ROUNDTABLE DISCUSSION

Real-World Challenges in the Structural Imaging Arena

Edwin C. Ho, MD, FRCPC, engages an expert panel on issues important to navigating a career in structural heart interventional imaging.

WITH ANDREW D. CHOI, MD, FACC, FSCCT; JEFFREY B. GESKE, MD, FACC, FASE; STEPHEN H. LITTLE, MD, FRCPC, FACC, FASE; AND DEE DEE WANG, MD, FACC, FASE, FSCCT

Transcatheter interventions have become a mainstay for modern cardiovascular interventions. However, much of the evolution of transcatheter therapies has been focused on device delivery and device success, with little recognition of the complex interventional imaging support necessary to guide the implantation of new therapies. This oversight has left many interventional imagers—who are equally dedicated to the success and delivery of modern technologies as they are to patient care—in an academic and clinical quandary. Due to the lack of societal recognition of the interventional imaging field, physicians and trainees interested in pursuing a career in interventional imaging have little supporting documentation or guidance to justify their time spent on planning and leading these procedures, with little reflection in direct relative value units (RVUs).

Caught in the no-man's-land of being labeled noninvasive versus interventional imagers, the question remains: How do physicians justify their time for the clinical need in transcatheter interventions? In this article, Edwin C. Ho, MD, FRCPC, a professional early in his career at the front lines who is passionate about patient care and transcatheter technologies and experiences these difficulties, asks interventional imagers established in the field how they navigate a career in structural heart interventional imaging.

TRAINING

Dr. Ho: What should trainees look for in searching for an interventional imaging fellowship? How do we standardize the training of future colleagues and make it more accessible to those who are interested in focusing on this cardiology subspecialty?

Dr. Little: The training pathways for interventional imaging are not straightforward. The stakeholders seeking training include those currently in an Accreditation Council for Graduate Medical Education (ACGME) core fellowship (cardiology or anesthesia), those in a non-ACGME fellowship (a multimodality imaging fellowship), and those already in the workforce who want to gain competency in structural imaging guidance. The needs, expectations, and challenges for each of these stakeholders are different. The easiest modification to consider for those already committed to a full-time fellowship is to accept some adjustment to the recently published Core Cardiology Training Symposium competencies for level III echocardiography training.[1] Currently, level III training does have requirements for exposure to several interventional procedures; however, specific training in structural heart imaging guidance should mandate specific additional time and experience to achieve competency for these specific procedures. The conversation now should focus on defining reasonable training pathways that incorporate substantial elements of the level III pathways but also permit some specialization for the intraprocedural role.

Until these training pathways are clarified (and endorsed), an interested trainee today should look for a training center that offers expert mentorship in specific procedures, a well-respected heart valve team, and high procedure volume.

Dr. Wang: Trainees interested in pursuing a career in interventional imaging should first understand what procedures or skill sets they want to be equipped with knowledge and proficiency in. This is similar to how a general cardiology fellow interested in interventional cardiology will have a sense of if they want to differentiate with additional skill sets, such as peripheral skills, and if they want additional training as a chronic total occlusion operator or structural heart implanter.

Many programs offer exposure to transcatheter aortic valve replacement (TAVR) imaging. If a cardiology fellow wants to be trained in a diverse amount of structural interventional imaging skill sets (eg, MitraClip [Abbott Structural Heart] procedures, paravalvular leak closure, transcatheter mitral intervention), they should look for hospitals with adequate volume to accommodate their diverse interests on the interview trail.

The first step toward standardizing training in the field of interventional imaging involves formally recognizing this as a new subspecialty within cardiology. The more publications and manuscripts that are produced on the skill sets and know-how of interventional imagers, the sooner formalized training documents will be established.

Dr. Geske: Because cardiovascular multimodality imaging is not an ACGME-accredited fellowship, there can be significant variation in exposure to interventional imaging. However, structural interventions are rapidly growing and new technologies are evolving—just look at the PARTNER 3 data and recent FDA approval of transcatheter mitral valve repair for functional mitral regurgitation. Trainees should look at the volume and variety of procedures that are performed at an institution they are considering. Institutional involvement in ongoing structural trials is certainly beneficial as well.

