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# Clinical Cardiology [ALERT]

Critical analysis of the latest clinical research in cardiovascular medicine

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ABSTRACT & COMMENTARY

# ARNI Therapy Associated With Reduction in Ventricular Arrhythmias

***By Joshua D. Moss, MD***

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**Dr. Moss reports no financial relationships relevant to this field of study.**

SYNOPSIS: In patients with congestive heart failure due to reduced ejection fraction who underwent remote arrhythmia monitoring via an implantable cardioverter defibrillator (ICD), both ventricular arrhythmias and appropriate ICD shocks were reduced while on sacubitril-valsartan compared to an angiotensin-converting enzyme inhibitor or angiotensin II receptor blocker alone.

SOURCE: de Diego C, González-Torres L, Núñez JM, et al. Effects of angiotensin-neprilysin inhibition as compared to angiotensin inhibition on ventricular arrhythmias in reduced ejection fraction patients under continuous remote monitoring of implantable defibrillator devices. *Heart Rhythm* 2017 Nov 14. pii: S1547-5271(17)31331-0. doi: 10.1016/j.hrthm.2017.11.012. [Epub ahead of print].

The authors of the PARADIGM-HF trial[1] discontinued the study early after noting clear superiority of the angiotensin-neprilysin inhibitor (ARNI) LCZ696, now FDA-approved as sacubitril-valsartan (Entresto), over enalapril in the treatment of heart failure. There were significant reductions in mortality, hospitalization for heart failure, and sudden death with ARNI therapy, although relatively few patients with sudden death had an implanted device to facilitate adjudication of ventricular arrhythmias (vs. other modes of sudden cardiac death such as asystole, electromechanical dissociation, and cardiac shock).

To further investigate the effects of ARNI therapy on ventricular arrhythmias, de Diego et al enrolled 120 consecutive patients with congestive heart failure (New York Heart Association [NYHA] class II or greater despite optimal medical therapy), reduced ejection fraction (EF) ≤ 40%, and an implanted defibrillator with home monitoring capability. Patients were followed for 18 months: nine months while on therapy with angiotensin inhibition alone (ramipril or valsartan), then nine more months on sacubitril-valsartan. Patients were treated concurrently with beta-blockers and a mineralocorticoid antagonist, if tolerated.

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The enrolled population had a mean age around 70 years and were predominantly male (76%), with an ischemic etiology of their cardiomyopathy (82%). Mean EF at the time of enrollment was 30%. In 35% of patients, the implantable cardioverter defibrillator device (ICD) or implantable cardiac resynchronization therapy defibrillator (CRT-D) had been implanted for secondary prevention, and 30% of patients were on antiarrhythmic drug therapy.

Not surprisingly, therapy with the ARNI was associated with multiple statically significant changes compared with angiotensin-converting enzyme (ACE) inhibitor or angiotensin II receptor blocker (ARB) therapy: improvement in NYHA functional class, decrease in brain natriuretic peptide (BNP) levels, increase in EF, decrease in left ventricular diastolic diameter, decrease in blood pressure, and increase in heart rate. However, there also was significantly higher survival free from ICD shocks; patients on ARNI therapy experienced one appropriate and one inappropriate ICD shock over nine months, while patients on angiotensin inhibition alone demonstrated eight appropriate and three inappropriate ICD shocks. Significant reductions also were noted in incidence of sustained ventricular tachycardia (VT) (0.8% vs. 6.7%), nonsustained VT (NSVT) episodes (mean 5.4 vs. 15 episodes per patient), and premature ventricular complex (PVC) burden. The decline in PVC burden in turn was associated with a significant increase in biventricular pacing percentage, from a mean of 95% to 98.8%. There was a nonsignificant decrease in episodes of paroxysmal atrial tachycardia or fibrillation. The authors concluded that in patients with congestive heart failure due to reduced ejection fraction who had an ICD, ventricular arrhythmias and appropriate ICD shocks were reduced on sacubitril-valsartan compared with an ACE inhibitor or ARB.

## ■ COMMENTARY

This study adds to our understanding of how ARNI therapy may alter the mode of death in patients with advanced heart failure. In this population with predominantly ischemic cardiomyopathy and congestive heart failure, angiotensin-neprilysin inhibition decreased the burden of ventricular arrhythmia, which in turn reduced the number of appropriate ICD shocks, compared with angiotensin inhibition alone. The authors did not report any mortality data, so, presumably, there were few or no deaths over the 18-month study period. However, it is plausible that a reduction in ventricular arrhythmias is a primary driver of reduction in sudden cardiac death with ARNI therapy.

