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Review Article

Integrating Structural Heart Disease Trainees within the Dynamics of the Heart Team: The Case for Multimodality Training

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ABSTRACT

Structural heart disease is a rapidly evolving field. However, training in structural heart disease is still widely variable and has not been standardized. Furthermore, integration of trainees within the heart team has not been fully defined. In this review, we discuss the components and function of the heart team, the challenges of current structural heart disease models, and possible solutions and suggestions for integrating trainees within the heart team.

ABBREVIATIONS

APP, advanced practice provider; SAVR, surgical aortic valve replacement; SHD, structural heart disease; TAVI, transcatheter aortic valve implantation.

Introduction

Over the past 2 decades, noncoronary transcatheter cardiac interventions–especially transcatheter aortic valve implantation (TAVI) – have established the field of "structural heart disease" (SHD), practiced by an interdisciplinary "heart team".[1]

Previously synonymous with congenital heart defects, SHD is now a distinct discipline of cardiovascular intervention.[2] SHD encompasses a wide variety of disorders that involve the valves, walls, and chambers of the heart. The exponential growth of this domain was made possible by significant developments in the engineering and design of transcatheter therapies.[3]

In a parallel path, regulators' early requirement of 2 cardiac surgeons and an interventional cardiologist for the initial evaluation of patients considered for TAVI was responsible for the emergence and evolution of the heart team in SHD. At its core, components of the heart team include specialists from interventional cardiology, cardiac surgery, cardiac imaging, and anesthesiology; however, the increased complexity of SHD addressed with transcatheter therapies–coupled with the rapid introduction of new technologies and increasing use of shared decision-making–have resulted in larger heart teams, including representation from nursing, rehabilitation, geriatrics, neurology, and others, resulting in evolving heart team dynamics.[4,5]

At the center of this transformation, the heart team must educate and train the next generation of SHD specialists. Like any emerging field, SHD must identify appropriate prerequisites to training as well as milestone progression.[6] A standardized SHD core curriculum with specific training milestones is critical to guarantee safe, effective, and consistent patient care.[7]

This review discusses the heart team's structure and function, the current state and challenges in SHD training, and the emerging role of SHD trainees within the heart team. The review also provides a roadmap for a comprehensive interdisciplinary SHD training.

Heart Team Structure and Function

Development of the Heart Team

The use of an interdisciplinary team to aid in medical decision making has been well-established for decades in certain specialties such as

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oncology. The oncologic tumor board consists of representatives from multiple subspecialties, including medical oncology, surgical oncology, pathology, radiology, and nursing. Given the benefits observed with the use of a standardized team of clinicians, patient care using a tumor board was recommended as early as the 1980s.[8,9] However, the concept was not applied in cardiovascular disease specialties for over a decade.

The emergence of the heart team was not initiated for the routine care of complex patients but in clinical trial settings. The SYNTAX (Synergy between percutaneous coronary intervention with Taxus and Cardiac Surgery) trial randomized patients with three-vessel or left main coronary artery disease to percutaneous coronary intervention or coronary artery bypass grafting.[10,11] All trial candidates were evaluated by a heart team, which consisted of an interventional cardiologist and cardiothoracic surgeon, for trial eligibility as well as suitability for treatment by either modality. From this initial experience, the heart team concept for management of complex coronary artery disease led to the more generalized implementation of a heart team, including an interventional cardiologist, cardiac surgeon, and general/primary cardiologist, leading to a multisociety guideline class I indication for heart team care.[12–14] In a similar manner, as cardiac transplant and left ventricular assist device programs grew, so did the heart team for the heart failure patient population, with heart failure specialists, cardiac surgeons, psychologists, and many others participating in the interdisciplinary care of patients being evaluated for advanced heart failure treatment modalities. This emergence of a team approach to cardiovascular care was also exemplified in the development of interdisciplinary cardiovascular care units and dedicated heart hospitals, encompassing all cardiovascular specialists under one umbrella.[15]

In this milieu, the initial PARTNER (Placement of Aortic Transcatheter Valve) trials A and B were designed to compare TAVI to medical or surgical therapy among patients at prohibitive or high risk for surgical aortic valve replacement.[16] The initial PARTNER trials brought the heart team to SHD to conduct interdisciplinary patient evaluation with designated coprincipal investigators (1 interventional cardiologist and 1 cardiac surgeon) both at the site level and national level. In addition, 2 cardiac surgeons' input regarding each patient's surgical risk was mandated by the Center for Medicare and Medicaid Services (CMS). This CMS mandate established a core requirement for the heart team in SHD. Subsequent PARTNER 2 and 3 trials,[17–19] and the analogous CoreValve trials similarly employed a heart team approach to patient selection and intervention.[20–23] The composition and function of the heart team differed between coronary revascularization trials and heart valve disease trials. While only one cardiac surgeon was required for evaluating coronary artery disease patients to be enrolled in the SYNTAX trial, 2 surgeons participated in evaluating patients for the initial PARTNER and CoreValve trials.