I believe that the role of the structural interventional imager will continue to grow. The first step in standardizing training is to recognize the vital importance of this role within the heart team. As recognition occurs, I think that improvements in reimbursement and standardization of training programs will follow.

Dr. Choi: Through structural interventions, cardiovascular medicine is rapidly changing, and it is important that our training pathways evolve to match. Our current training paradigm in imaging is modality-centric, yet interventional imaging requires a multimodality, patient-centric approach. With this in mind, a trainee should seek an institution with a strong echocardiography program and a strong cardiac CT program. For cardiology trainees, the latter may involve seeking an institution with a strong cardiology-radiology collaboration (#CardsRads on Twitter) or a cardiology-driven advanced imaging program.

Dr. Ho: Because there is so much variability in device access and volumes across different centers internationally, do you think there is a minimum number and type of procedures that a trainee must learn to develop proficient skills in interventional imaging?

Dr. Little: A specific minimum procedure volume is difficult to mandate. The idea of training is to see both easy and complex cases, experience challenges, and learn from each encounter. The breadth of cases and the level of imaging independence (the freedom to falter and recover) are just as important as the total number of cases performed. Additionally, it must be emphasized that training is about achieving competence, not expertise. No matter how good the training, expertise in a specific area of medicine will always require additional time. Hopefully, if the training is good, the volume is high, and the interest to learn continues, then expertise can be achieved relatively quickly.

Dr. Choi: When I started in the field of TAVR in the midst of the PARTNER trials, two-dimensional transesophageal echocardiography (TEE) was mandatory, but procedural complications were common. With advances in imaging planning (three-dimensional TEE and CT) and device improvements, complications are now rare. In fact, intraprocedural TEE may often be omitted; however, the complexity remains. Mitral (and most recently, tricuspid valve) imaging has added intricacies, and we think the threshold for competence should be higher here than for TAVR. I personally developed expertise in the operating room through complex intraoperative cases alongside a cardiologist and surgeons—a rarity at many places.

Dr. Wang: From the recent manuscript in *Structural Heart: The Journal of the Heart Team*,[2] we have proposed among our group of high-volume operators and imagers a recommended minimum procedural volume to help physicians understand what they should look for in training. Similar to the structural interventionalist, interventional imagers have an equal need for training of muscle memory, tactile sensation, spatial visualization, and catheter (ie, TEE probe) manipulation skills.

Another key aspect to developing proficient skills in interventional imaging involves training with the structural implanter you will work alongside. Structural intervention is analogous to a pairs figure skating team. The structural implanter and interventional imager are partners and co-operators in these high-risk procedures. The interventional imager must be in step with the implanter during procedures, proactively anticipating, preventing, and assessing for

procedural complications. Interventional imagers should attend hands-on training courses for new devices with the implanters, and they should learn to think and communicate in ways that will empower the structural implanter with helpful information in procedural guidance. This partnership must be formed on mutual trust and respect.

Dr. Geske: The short answer is yes. Not all structural interventions are the same, and to develop a skill set for interventional imaging, one needs exposure to various procedures (not just TAVR, for example). Beyond the need for broad exposure, it's worth recognizing that there is a difference between competence and expertise. Someone who is pursuing training with a focus on structural imaging and wants to establish expertise in the field will need a greater exposure to various structural procedures.

Dr. Ho: Interventional imagers must use advanced skills in echocardiography, CT, and fluoroscopy to successfully guide transcatheter structural procedures. Do you think formal multimodality imaging training should be included in future training standards?

Dr. Wang: We are fortunate to be developing the field of structural heart disease treatment in an era where technology that can help support innovation exists. However, training and public understanding of the complexities of imaging fellowships has been diluted with the term *multimodality*. Multimodality imaging has been a coined term for advanced imagers in the past decade who specialize in more than one imaging modality (eg, echocardiography and nuclear medicine imaging, echocardiography and cardiac MRI, echocardiography and coronary CTA). However, every aspect of structural heart transcatheter procedures involves imaging—including fluoroscopy, which happens to be one of the oldest forms of imaging.

