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#### THE AUTHORS REPLY:



The letter by Dr. Y-Hassan regarding our editorial (1) on the work by Christensen et al. (2) entitled “Cardiac sympathetic disturbance in Takotsubo cardiomyopathy: primary etiology or a compensatory response to heart failure?” hypothesizes that the local cardiac sympathetic hyperactivation-disruption that occurs in patients with chronic heart failure, regardless of the underlying cause, may in fact be a form of Takotsubo cardiomyopathy occurring in repetitive attacks or in chronic form, triggered by heart failure or its severe symptoms.

In heart failure, the cardiac sympathetic system is activated during left ventricular remodeling, which may mimic the trigger effect of Takotsubo syndrome. However, unlike chronic persistent left ventricular dysfunction in heart failure, Takotsubo cardiomyopathy is a transient left ventricular systolic dysfunction characterized by apical ballooning with relative sparing of the basal segments. Although cardiac sympathetic disturbance has been linked to Takotsubo syndrome as the primary cause in both experimental animals and in human subjects, catecholamine excess may also occur as a consequence of acute myocardial ischemia which can cause myocardial stunning and transient contractile dysfunction. Myocardial stunning triggered by myocardial ischemia from atherosclerotic coronary disease (causing preconditioning and ischemic stunning) or from coronary or microvascular vasospasm in the absence of coronary artery disease (e.g., Takotsubo patients) confer protection against subsequent episodes of ischemia and preserve energy metabolites by downregulating contractile function and metabolism (3). Such repetitive stunning may present clinically as chronic left ventricular dysfunction and heart failure. In repetitive myocardial stunning, a unique metabolic adaptation occurs (abnormal glucose use despite restoration of regional myocardial blood flow) that is different from the adaptation typically described in clinical and experimental models of myocardial hibernation in chronic coronary artery disease (preserved or enhanced glucose use in a region with decreased regional myocardial blood flow) (3).

The Takotsubo patients in the study by Christensen et al. (2) had heart failure with low left ventricular ejection fraction whereas the control subjects consisted of a heterogeneous group of patients with myocarditis or aborted infarction who were not necessarily in heart failure. Moreover, because the  $^{123}\text{I}$ -mIBG scans in the study were performed at the subacute phase of the disease (not before or at the onset of the disease), it is not clear from the data whether cardiac sympathetic disturbance was the primary cause of Takotsubo cardiomyopathy or simply a compensatory response to heart failure (1). Perhaps future studies can provide mechanistic distinction and additional details that may shed light on this intriguing syndrome.

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#### Path to Cardiovascular Multimodality Imaging Subspecialty



I commend the American College of Cardiology Cardiovascular Imaging Council for putting together an excellent document that lays out the landscape of the future of cardiovascular imaging (1). However, as a formally trained multimodality cardiac imager (level III in echocardiography/cardiac magnetic resonance imaging and level II in cardiac computed tomography [CT]/nuclear cardiology) practicing in an academic center, I would like to make several observations. First, the “silos of expertise” approach in cardiac imaging may cause an inherent and, at times, strong bias of referral to certain techniques that might preclude patients from getting more

appropriate tests according to clinical presentation and disease process. Second, by viewing some modalities as competing, we hinder any additional opportunities that an alternative modality may offer to patients, such as a better understanding of their disease process or decisions that might affect their outcome. I think that there is a role for the multimodality imager as well, and I concur with the editorial letter by Marwick et al. (2). To deliver quality and value-based care, we need cardiovascular specialists that have a deeper understanding of the advantages and limitations of each imaging technique. Their role in clinical research is of importance as they may be more likely to have advanced, unbiased understanding of each technique. This is essential if we want to produce knowledge that will add more value to care. Establishing and enhancing imaging paths that are disease centered, such as reflected by some of the multimodality imaging expert consensus and guideline documents generated by the American Society of Echocardiography (3,4), defines the need and establishes a role of having expert imagers in more than 1 technique. This may promote good stewardship and enhances patient care.

A core curriculum that gives a basic, but deep understanding of the principles that will be consistent and unifying should allow the trainee to develop the required skills. The Core Cardiology Training Symposium has established such a curriculum for multimodality imaging as a subspecialty vetted by an excellent group of experts and 14 key principles, which as a multimodality imager, I fully support (5). During my 2 years of cardiovascular imaging training, with the little time I had to spare, I took the cardiology, nuclear cardiology, echocardiography, and cardiac CT boards. This process needs to be unified into modules of certification. Most cardiology practices do not own a CT or magnetic resonance imaging scanner. For a successful cardiac imaging program to work in most places, it requires close collaboration between radiology and cardiology. There has to be a core curriculum of multimodality imaging training vetted by the different cardiology and radiology societies for the radiologist that wants to become a multimodality cardiac imager. A similar model of integration of different specialties may be seen in sleep medicine, critical care, and others, where different specialists are able to have similar requirements to become certified and vetted subspecialists. Collaborative models between both services, such as shared earnings and expenses, reading rosters, and quality improvement meetings with valuable interactions, may promote success in enhancing the skills of readers with different backgrounds. I think that with

this statement, the American College of Cardiology Cardiovascular Imaging Council has started a healthy conversation that will shape the future of the cardiovascular imager (1).

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#### THE AUTHOR REPLIES:



The American College of Cardiology (ACC) Think Tank on the Future of Cardiac Imaging (TT) Steering Committee would like to thank Dr. Lopez-Mattei for writing in support of multimodality imaging. As we recognized in the proceedings (1), this is an attractive concept. However, the TT participants also cautioned that prioritizing the number of modalities over expertise may be detrimental to our training and research programs and possibly patient care. Indeed, the TT felt that achieving imaging expertise should be the primary goal, an emphasis designed to strengthen the role of cardiac imaging in outcomes-based care.

The TT also agrees with Dr. Lopez-Mattei's concern regarding the potential for referral bias and competition if the modalities are siloed. To this end, we