Growth of the SHD Heart Team

With advances in the management of complex coronary and structural heart disease, the heart team continues to expand to provide an interdisciplinary approach to care. For example, as pre-TAVI computed tomography [CT] imaging has become the standard, a cardiac CT specialist has become a critical member of the heart team.[24] Additionally, as transcatheter interventions have progressed to include the pulmonic, mitral, and tricuspid valves, the role of intra-procedural imaging has become increasingly important, giving rise to the fundamental role of structural heart disease imagers on the heart team.[25] Other members of the heart team include the general or primary cardiologists, anesthesiologists, advanced practice providers, and palliative care specialists, whose expertise is invaluable in cases where invasive treatment may not be appropriate.[26] At many teaching institutions, trainees in each specialty are also included in the heart team. Beyond medical specialists, patient-centered care requires that the patient and family themselves be involved with the incorporation of patient values, expectations, information, and shared decision-making regarding a final treatment decision.[27]

While a heart team includes the core subspecialists who collaborate on multidisciplinary decision-making, the exact composition, referral pathway, and organization of the heart team differs from institution to institution. Two principal models are common for the workflow of heart teams caring for patients with SHD. In the first, a cardiologist acts as the gatekeeper for referrals of patients with valve disease to the heart team. The cardiologist reviews each case and refers to surgical intervention, transcatheter intervention, or further discussion with the full heart team for collective triage and procedure planning. The main advantage of this model is the streamlining of decision-making. However, there may be missed opportunities for a full team review of complex cases.

In the second model, referral comes directly to the full heart team through a unified referral protocol. Each case is then reviewed by the full team, and recommendations are made in coordination with the referring provider. The advantage of this model is having all cases and imaging reviewed by all heart team members, providing input from different specialists. However, the process with this model can be time consuming and may lead to delays in care. Additionally, different members of the heart team may be reimbursed differently or not at all for the time and effort spent in reviewing cases.[26]

Current and Future Directions of the Heart Team

Since its formal inception as part of the SYNTAX trial, the heart team has developed into an integral component of care for patients with complex cardiovascular disease, including those with SHD. As the breadth of transcatheter structural procedures has grown, the scope and composition of the heart team has also evolved. Robust and copious data confirm the benefit of the heart team model of care.

Among patients undergoing evaluation for aortic stenosis, interdisciplinary assessment has been shown to reduce mortality among patients treated with TAVI as well as surgical aortic valve replacement.[28,29] Similarly, patients with mitral valve disease also had a mortality benefit when a heart team model of care was followed.[30,31] Guideline recommendations reflect the importance of heart team approach for valvular heart disease,[32–35] with the most recent ACC/AHA Guideline for the Management of Patients with Valvular Heart Disease giving a 1C recommendation for the evaluation of all patients with severe valvular heart disease by a multidisciplinary heart team.[35]

While the heart team has been shown to provide clinical benefits, most studies evaluating these benefits remain small, retrospective, and confined to single centers.[36] Furthermore, several barriers continue to impede the universal implementation of an effective heart team. These barriers include time constraints for gathering all participants, delays in decision-making, and reimbursement limitations. Additionally, the challenges of including patients and families in interdisciplinary decision-making are also barriers to implementation of an ideal heart team model.[26,37] Published data indicate that a team of experts is not necessarily an expert team.[38] Additionally, the medical decision-making process may not be a straightforward one that happens in harmony. An effective team should have shared goals and interdependency.[39]

A central part of heart team evolution was evolving reimbursement models. The CMS requirement for a heart team evaluation of patients with severe symptomatic aortic stenosis as a condition for payment may have played an essential role in heart team development in SHD. Furthermore, specific requirements of heart team components and their experience has become the standard for CMS reimbursement of other SHD and valve procedures. On the other hand, a team would only work as a team if it were rewarded as a team.[40] Current reimbursement models vary among institutions. Separate budgets from different departments and fee for service reimbursement models may not allow team members to reflect and discuss educational points in depth. Overcoming this challenge should start with establishing a shared budget and reward system and appropriate incentives for the heart team.