The future interventional imager should be able to interpret the following imaging modalities as cornerstones for training: fluoroscopy, hemodynamics, echocardiography, and CT. However, it is not feasible for one person to be an all-star in all multimodality imaging skill sets (eg, carotid duplex, nuclear medicine imaging, vascular studies, cardiac positron emission tomography, cardiac MRI). At the end of their fellowship training, the interventional imager should know how to think like an interventional imager but be able to translate for and speak like an interventionalist.

Dr. Choi: A new multisociety expert consensus proposal was just published in April 2019 to optimize care for valvular heart disease, and it briefly speaks to multimodality advanced imaging being part of a comprehensive valve center.[3] I hope recent publications on this topic in *Journal of the American College of Cardiology (JACC): Cardiovascular Imaging*[4] and *Structural Heart: The Journal of the Heart Team*,[2] as well as publications by other like-minded imagers, will add to further synthesis in training standards.

Dr. Geske: We are learning more and more that structural interventions benefit from multimodality guidance. Although echocardiography remains a cornerstone of structural interventional imaging, it is becoming increasingly apparent that imagers need to have competence in synthesizing data from various modalities, such as CT and fluoroscopy. As new technologies emerge, the role of multimodality assessment will only continue to grow.

Dr. Little: Today, the best preparation for a career in structural imaging should include advanced echocardiography (incorporating three-dimensional imaging and display when appropriate), a sound understanding of CT imaging, and familiarity with the multiple commercial software programs that are widely used to screen patients and decide on specific device sizes. Additionally, cardiac MRI is an imaging modality increasingly being used to evaluate complex regurgitant valve lesions and cardiac chamber remodeling. Thus, the field of structural heart intervention is clearly a multimodality imaging enterprise. The more each heart team member understands these options, the stronger the team will be.

CAREER DEFINITION

Dr. Ho: Interventional imaging as a career and title often confuses many people. When I was a trainee, most of my supervising cardiologists had no idea what I was talking about. Are there ways to improve how we define our roles or titles? Given our extensive focus and dedicated time for procedures, does the category of "noninvasive cardiologist" still apply to an interventional imager?

Dr. Little: It is hard to work within a fluoroscopic environment for multiple hours, acknowledge the hazards of ionizing radiation, experience the physical discomfort of protective lead, and know that you share equally in the success or failure of any case—and to be called a "noninvasive cardiologist." But within cardiovascular medicine, many of these historical work categories are changing. Cardiovascular surgeons are learning to manipulate wires and catheters, interventional cardiologists are using intravascular ultrasound, and echocardiographers have become highly trained proce-

duralists. At the front line of structural heart intervention, the roles of the physicians are rapidly evolving. The members of the heart team usually embrace these changes, but the physicians and administrators who are unfamiliar with the team activities often do not.

Dr. Geske: At Mayo Clinic, we have established a core group of interventional imagers within our pool of echocardiographers. This has come about from recognition that experience with interventional procedures and expertise with guidance in the cath lab affects quality. The first step to defining the role of interventional imaging is to recognize the impact that these individuals have on quality. Imaging guidance of structural interventions is an essential component of procedures. Increasingly, we are seeing those who have trained in multimodality imaging enter our dedicated group of interventional echocardiographers. Many of these individuals also perform echo-guided pericardiocentesis, further blurring the labels of "invasive" and "noninvasive" cardiologists.

Dr. Choi: In general, I think titles look nice on individual business cards, but on a day-to-day level, the work of the interventional/structural imager is within the overall heart team. However, given the complexity of the work in this field, it is important to define interventional imaging from the perspective of advocacy, guidelines, and benchmarking.

