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From a priori to evidence and advocacy: The evolving paradigm of CCT competency for structural heart disease

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Invited Editorial

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Since 2005, the technological advances of multidetector-row cardiovascular computed tomography (MDCT) have fostered a new, modern era of multimodality imaging in cardiovascular medicine, and maturation of coronary CT is now supported by multi-guideline[1,2] recommendations for first-line imaging testing for patients with suspected stable and acute forms of coronary artery disease. During the evolution of application of coronary CT to clinical practice, the field of structural heart imaging concomitantly arose with the requirement of MDCT as a prerequisite standard for structural and valvular heart disease planning for transcatheter interventions.[3]

Pre-procedural MDCT evaluation has been instrumental in guidance of transcatheter aortic valve replacement (TAVR) interventions in patients of extreme inoperable,[4] high,[5] intermediate,[6,7] and low[8,9] risk symptomatic severe aortic stenosis. MDCT preprocedural imaging of TAVR is a vital component to successful TAVR planning. Structural CT planning created the need for novel competency standards for imaging physicians to demonstrate facility and proficiency. The 2020 Society of Cardiovascular Computed Tomography (SCCT) guideline for training levels of Independent (IP; Level II) and Advanced (AP; Level III) Practitioner physicians in CCT defined standards for TAVR was established based on expert consensus. Prospective data validating these competency metrics have been unavailable to date.[10]

In this issue of the *Journal*, the LEARN-CT study by Paolisso et al.[11] sought to investigate the effective learning curve and minimum number of cases specifically for cardiology fellows in training (FIT) to obtain an 80% level of accuracy regarding annular assessment measurement relative to an expert TAVR-CCT specialist reference reader. This was a prospective, observational study over a 7-month period involving four FITs (two interventional cardiology and two non-invasive cardiac imaging, all without prior pre-procedural TAVR structural CT analysis experience) and one expert physician reader with 5+ years of peri-procedural TAVR structural CT experience. Prior to reading the structural CTs, a 3-h curriculum consisting of lectures focusing on software interface, functions, and post-processing analysis of the imaged aortic annulus, and finally 3 pre-study sample cases were reviewed with each trainee. During the entire study period the FITs attended weekly institutional TAVR meetings, where all cases were discussed. After the pre-reading training, the four FITs and expert physician each performed an independent analysis of the same 40 cases (all trileaflet aortic valves without prior valve replacement) in blocks of 5 according to the chronological order in which patients were consecutively scheduled for TAVR. Each case underwent repeat analysis by the physician after a 48-h time span, prior to proceeding to a subsequent series of cases. In summation, each individual performed 80 case readings. All physician readers performed the measurement analysis with a semi-automated software (3mensio Structural Heart, version 9.1 SP3, Pie Medical Imaging, Maastricht, Netherlands) according to an expert consensus TAVR-CCT radiology document.[12] Each reader was blinded to the results of the other readers. At the end of each examination, the reader was asked to select the appropriate valve size both for balloon-expandable and self-expandable valves according to standard published cutoffs. The first measurement of each case was used to assess accuracy of each FIT compared to the expert physician; the second measurement of each case was used to evaluate intra-observer variability for each FIT.

The primary outcome of the study was minimum of case readings to achieve ≥80% accuracy in TAVR aortic annulus sizing, defined as agreement in choosing the correct prosthesis size for both of valve types by each of the 4 FITs with respect to the expert. After completion of 50 readings (5 series of 5 cases, each interpreted twice), the cardiology FITs demonstrated ability to appropriately select TAVR prosthesis size in ≥80% accuracy of cases as compared to the reference reader. The FITs achieved 80%, 80%, and 85% accuracy for the sixth (cases 26–30/readings 51–60), seventh (cases 31–40/readings 61–70), and eighth (cases 41–50/readings 71–80) series, respectively. Secondary outcomes were intra- and inter-observer variability. The FITs had high intra- and inter-observer agreement for both annulus area and perimeter measurements, with intraclass coefficient of 0.96–0.99.