Structural Heart Disease Training

Current State and Challenges

Training in SHD has historically been fragmented and informal.[7] Current modes of SHD training include unaccredited fellowship training,

Table 1
Proposed care continuum for patients with SHD and proposed heart team members' roles in training

Skill	Supervising heart team member	Setting
Outpatient preop evaluation	Cardiac surgeon, interventional cardiologist, and anesthesiologist APPs	Heart valve clinic
Inpatient SHD consults	Cardiac surgeon, interventional cardiologist, and anesthesiologist	Inpatient wards
Pre procedural imaging evaluation	Imaging cardiologist Interventional cardiologist	Heart valve clinic Imaging suite
Procedure	Interventional cardiologist and cardiac surgeon	Hybrid OR / Cath lab
Post procedure patient care	Interventional cardiologist General cardiologist Intensive care unit physician APPs	Inpatient wards
Follow-up	Interventional cardiologist General cardiologist APPs	Heart valve clinic

APP, Advanced practice providers; OR, Operating room; SHD, Structural heart disease.

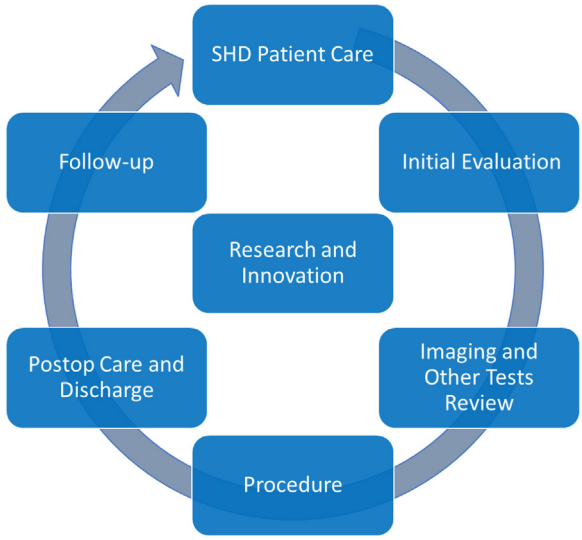

Figure 1. The continuum of care for structural heart disease (SHD) patients.

industry-sponsored forums and device-specific training, and training through on-site proctorship.[41] Despite the unaccredited status of SHD fellowship training, there has been exponential growth in training programs.[42] The American College of Cardiology website now reports thirty-nine training programs, with some programs taking up to 2 trainees every year.[42] This growth has occurred despite the conspicuous absence of formalized training requirements. Another challenge to formal fellowship training in SHD is the variability in fellowship funding sources between different programs, with many trainees simultaneously working as general or interventional cardiologists to cover their fellowship salaries and benefits.

The first step toward standardization of SHD fellowship training is to identify prerequisites for SHD training. Currently, most training programs accept SHD trainees from interventional cardiology backgrounds, with very few accepting trainees who have completed cardiac surgery training. Identifying prerequisites for SHD training will help standardize the starting point for the SHD training process. Programs accepting trainees from cardiac surgery should have a system in place to assist with building catheter and wire skills for these trainees.

Second, training is optimally conducted at high-volume centers with established programs in the specialties that participate in the heart team and follow a well-established process in evaluating patients with SHD. This process should include regular meetings (that is, multidisciplinary meetings) for all heart team members. The heart team should play an essential role in the comprehensive training of SHD trainees. SHD trainees accumulate important technical and cognitive skills from each member of the heart team based on each member's expertise. For example, acquiring core competencies in CT and echocardiography imaging should be supervised by SHD imaging specialists. While SHD trainees with interventional cardiology backgrounds may have exposure to these imaging modalities during their prior training, trainees from cardiac surgery will benefit tremendously from learning in an environment that fosters multimodality training.

Table 2
Structural heart disease procedures and proposed general milestones to be achieved each quarter by SHD trainees

	Skill level			
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Structural procedures - ASD/PFO closure - LAA closure - Paravalvular leak closures - Percutaneous valve implantation - Percutaneous valve repair - Percutaneous intervention for pulmonary vein stenosis - Septostomy - Valvuloplasty	- Detailed and deep understanding of commercially available platforms (device properties, delivery systems, and Pros/Cons for each system) - Ability to perform CTA reconstruction of the treatment target - Ability to interpret imaging studies as it relates to structural heart disease - Ability to evaluate frailty and surgical risk	- Ability to integrate clinical, imaging, and preop testing information to prepare a cohesive treatment plan - Ability to stratify cases based on complexity - Obtain large bore access independently with recognition of vascular complications - Ability to critically interpret the literature on the indications and performance of commercially available platforms	- Supervised then independent performance of device implantation in straightforward anatomy - Ability to recognize complications in a timely fashion - Expand the knowledge base to devices under investigation and their properties	- Ability to devise a treatment plan for complex cases - Ability to efficiently recognize and treat complications - Proficiency in use of bail-out and retrieval devices - Ability to critically analyze and recognize the nuances of newly introduced devices - Ability to treat recognized device failure and long-term complications

ASD, Atrial septal defect; LAA, Left atrial appendage; PFO, Patent foramen ovale; SHD, Structural heart disease.