Dr. Wang: Interventional imaging as a career will be more recognizable as more transcatheter devices receive CE Mark approval, pass through their clinical trial phases, and enter the commercial market to allow more hospitals and physicians access to the new technologies. We are at a fortunate time in the field of cardiology where there is so much innovation occurring. However, only a limited number of hospitals are involved in these clinical trials for new technologies. This lag in access to clinical trial devices, training, and education often amplifies the misunderstanding of therapies and treatment options available for patients. Improving understanding will occur as more data are published, more time is invested by societies to engage clinicians on the impact of these clinical trials, and time passes.

Improving understanding and acceptance of interventional imagers starts with clearly articulating what their daily duties are and emphasizing the value of their work to the patient, the heart team, and the hospital. Every general cardiology fellow starts off as a noninvasive trainee. When a cardiology fellow starts their interventional training performing structural procedures, and an interventional imaging fellow steps into the cath lab or operating room to guide these procedures and stands next to the fluoroscopy C-arm wearing the same leads as the implanter but receiving three times the radiation exposure of the implanter, they become part of the structural heart interventional team.

CAREER TRAJECTORY

Dr. Ho: Ambitious young cardiologists who are interested in interventional imaging likely have some concerns about the legitimacy of the field, particularly in terms of whether one can truly build an academic career in this space alone. Do you think interventional imaging will eventually become a separate entity from noninvasive imaging and offer the same academic career potential?

Dr. Geske: Strike while the iron is hot! There is a renaissance of structural interventions going on now! As procedural volumes continue to quickly rise, there is a wealth of opportunities for academic study. Regardless of whether interventional imaging becomes a separate entity from noninvasive imaging, I strongly believe that there are numerous academic niches that need to be filled.

Dr. Wang: Do what you love. Structural heart is a field in its infancy. Interventional imaging will become the cornerstone of structural heart imaging because it has a role in every step of patient evaluation, including assisting the team in identifying patients who may need intraprocedural hemodynamic support, identifying intraprocedural indications for atrial septal defect closures, discussing anatomic pros and cons for transcatheter mitral valve replacements versus repair strategies, and left ventricular assist device implantation. Structural heart as a field is breaking down the traditional silos of medicine and making the concept of the heart team the standard of care. There is academic potential in every career, especially the new subspecialty of interventional imaging.

Dr. Little: The academic and employment opportunities for a newly minted interventional imager are excellent. Very few programs are currently training for this field, yet the clinical need is growing rapidly. With the expansion of MitraClip indications and the expected expansion of TAVR indications (including the low-risk surgical population), the need for appropriately skilled imagers within these heart teams is paramount. Already, there is a national need for this skill set, and that need will only increase. What is likely to change significantly is the employment model. Rather than the fee-for-service (ie, work RVU [wRVU]) model, it will more likely be a model of hospital employment based on procedure par-

ticipation and high-quality clinical outcomes. As the nation slowly moves to recognize payment models based on outcomes and as public reporting of hospital outcomes becomes more common, the structural imager will be highly valued by employers and colleagues alike.

Dr. Choi: To quote hockey great Wayne Gretzky, "Skate where the puck is going, not where it has been." Structural imagers are in high demand, and the future is in mitral and tricuspid interventions. However, this remains a niche field, and we still need outstanding clinical cardiologists first and foremost. The imager should also maintain a broad-minded approach to training.

Dr. Ho: Research recognition and opportunities for interventional imagers are quite limited in the field at this time. Although interventional imagers are often heavily involved in patient care/selection/screening, the actual structural heart intervention, and the clinical follow-up process, it is rare to see them involved in clinical trials as primary investigators (or coprimary or even site investigators) and included in publications. This can be seen as a barrier to career advancement in the field. How do we change this moving forward?

Dr. Geske: I agree that the degree of imager representation in clinical trials has been disappointing. Perhaps that makes the prospect of academically oriented imagers entering the field all the more motivating. Having a precedent can be reassuring, but breaking new ground (which is inherent to the current interventional imaging revolution) is all the more exciting.