The authors are congratulated on this important new work in structural CCT competency. In placing the LEARN-CT Study within the context

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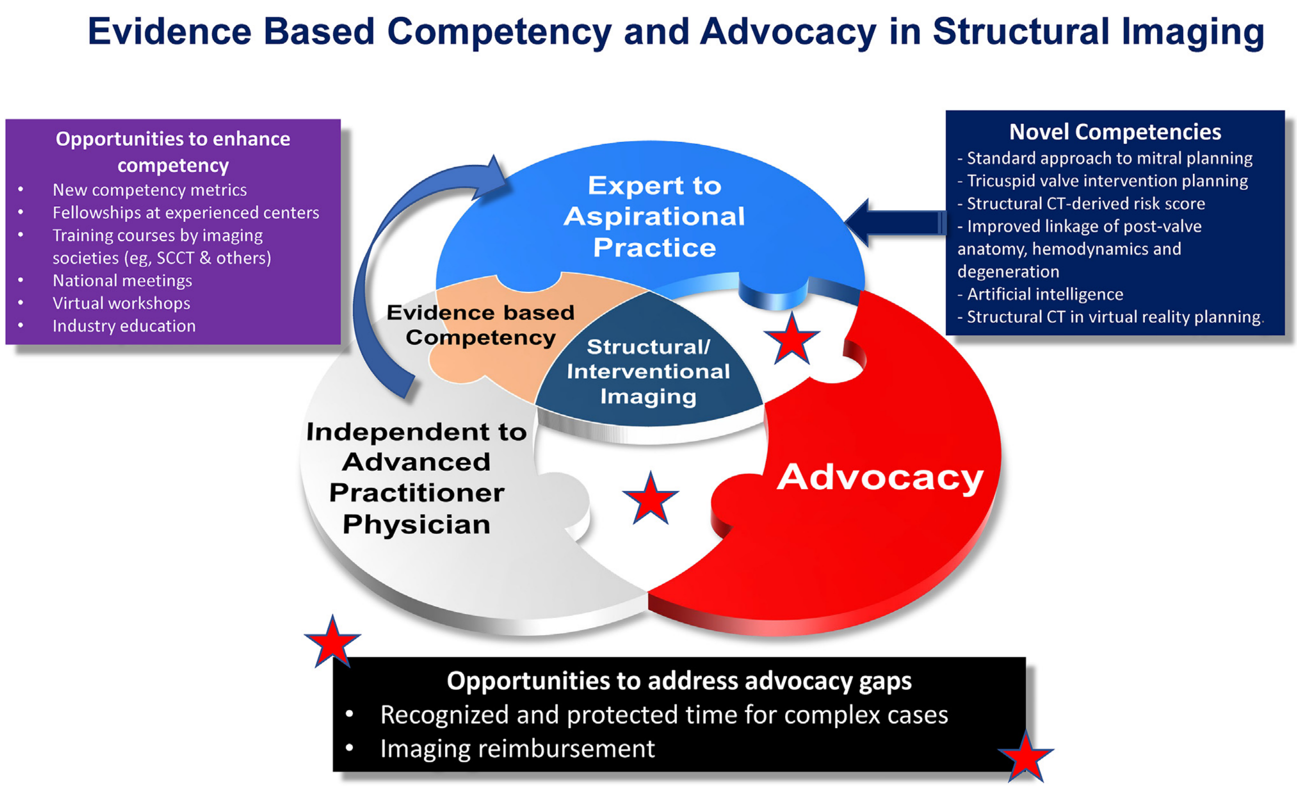

Fig. 1. Evidence Based Competency and Advocacy in Structural Imaging. The steps to cardiovascular computed tomography structural imaging excellence start with foundational education and training for exposure and achievement of baseline competency skills in the early years of formal training; next to acquire independent and advanced competency skills by progressing from classic, uncomplicated cases to ever increasing complex and niche applications during the final years of formal general and subsequent subspecialty/advanced fellowship. Then, beyond fellowship, lifelong learning to achieve expertise through real-world clinical case experience, continuing medical education and training into novel and aspirational frontiers. These competency efforts should be supported by ongoing and renewed advocacy efforts to support the next generation of structural imaging physicians to acknowledge this expertise through protected time and appropriate reimbursement for structural imaging physician centrality in the multi-disciplinary heart team.

of the 2020 SCCT IP/AP training guideline and in the field broadly, this study provides important evidence for reproducibility and evaluation of the aortic annulus for early physician practitioners seeking to learn TAVR planning. The authors' findings presented in the current study further supports the SCCT's expert consensus document recommendations of 50 mentored structural MDCT examinations that include basic competency in uncomplicated aortic annulus sizing for TAVR planning. The findings also are helpful to understand that competency may be achieved for both interventional cardiology and imaging cardiologists. The LEARN-CT Study's findings create a model to further understand the necessary minimums for structural heart disease MDCT training in extending basic competency standards for other approaches that include transcatheter mitral valve replacement (TMVR), left atrial appendage occlusion, and transcatheter tricuspid valve replacement not yet fully established by evidence in societal guidelines.

