IE competencies may not apply to all level III echocardiographers, an expert consensus group proposed unique SHD competencies within the level III framework.[4]

Why are these new recommendations necessary?

Due to the rapid growth of transcatheter therapies for SHD, the evolution of the IE field, and the recognition that IE competencies may differ from those of a general level III-trained echocardiographer, ASE felt that it was important to adopt specific nomenclature for the level III IE and develop specific recommendations for the elements of training, including general and procedure-specific competencies, as a guide to both trainees and trainers ***(Figure 1)***. Furthermore, recognizing that prospective trainees may be in the process of completing a fellowship in cardiology or

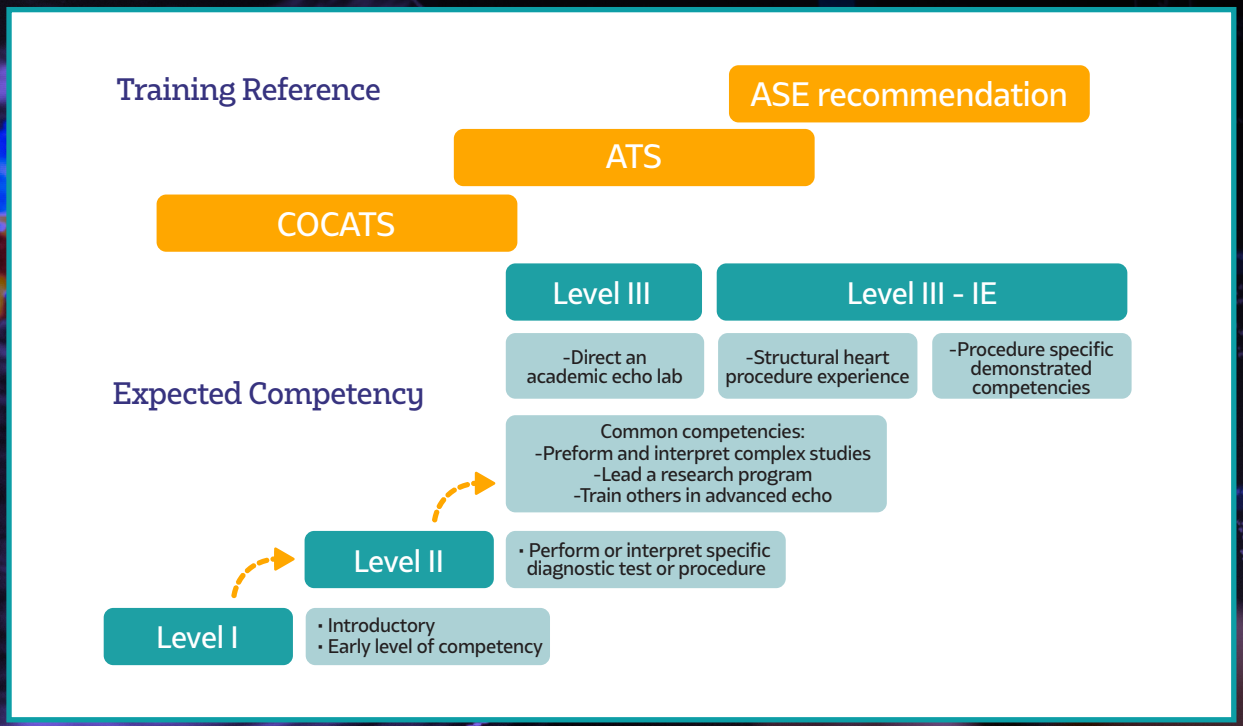

FIGURE 1. Cardiology training references and expected competencies in echocardiography. Modified from Hahn et al.[3]