Dr. Wang: It is critical for the interventional imager to be recognized as a member of the heart team. As industry develops clinical trials that are dependent on interventional imaging guidance, there will need to be more recognition of interventional imagers as co-operators.

Dr. Choi: I see a slightly different perspective. COAPT, one of the main late-breaking clinical trials at the American College of Cardiology's (ACC) 68th Annual Scientific Session, included echocardiography data presented by an echocardiographer, Dr. Federico Asch. *JACC: Cardiovascular Imaging* has had recent issues focus on aortic and tricuspid interventions.[5,6] Yet, we do need to encourage more prospective collaborations. Social media has been a wonderful way to shrink the world to foster these collaborations.

Dr. Little: An excellent question and a real problem today. Some of this pattern in clinical trial leadership stems from the first-generation TAVR experience when the devices required transapical surgical implantation. But, why has this persisted today when the structural heart imager plays a central role in patient selection, treatment, and follow-up? As the device companies who sponsor these trials begin to see challenges in trial enrollment and procedure quality, perhaps now is the time to add volume to the voice of leaders in structural heart imaging.

Dr. Ho: At this time, it appears that there is variability in how successful a structural imaging expert can become based on the site where she or he works. Do you think there is something unique about your site that supported you in becoming a recognized expert in the field? In general, how can structural programs, cardiology divisions, and hospitals create an environment that can allow an interventional imaging expert to excel?

Dr. Wang: At Henry Ford Hospital, I am very fortunate to work under the leadership of Dr. William O'Neill, Medical Director of the Center for Structural Heart Disease; Dr. Henry Kim, Chair of Cardiology; and Dr. Eric Scher, Chair of the Department of Internal Medicine. From very early on in the building of our structural heart program, the hospital has recognized and understood the value of imaging toward patient-centric care. Without the support of cardiovascular leadership and administrators, this is a very difficult career to navigate.

Traditional RVU metrics hinder the scalability of a robust structural heart program because the system identifies procedures as single-operator cases. Structural heart procedures break traditional RVU metrics and definitions. For example, a MitraClip procedure requires two operators: the implanter and the imager who guides the implanter during the procedure. Therefore, if a health system anticipates growing a procedure such as Mitraclip or mitral paravalvular leak, the amount of time the interventional imager spends on reviewing and synthesizing multimodality imaging case files, putting together a procedural case plan, and intraprocedurally guiding the case must all be accounted for as productivity.

There is no perfect reimbursement system to account for the work of the interventional imager. Interventional imagers must understand the economics of transcatheter therapies and how their time contributes to the delivery of safer patient care, faster and more efficient procedures, and patient-centric evaluations. Hospital health systems interested in starting a structural heart program would benefit from visiting established high-

volume structural heart centers to understand the different components to building a successful heart team.

Dr. Choi: The success of our structural and interventional imaging program is rooted in strong clinical leadership, from the chief to interventional cardiology leadership, that promotes a collaborative approach among implanting physicians and imaging physicians. On an administrative level, we utilize a salaried structure with fair distribution of revenue across team members. The success of the program is measured by clinical quality and outcomes, rather than by volume. The interventional imager is protected from other clinical responsibilities on procedural days.

Dr. Geske: Mayo Clinic has been a pioneer in structural interventions and has recognized the crucial role of imaging guidance throughout the process. Because Mayo Clinic utilizes a salaried system, as opposed to one based on RVUs, reimbursement is distributed among the department. Within our imaging group, we have dedicated structural imagers. Divisional leadership has recognized the growing time commitment that interventional imaging has created and has adapted physician scheduling to account for the time required to guide procedures.

GUIDELINES

Dr. Ho: There are currently no training or competency guidelines for interventional imaging. Instead, industry provides specific protocols for each device. Is there a role for developing a general screening/imaging guideline for current structural interventions to maximize consistency and quality? If such a guideline were to be written, how would we potentially address device-specific imaging requirements and the rapidly changing field (eg, new device iterations, new devices or device categories, advances in imaging software, new developments in patient selection)?