Figure 2. Jigsaw puzzle representing the heart team components, and the structural heart disease (SHD) trainee playing a central role within the dynamics of the heart team.

Suggested Standardized Core Competencies for SHD Trainees

Repetition has gained its rightly paramount position in learning theory.[43] While transient mental associations may be formed rapidly, repetition engraves concepts into our memories. Medical training utilizes repetition to cement trainees' skills, especially in procedural specialties. Different levels of competency in invasive and interventional cardiology training are, in part, based upon the number of procedures performed. Additionally, the numbers required for each level (I-III) must be accomplished over a certain time period.[44] This condensed task performance is referred to as "blocked repetition".[45] A similar structure is needed for SHD training. Specifically, optimal SHD training requires high-volume repetitions over a circumscribed period of time of different functions of the heart team.[45] These tasks should be supervised by the heart team members, each according to their specific expertise (Table 1). A designated program director must coordinate and supervise the accomplishment of prespecified milestones for each of these functions.

Table 2 summarizes the SHD procedures and suggests general competency levels for each quarter of a 1-year advanced training program. Tools to measure adequate competency for each aspect of SHD training should be developed. A roadmap of SHD training is presented in Figure 1. The continuum of SHD patient care starts with an initial outpatient evaluation or inpatient consult. SHD trainees should be mentored by heart team members to evaluate the imaging and diagnostic testing and develop treatment plans while anticipating potential complications. In this model, focusing on procedural skills is only a part of the full spectrum that is required to care for SHD patients.

Trainees' Integration Within the Heart Team

Trainees' integration within the heart team remains in its infancy. Tellingly, a simple search on PubMed for the term "heart team" yields over 19,000 results with exponential growth over the last decade. However, adding the term "trainee" or "fellow" brings the results to only one, highlighting the need for more research on trainees' integration into heart teams.[46]

The heart team model offers a potentially unique opportunity for training the next generation of SHD specialists in every specialty that contributes to the heart team.[46] Institutional efforts should be made to bring trainees from different specialties together under the umbrella of the heart team. This may be achieved by establishing a "heart team" rotation for subspecialties that comprise the heart team. Having specific rotation requirements will allow SHD trainees to interact with specialists from multiple disciplines. More than ever, the opportunity for other specialists' input in the training of interventional cardiologists as SHD trainees is critical.

There are many ways in which the multidisciplinary training of SHD trainees can be achieved within the heart team.

- First, the SHD trainee should serve as a gatekeeper for the heart team. In this model, patients with SHD requiring heart team evaluation are first evaluated by an SHD trainee. The trainee then shares a preliminary diagnostic or intervention plan with other heart team members. By interacting with multiple heart team members daily, the trainee can help them develop consensus. A trainee in this role may help to expedite the heart team review process and make workflow more efficient (Figure 2). Future studies may help elucidate whether this approach leads to more efficient patient care and improved clinical outcomes.
- Second, the SHD trainee should be responsible for case preparation for interdisciplinary heart team meetings. During case presentation, the trainee should propose a comprehensive plan for each patient to be reviewed by the heart team. Constructive feedback from heart team members will help advance the trainee's knowledge and confidence.
- Third, SHD trainees should have protected time for research and publication. Research within the heart team offers a unique opportunity for collaboration and mentoring. Different specialists within the heart team may have access to different databases that may have the potential for cross-linking. This will provide tools for new research prospects. Furthermore, SHD trainees may be exposed to new opportunities for research funding from sources they might not otherwise identify.

Conclusions

The composition and function of the heart team have evolved to include specialists from different domains as well as patients and their family members. The "heart team" approach to SHD care improves patient selection and potentially clinical outcomes. However, it may also be associated with delays of care for a very sick population. Hence, the long-term clinical outcomes associated with a "heart team" remain to be elucidated in larger studies. Evolving heart team models must not only optimize patient care and increase efficiency but also account for reimbursement considerations. Integrating trainees into the heart team and developing standardized training curricula form a fertile ground for research and are critical to ensuring the sustainability of the heart team model.

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