TABLE 1 Elements of institutional support for IE training for fellows

· ACGME-accredited general cardiovascular and/or cardiothoracic anesthesiology training programs (or international equivalent) that provide exposure to a broad spectrum of patient populations and cardiovascular pathology
· Support of a multidisciplinary valve team (including but not limited to cardiac surgeon, interventional cardiologist, imaging specialist, clinical cardiologists, heart failure specialist, cardiothoracic anesthesiologist, valve coordinator) with regularly scheduled multidisciplinary heart team conferences
· Full range of diagnostic and therapeutic facilities, including ambulatory clinic, cardiac surgery operating room, cardiac catheterization laboratory, IAC-accredited (or equivalent) echocardiography laboratory or perioperative echocardiography service, CCT, vascular laboratory, CMR, and postprocedural recovery facilities
· Cardiothoracic surgery program and interventional cardiology program with appropriate procedural range and volume to support structural heart procedures†
· Administrative support to monitor performance and benchmark measures and ensure participation in the NCDR
· Up-to-date echocardiography equipment that allows advanced imaging capabilities, including 3D echocardiography acquisition, postprocessing, and image storage capabilities in an up-to-date PACS
· Cardiology or cardiothoracic anesthesiology faculty members capable of performing and teaching advanced echocardiographic imaging for structural cases*
· Adequate radiation safety training and protective equipment

CCT, Cardiac computed tomography; *CMR*, Cardiac magnetic resonance; IAC, Intersocietal Accreditation Commission; *NCDR*, National Cardiovascular Data Registry; *PACS*, picture archiving and communication system.

*Faculty members should be level III trained (or international equivalent) and have achieved NBE testamur status (or international equivalent).

REFERENCE

† Bonow RO, O'Gara PT, Adams DH, et al. 2019 AATS/ACC/SCAI/STS expert consensus systems of care document: operator and institutional recommendations and requirements for transcatheter mitral valve intervention: a joint report of the American Association for Thoracic Surgery, the American College of Cardiology, the Society for Cardiovascular Angiography and Interventions, and the Society of Thoracic Surgeons. J Am Coll Cardiol 2020;76:96-117.

cardiovascular anesthesiology, or practicing physicians interested in developing IE skills, it was necessary to establish distinct pathways to achieve competency.

What are the institutional requirements to provide level III training in IE?

In addition to the criteria required to provide general level III training in echocardiography outlined in the 2019 ATS document, institutions seeking to provide level III IE training should have an established multidisciplinary heart valve team with sufficient expertise, volume, and case complexity to provide a well-rounded IE training experience.[3] Faculty and trainees should have access to a full range of diagnostic and therapeutic facilities and equipment, including an IAC-accredited echocardiography laboratory and up-to-date echocardiography equipment that allows advanced 2D and 3D imaging capabilities. Cardiology or cardiothoracic anesthesiology faculty members should be proficient in performing and teaching advanced echocardiographic imaging for structural cases. Finally, established ACGME-accredited general cardiovascular medicine and/or cardiothoracic anesthesiology training programs that provide exposure to a broad spectrum of populations and pathology and institutional administrative support are fundamental to establishing a successful IE training program. The elements of institutional support for IE training for fellows are summarized in **Table 1**.

Who should have the opportunity to enter a formalized Interventional Echocardiography training program?

The new ASE recommendations recognize that training in IE should be available to cardiology and cardiothoracic anesthesiology trainees or practicing physicians and outline different training pathways to achieve level III IE competency ***(Figure 2)***. Regardless of their career stage, trainees seeking level III IE training should meet the minimum procedural volume required to achieve COCATS level II competency in adult echocardiography and/or be eligible or have achieved NBE testamur status (or equivalent) in adult echocardiography or perioperative echocardiography. Experienced cardiologists and cardiothoracic anesthesiologists who plan to receive on-the-job IE training through a "practice experience" pathway should demonstrate a minimum procedural volume, including at least 50 TEEs per year in two of the three years immediately preceding IE training. The document summarizes prerequisites for trainees or practicing physicians seeking IE training in **Tables 2 through 4**.