Dr. Little: The recently published advanced training document does provide important new descriptors of the competencies expected to be achieved during level III echocardiography training.[1] Several expert groups are currently working to describe preliminary recommendations about how to achieve special competencies for the imaging guidance of specific interventional procedures. However, many procedures are in a state of rapid change. As each procedure (and associated devices) becomes more mature, there will undoubtedly be a wave of guidelines and practice recommendations for those seeking training.

Dr. Geske: I do believe that we need to define standards for competency and establishing expertise in interventional imaging. Because this extends beyond a single modality, input and representation from various imaging societies (eg, American Society of Echocardiography, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance) will be needed. However, the field of structural interventions is rapidly evolving, and interventional imaging is evolving along with it. Therefore, the idea of an all-encompassing, massive guideline that will serve as a reference document for years seems misguided. In my mind, a more living document that is adapted as technologies emerge would be much more applicable.

Dr. Choi: In addition to the recently published proposed curricular standards in *Structural Heart: The Journal of the Heart Team*[2] and *JACC: Cardiovascular Imaging*,[4] upcoming cardiac CT educational curriculum guidelines for cardiology and radiology trainees will add emphasis on structural imaging. I am excited by recent ACC/American Heart Association clinical practice guidelines,[7] which recognize that the development of guidelines themselves need to evolve. This document notes that the future of guidelines is the concept of the "modular knowledge chunk," which allows for rapid evolution of societal guidelines. Perhaps this can be a model that the rapidly growing field of interventional imaging can follow.

Dr. Wang: There has been enough volume in the structural heart field to allow a basic algorithm for defining routine transcatheter procedures such as TAVR and left atrial appendage closures. However, the structural heart field is still rapidly developing and undergoing iterative improvements and technological breakthroughs. Any guidelines or training competency statements that are released should be revisited on a frequent basis because the structural heart and interventional imaging fields are dynamically evolving.

REMUNERATION

Dr. Ho: Remuneration is a challenge for interventional imagers in many countries. Traditional models of determining physician productivity and associated reimbursement calculations (eg, the RVU-based system in the United States or the fee-for-service billing model in Canada) do not account for the consultative preprocedural screening, case planning, intraprocedural expertise, and skill sets involved in guidance of high-risk transcatheter procedures. What are realistic options to overcome these limitations?

Dr. Geske: There is a very real, national concern that the current state of reimbursement does not adequately compensate for the degree of expertise, amount of time, and potential risks—including radiation exposure and the need to wear lead—that are associated with interventional imaging. Mayo Clinic has a salaried system as opposed to being based on RVUs. This, alongside leadership recognition of the value added by interventional imaging, has resulted in an environment that is supportive of the resources needed to grow structural interventional imaging. Guidance of a complex procedure may sometimes take hours, and having departmental and divisional support of this time is needed.

Dr. Wang: The RVU-based system in the United States does not accurately reflect the technical, physical, or mental skill set required for an expert interventional imager to successfully guide a high-risk procedure. Clinical and administrative leadership support is critical to ensuring the interventional imager has adequate radiation-shielding resources, periprocedural planning time, and intraprocedural workflow to allow for uninterrupted focus on the procedure at hand.

Salary models are the most realistic options for the interventional imaging career. If interventional imagers constantly have to find ways to justify their time, worry about lost time due to procedures, and make up their "lost revenue," then these talented physicians will mentally and physically burn out of this career pathway.

Dr. Little: New models of remuneration will undoubtedly develop. Recognition of the role of the imager in achieving and maintaining high-quality procedural outcomes will drive this change. The wRVU will go away. As the payment for some structural procedures increases or as the volume of those procedures increases, hospital administrators will be looking to hire well-trained imagers to guide those teams.

Dr. Choi: This is an important question to ask. A potential future model could move from a traditional departmental structure to an administrative structural heart team that allows for shared resources and revenue allocation. In the present day, strong institutional leadership that recognizes the need for protected time for the individual imager is key, while the major professional societies take the lead in effective national approaches to advocacy. ■

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