There are several limitations of the study. This was a small, single-center study with only a single-digit number of trainees involved, thus diminishing the broad generalizability of these findings. Whereas the 2020 CCT training guideline emphasizes competency for both cardiologists and radiologists, the current study was limited to cardiology trainees with an understanding of aortic valve pathophysiology. The clinical imaging evaluation of TAVR MDCT procedural planning extends beyond training for aortic annuli sizing and is fairly comprehensive: requiring full assessments of the peripheral vasculature for standard and alternative access evaluation, carotid protection device feasibility, prediction of optimal fluoroscopic projection angles for device deployment, and landing zone calcium of the aorto-annular complex impacting prediction of procedural risk, such as paravalvular regurgitation or ventricular septal defect from infra-annular calcium or coronary obstruction. In this study, the authors limited structural MDCT training to trileaflet morphologies, additionally excluding valve-in-valve TAVR planning. Basic level TAVR planning requires an understanding of common potential procedural risks; in this study, not accounted for is the critical learning curve required for coronary height evaluation as part of coronary obstruction risk in TAVR patients. Additionally, the pre-TAVR scan covers the thorax and abdomen; identification of incidental findings in these anatomic locations are non-trivial real-world possibilities, which was not assessed in this study. Radiologists in training add comprehensive understanding of clinically important findings through their rotations in chest and body imaging that highlight the benefits of a collaborative cardiology and radiology approach to the evaluation of these cases. Finally, this study utilized one specific semi-automated software that may alter the learning curve for accurate identification of the virtual aortic annular plane. To date, there is no standardization on accuracy of semi-automated TAVR software on aortic annular and coronary height detection.

Looking to the future, the complexity of cardiovascular CT science increases the scope of learning for advanced cardiovascular imaging physicians. Physician practitioners must not only achieve basic competency in coronary imaging but *must* reach a minimum threshold exposure to TAVR MDCT and structural procedural training. The authors should be commended for providing a scaffold for the field of Structural Heart Imaging to develop MDCT education standards with their prospective study design for all learners. This data highlights the crucial importance of an achievable level of physician imaging expertise to allow for multi-disciplinary heart teams to develop confidence in complex structural procedural case planning that is independent of vendors. Recent survey data from the SCCT's Fellows and Resident Leaders of SCCT (FiRST) Committee notes that while 86% of survey respondents reported presence of structural interventional imaging scanning within their institution, only 48% of radiology fellowships and 19% of cardiology imaging fellowships surveyed included structural interventional imaging training.[13] These findings highlight new target goals for updating methods of education delivery. Modern educational forums delivered via virtual workshops, online didactics, and away electives are current avenues for societal exploration to advancing physicians' educational needs. The refinement of competency standards must go hand in hand with renewed advocacy efforts to support the next generation of Structural Heart Imaging clinicians (Fig. 1).

There remains a delay in recognition of the clinical expertise provided by interventional imaging physicians with multi-modality imaging training, capable of melding the findings specialized in structural CT to intraprocedural interventional echocardiography. National survey data from the American College of Cardiology's Imaging Council Structural Heart Workgroup found that the average interventional imaging physician spends a minimum of 7–14 hours of their clinical time per week in pre-procedural patient evaluation, and intraprocedural support. However, the majority (57%) of these imaging physician experts received no protected time for these efforts. Furthermore, time spent in the interpretation of complex structural CTs remains grossly undervalued by payors in North America.[14]

In conclusion, the LEARN-CT Study with TAVR serves as a feasible blueprint to model other facets of structural heart disease imaging training. As the field of structural imaging continues to expand, this study supports the need to continue to advance and update competency standards for all levels of physician practitioners. Advocacy for standardized education in the field of structural imaging provides a critical building block to development of societal-driven objective parameters for safe and scalable advancement of new transcatheter devices.[15]

Declaration of competing interest

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