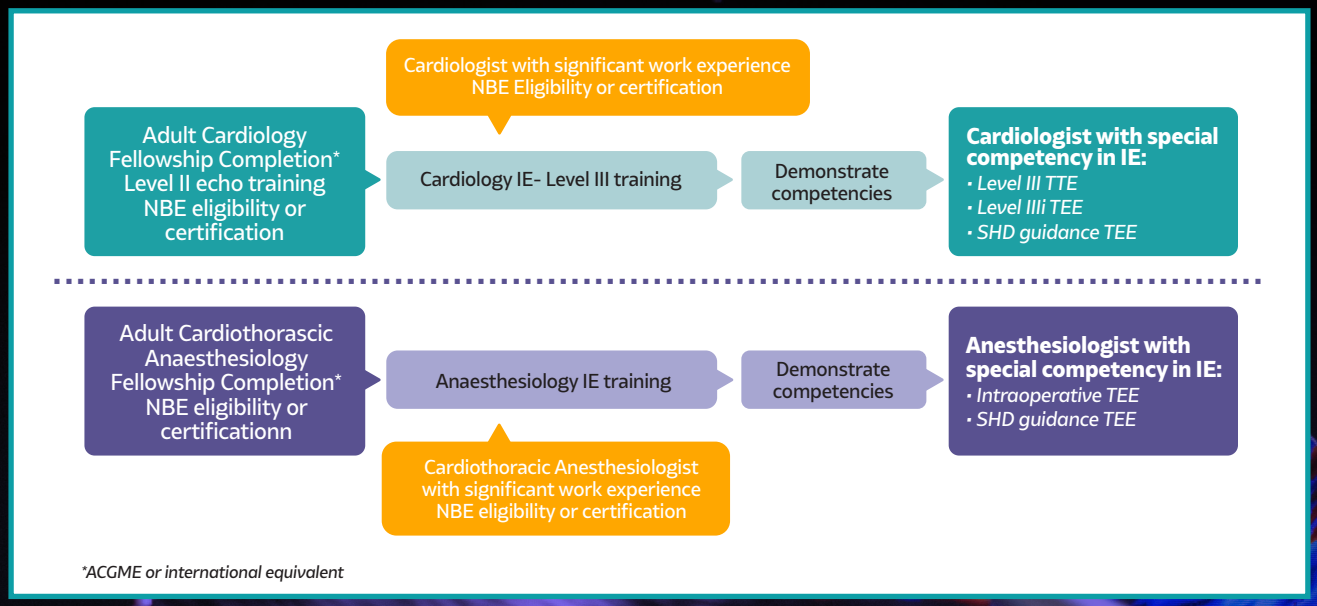

FIGURE 2. Training pathways to achieve level III IE competency

When should this training occur, and what is the recommended duration of the training?

It was the consensus of the writing group that significant dedicated training, after completing a general cardiology or cardiothoracic anesthesiology fellowship, is required to develop the skills and experience to achieve SHD imaging competency. For cardiology trainees, the recommendation is to undergo an additional 9 to 12 months of advanced echocardiography training after completing a three-year ACGME-accredited cardiology fellowship, irrespective of whether level II or level III training was achieved in the core cardiology training program. For cardiothoracic anesthesiology trainees, the recommendation is to actively participate in at least 75 structural heart cases, of which 40 must be personally performed, anticipating requiring an additional minimal SHD-focused training period of six months after completion of a one-year ACGME-accredited cardiothoracic anesthesiology fellowship. Cardiologists or cardiothoracic anesthesiologists with significant practice experience (defined as at least 150 complex TEE studies performed) may complete IE training through a "practice experience" pathway and demonstrate competencies faster than less experienced trainees; however, they are subject to the same competency milestones.

TABLE 2 Prerequisites for trainees entering a dedicated IE training program

• Completion of an ACGME-accredited cardiology or adult cardiothoracic anesthesiology fellowship (or equivalent if trained outside the United States)
• Cardiology or anesthesiology board eligibility or certification (or equivalent if trained outside the United States)
• NBE eligibility or testamur status (or international equivalent)
• Cardiology: minimum procedural volume required to achieve COCATS level II competency in adult echocardiography
• Anesthesiology: minimum procedural volume required for board certification by the NBE for special competence in advanced perioperative TEE for anesthesiologists

TABLE 3 IE prerequisites for cardiologists receiving practice experience training after fellowship

• Completion of ACGME-accredited cardiology fellowship and specialty board certification (or international equivalent)
• NBE testamur status (or international equivalent)
• Demonstration of performance and interpretation of ≥50 transesophageal echocardiograms† per year for 2 of the 3 years immediately preceding IE training

REFERENCE

† National Board of Echocardiography, Inc. Application for certification: adult echocardiography handbook, (ASCeXAM). Accessed March 9, 2022.

TABLE 4 Prerequisites for anesthesiologists receiving practice experience in IE training after fellowship

• Completion of ACGME-accredited adult cardiothoracic anesthesiology fellowship and specialty board certification (or equivalent if trained outside the United States)
• Examination of Special Competence in (Advanced Perioperative Transesophageal Echocardiography [Advanced PTEeXAM]) testamur status or international equivalent
• Applicants must have performed and interpreted ≥50 perioperative transesophageal echocardiograms per year in 2 of the 3 years immediately preceding IE training

Is there a minimum procedural volume to achieve competency in IE?

Compared to interventional cardiology training, less data exist regarding the optimal number of procedures needed to achieve expertise in SHD imaging. Therefore, the minimum procedural volume previously suggested by the 2019 ATS was reproduced in **Table 8** of the new recommendations, with the understanding that these numbers are based on consensus, intended as general guidance, considered an absolute minimum, and assume exposure to a broad range of patients, pathologies, modalities, and therapies. Specifically, these recommendations include the echocardiographic guidance of 75 interventional procedures, of which 30 should be structural valve interventions, 10 transseptal catheterization guidance, 15 percutaneous closure of septal defects and perivalvular leaks, 10 alcohol septal ablations, and 10 left atrial appendage exclusion devices. Additional supervised procedures are likely needed for complex cases and novel devices, and competency must be based on evaluation by the supervising echocardiography laboratory director. The document also references the use of TEE simulation training, which could potentially help to flatten the learning curve for trainees in IE. Of note, the recently published ACC/American Heart Association/Society for Cardiovascular Angiography and Interventions ATS on Interventional Cardiology recommends more specific and significant procedural numbers to achieve competency as a proceduralist.[5] The recommended procedural numbers for imaging may continue to evolve in the future.

TABLE 8 Minimum procedural volume typically necessary for the development and demonstration of level III IE[††]

Procedure/technical skill	Number*
Echocardiographic guidance of interventional procedures,[†] which include	75
Structural valvular interventions[‡]	30
Transseptal catheterization guidance	10
Percutaneous closure of septal defects and perivalvular leaks	15
Alcohol septal ablation	10
Placement of devices to exclude the LAA	10
Intraoperative TEE, which includes	75
Surgical valve repair or replacement	50
Ventricular assist device placement and assessment	20
Intracardiac Echocardiography	10

*Numbers are based on consensus; are intended as general guidance, on the basis of the educational needs and progress of typical level III echocardiography trainees; and represent the cumulative experience that may occur at any time during training. Competency to perform each procedure must be based on evaluation by the supervising echocardiography laboratory director and may exceed or be below the threshold number shown in this table.

† The experience represented by these numbers must include exposure to a broad range of adult patient ages, pathologies, modalities, and therapies, including complex congenital heart disease, mechanical circulatory support devices and transplantation, ultrasound enhancing agents, and 3D and speckle -racking to achieve the competencies outlined in the competency components and curricular milestones for level III training in echocardiography. Additional training may occur at centers with high volumes of complex congenital heart disease or mechanical assist devices and transplantation to achieve the outlined competencies.

‡ The range of experience must include exposure to a broad range of indications, settings, and pathologies, inclusive of operative and intraprocedural studies and the use of 3D echocardiography to achieve the competencies outlined in the competency components and curricular milestones for level III training in echocardiography

REFERENCE

†† Writing Committee Members, Wiegers SE, Ryan T, et al. 2019 ACC/AHA/ASE advanced training statement on echocardiography (Revision of the 2003 ACC/AHA clinical competence statement on echocardiography): a report of the ACC Competency Management Committee. J Am Soc Echocardiogr 2019;32:919-43.

What are some of the common core competencies of IE Training?

The new recommendations outline baseline and core competencies specific to IE training. Proficiency in comprehensive 2D and 3D echocardiography, the skill to independently perform these studies, and detailed knowledge of cardiac anatomy, valvular, and SHD are considered prerequisite general competencies for entering IE training, as summarized in **Table 6**. Competency components expected by the end of IE training include expertise in advanced TEE of complex cardiac disorders

TABLE 6 Prerequisite general competencies of the IE trainee

· Know the basic principles of echocardiography, physics, artifacts, and best practices for image optimization for both 2D and 3D echocardiography
· Know the use of 2D and 3D and Doppler echocardiography to evaluate native and prosthetic valve disease, basic adult congenital heart disease (including atrial and ventricular septal defects), and imaging of LAA
· Know the standard views included in a comprehensive TEE for SHD assessment*
· Skill to independently perform comprehensive diagnostic or perioperative 2D, 3D, and Doppler TEE†,‡
· Skill to independently perform 3D transesophageal echocardiographic image acquisition, cropping, and postprocessing††
· Skill to identify the potential complications of and how to manage them‡
· Skill to effectively communicate detailed information on cardiac anatomy periprocedurally and intraprocedurally in addition to collaborating in interdisciplinary cardiovascular care teams

TABLE 7 Medical knowledge and procedural skills competency components for level III IE training: common to all procedures

Medical knowledge
· Know the comprehensive anatomy of the structure being treated and its relationship to surrounding structures
· Know standard and nonstandard imaging with TTE and TEE of native and prosthetic valve disease, LAA, and basic congenital lesions before, during, and after SHD interventions
· Know the limitations and advantages of 3D vs 2D echocardiographic imaging for SHD assessment and procedural guidance
· Know the physical characteristics, sizing requirements, and expected functional characteristics of available surgical and percutaneous devices
· Know the indications, contraindications, and complications for each device procedure
· Know the strengths and limitations of each type of noninvasive imaging (i.e., echocardiography, CCT, and CMR) for assessing cardiac structure and function (i.e., valves, chambers, septa, and appendage)
· Know the intraprocedural imaging protocols for device implantation, including the assessment of postdevice technical success and evaluation of complications
· Know the postprocedural imaging protocols required to assess the structure and function of each device
· Know the strengths, limitations, and correlation of invasive and noninvasive assessment of native and postdevice valve function
· Know the fluoroscopic landmarks in relation to transesophageal echocardiography imaging landmarks
· Know when to use alternative intraprocedural imaging modalities, including but not limited to fusion imaging and ICE
· Know the fundamentals of radiation safety and the ALARA principle and the methods of reducing radiation exposure
· Know when TEE for SHD is contraindicated and the clinical and patient-specific factors that may increase the risk for a complication
Procedure skills
· Skill to appropriately apply the use of 2D and 3D imaging and Doppler hemodynamics, as well as 3D MPR, for preprocedural assessment of SHD
· Skill to appropriately and expeditiously apply the use of 2D and 3D imaging and Doppler hemodynamics, as well as 3D MPR, for intraprocedural guidance
· Skill to anticipate the procedural steps for device implantation and appropriately image moving wires, catheters, and devices during procedures
· Skill to assess postdevice technical success and procedural complications
· Skill to communicate effectively and guide the interventionalist for the safe and precise implantation of devices
· Skill to implement radiation safety measures and ergonomic considerations
· Skill to adopt new and emerging imaging technologies

ALARA, As low as reasonably achievable.

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† Nicoara A, Skubas N, Ad N, et al. Guidelines for the use of transesophageal echocardiography to assist with surgical decision-making in the operating room: a surgery-based approach: from the American Society of Echocardiography in Collaboration with the Society of Cardiovascular Anesthesisiologists and the Society of THoracic Surgeons. J Am Soc Echocardiogr 2020;33:692-734.

†† Lang RM, Badano LP, Tsang W, et al. EAE/ASE recommendations for image acquisition and display using three-dimensional echocardiography. Eur Heart J Cardiovasc Imaging 2012;13:1-46.

TABLE 9 Medical knowledge and procedural skills competency components for level III IE training: transseptal puncture

Medical knowledge
· Know the interatrial septal anatomy, including the location of the fossa ovalis, PFO, and their relationships to surrounding structures
· Know common variants and abnormalities of the IAS and associated structures, including atrial septal aneurysm, lipomatous atrial hypertrophy, Eustachian valve, and Chiari network
· Know the ideal sites of transseptal puncture for specific devices and procedures
Procedure skills
· Skill to visualize the IAS using 2D and 3D echocardiography during all phases of the transseptal puncture
· Skill to guide the transseptal puncture in the location of the fossa ovalis that is specific to the type of percutaneous procedure, device used, and location of pathology

TABLE 10 Medical knowledge and procedural skills competency components for level III IE training: transcatheter mitral valve interventions

Medical knowledge
· Know the anatomy of the mitral valve and adjacent structures
· Know the mechanisms of mitral valve disease and morphologic differences that define primary and secondary MR
· Know the comprehensive echocardiographic evaluation (TTE, TEE, 3D echocardiography, and 3D MPR) of mitral valve disease, including the identification of mitral valve morphology, grading of severity, and suitability for transcatheter intervention
· Know the role of multimodality imaging for identification of mitral valve morphology, grading of severity, and procedural planning
· Know the anatomic predictors of technical and procedural success of transcatheter mitral valve interventions and how to assess for procedural candidacy
· Know the steps for mitral device deployment and the required imaging for guidance
Procedure skills
· Skill to optimally guide transseptal puncture, delivery of guide catheter and transcatheter mitral valve devices into the left atrium and optimal device positioning
· Skill to perform rapid and accurate assessment of complications during the interventional procedure (i.e., leaflet injury, singleleaflet device attachment, device malposition, pericardial effusion)
· Skill to evaluate the technical and hemodynamic success of the mitral valve procedure and the need for further intervention

before, during, and after SHD interventions, proficiency with intraprocedural 3D imaging, knowledge of the devices, indications, procedural steps, and complications, and radiation safety. The IE should also be familiar with 2D and 3D intracardiac echocardiography, an evolving and rapidly developing field, but specific competencies are yet to be defined. Detailed medical knowledge and procedural skills competency components for level III IE training that are common to all procedures are summarized in **Table 7**.

TABLE 11 Medical knowledge and procedural skills competency components for level III IE training: transcatheter aortic valve interventions

Medical knowledge
· Know the aortic valve and root anatomy for both tricuspid and bicuspid morphologies, and the anatomic predictors of procedural complications
· Know the comprehensive multimodality evaluation of aortic stenosis for grading of severity and procedural planning
· Know the effects of stroke volume and blood pressure on the assessment of aortic stenosis severity
· Know the anatomic features that increase complication risk for transcatheter intervention (e.g., coronary obstruction, aortic root disruption, heart block, perivalvular regurgitation), and features that predict procedural success
· Know the anatomic and clinical features that may favor surgical or transcatheter intervention
Procedure Skills
· Skill to size the aortic annulus, root, coronary height, and determine the risk for coronary obstruction, using 3D echocardiography with MPR
· Skill to guide predeployment valve position and assess immediate postdeployment valve position and function
· Skill to perform a rapid and accurate assessment for complications, including annular rupture, aortic dissection, pericardial effusion, acute aortic or MR, and coronary flow compromise, and promptly communicate findings
· Skill to quantify valvular function, including the presence and severity of central or paravalvular aortic regurgitation

TABLE 12 Medical knowledge and procedural skills competency components for level III IE training: imaging for transcatheter tricuspid valve interventions

Medical Knowledge
· Know the anatomy of the tricuspid valve apparatus and adjacent structures
· Know the mechanisms of tricuspid valve disease and morphologic differences that define primary, secondary, and cardiac implantable electronic device–related tricuspid regurgitation
· Know the comprehensive echocardiographic evaluation (TTE, TEE, 2D, 3D echocardiography, and 3D MPR) of tricuspid valve disease, including the identification of tricuspid valve morphology, grading of severity, and suitability for transcatheter intervention
· Know the role of multimodality imaging for identification of tricuspid valve morphology, grading of severity, and procedural planning
· Know the imaging characteristics of transcatheter tricuspid valve devices
· Know the anatomic predictors of technical and procedural success of transcatheter tricuspid valve interventions and how to assess for procedural candidacy
· Know the steps for tricuspid valve device deployment and the required imaging for guidance
Procedure skills
· Skill to determine appropriateness of specific device therapies
· Skill to perform a rapid and accurate assessment for complications (i.e., leaflet injury, single-leaflet device attachment, device malposition, pericardial effusion)
· Skill to evaluate the technical and hemodynamic success of tricuspid valve device implantation

Getting more specific: procedure-specific competencies

The IE training document discusses the specific skill and knowledge competencies needed for each transcatheter SHD intervention currently being performed under echocardiography guidance. The specific procedures include transseptal puncture, mitral procedures, transcatheter aortic valve interventions, tricuspid procedures, interventions on replaced and repaired valves, left atrial appendage occlusion procedures, and transcatheter septal occluder procedures. The medical knowledge and procedure skills competency components for level III IE training for each procedure are listed in **tables 9-15**.

A core principle emphasized in this document is that the length of program duration or achieved procedure numbers are less important than demonstrated competencyin the procedure-specific IE competencies within the milestone domains of knowledge, skill, and communication.

TABLE 13 Medical knowledge and procedural skills competency components for level III IE training: interventions on replaced and repaired valves

Medical knowledge
· Know the assessment of the mechanism and accurate quantification of severity of structural and nonstructural dysfunction of replaced and repaired valves
· Know the device-specific sizing techniques for transcatheter management of prosthetic valve dysfunction
· Know the anatomic features that pose increased risk for adverse outcomes after device therapy for prosthetic valve dysfunction
· Know the characteristics of available septal occluder devices
Procedure skills
· Skill to distinguish between prosthetic paravalvular and valvular regurgitation
· Skill to accurately quantify and describe the location of a PVL and provide imaging guidance for percutaneous closure
· Skill to rapidly display and interpret multiplanar imaging to guide positioning of the percutaneous device

TABLE 14 Medical knowledge and procedural skills competency components for level III IE training: LAA occlusion procedures

Medical knowledge
· Know the key anatomic features of the LAA, including its ostium, body, and accessory lobes
· Know the variety of LAA shapes (windsock, chicken wing, cauliflower, etc.) and their impact on percutaneous LAA closure
· Know the anatomic relationships of the LAA to the surrounding structures, including the mitral valve, pulmonary artery, pericardial space, and left-sided pulmonary veins
· Know the characteristics of available LAA occluder devices
Procedure Skills
· Skill to visualize the LAA in multiple 2D and 3D transesophageal echocardiographic views for LAA sizing and procedural guidance specific to each closure device
· Skill to evaluate the technical success and complications of the LAA closure device implantation and the need for further intervention

TABLE 15 Medical knowledge and procedural skills competency components for level III IE training: transcatheter septal occluder procedures

Medical knowledge
· Know the characteristics of available septal occluder devices
· Know the anatomy of the fossa ovalis, IAS and interventricular septum, and relationship with adjacent structures
Procedure Skills
· Skill to perform agitated saline contrast study to assess for intracardiac shunt
· Skill to size ASD, PFO, and VSD and adjacent anatomy using 2D and 3D echocardiography, as well as 3D MPR
· Skill to guide the delivery system through the septal defect using a combination of 2D and 3D imaging, including ICE
· Skill to perform a comprehensive assessment for appropriate device position, stability, function, and presence of PDL

ASD, Atrial septal defect; *VSD*, ventricular septal defect.

A core principle emphasized in this document is that the length of program duration or achieved procedure numbers are less important than demonstrated competency in the procedure-specific IE competencies within the milestone domains of knowledge, skill, and communication.

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