The potential mechanisms of this arrhythmia reduction are not immediately clear. The most plausible explanation simply may be the reduction in heart failure (with improved filling pressures and decreased volume overload) and improvement in left ventricular systolic function afforded by inhibition of neprilysin, the enzyme responsible for degradation of natriuretic peptides and several other vasoactive substances. Resultant decreases in cardiac fibrosis, myocardial wall stress, and sympathetic tone all may play a role. A direct electrophysiological effect is possible, but prior studies have shown no effect of sacubitril-valsartan on the ECG, including QTc. Notably, potassium levels were significantly higher with ARNI therapy, but there were no significant differences in potassium levels between patents with or without ventricular arrhythmias.

The principal weakness of this study is the sequential design of therapeutic intervention. All patients first were treated with an ACE inhibitor alone, after which all were transitioned to sacubitril-valsartan. Thus, the improvement in both heart failure parameters and burden of ventricular arrhythmias could be attributable in part simply to therapeutic optimization over time in a closely followed cohort of patients referred to a heart failure clinic. Ideally, a cohort of patients would have continued with angiotensin inhibition alone as a control. That said, it is clearly feasible that ARNI therapy could have driven the clinical benefits, given the corroborating knowledge from the PARADIGM-HF trial. It is unknown whether similar reductions in arrhythmia burden would be achieved in a cohort of patients with non-ischemic cardiomyopathy.

The data and results should serve to reinforce what we already know: For patients with a cardiomyopathy and increasing arrhythmia burden (whether manifesting as PVCs, NSVT, or sustained VT), aggressive medical therapy to optimize

heart failure management should be the first step in management. Only one appropriate ICD shock was recorded in 120 patients over nine months on ARNI therapy. Whether routine addition of an angiotensin-neprilysin inhibitor to our patients' standard heart failure regimen ultimately might shift the risk-benefit analysis for primary prevention ICD implant will be an intriguing and controversial question worth further investigation. ■


REFERENCE

1. McMurray JJ, Packer M, Desai AS, et al. Angiotensin-neprilysin inhibition versus enalapril in heart failure. *N Engl J Med* 2014;371:993-1004.


ABSTRACT & COMMENTARY

# Cardiac MRI Most Valuable Test for Diagnosis and Prognosis in Cardiac Sarcoidosis


***By Van Selby, MD***

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**Dr. Selby reports no financial relationships relevant to this field of study.**



SYNOPSIS: Among patients with extracardiac sarcoidosis, cardiac MRI was the best test for diagnosing cardiac involvement and the strongest independent predictor of adverse outcomes.

SOURCE: Kouranos V, Tzelepis GE, Rapti A, et al. Complementary role of CMR to conventional screening in the diagnosis and prognosis of cardiac sarcoidosis. *JACC Cardiovasc Imaging* 2017;10:1437-1447.


There is no gold standard criterion for diagnosing cardiac sarcoidosis. Cardiac MRI, specifically evaluation for late gadolinium enhancement (LGE), carries both diagnostic and prognostic utility. However, few studies have examined how cardiac MRI should be incorporated into standard diagnostic testing algorithms for cardiac sarcoidosis.

Kouranos et al studied 321 patients with biopsy-proven extracardiac sarcoidosis. All patients underwent standard diagnostic testing for cardiac involvement (ECG, Holter monitor, and echocardiography), as well as cardiac MRI with LGE. Patients were followed for the primary composite outcome of all-cause mortality, sustained ventricular tachycardia, or hospitalization for heart failure.

Using the Heart Rhythm Society consensus criteria, cardiac sarcoidosis was diagnosed in 29.9% of patients. Of all the diagnostic tests and clinical characteristics studied, cardiac MRI was the most accurate diagnostic tool (area under the curve = 0.984). Echocardiography exhibited high specificity but poor sensitivity for the detection of cardiac involvement, and adding echocardiography to cardiac history and ECG did not improve sensitivity significantly. During a median follow-up of 84 months, the primary outcome occurred in 7.2% of patients. Among the entire study population, LGE was a strong independent predictor of the primary outcome (hazard ratio [HR], 5.8; $P = 0.004$). In patients with cardiac symptoms and/or an abnormal ECG, cardiac MRI was the only independent predictor of the primary outcome (HR, 12.71; $P = 0.021$). Among 126 patients with no cardiac symptoms and no abnormalities on ECG or echocardiography, cardiac MRI identified cardiac sarcoidosis in 26 patients, although the presence of LGE was not associated with increased risk of the primary outcome. The authors concluded that cardiac MRI is the most valuable test in the diagnosis and prognosis of cardiac sarcoidosis in a general sarcoidosis population.

## ■ COMMENTARY

Cardiac involvement is identified in approximately 5-10% of patients with sarcoidosis. However, autopsy studies suggest the true prevalence is significantly higher (between 20-30%), and cardiac disease contributes disproportionately to morbidity and mortality in patients with sarcoidosis. Cardiac sarcoidosis is characterized by patchy involvement, limiting the utility of standard diagnostic tools, including endomyocardial biopsy. Cardiac MRI offers a more comprehensive evaluation of the myocardium, making it better suited for evaluating such a disease. Previous studies have shown the diagnostic and prognostic significance of LGE identified by cardiac MRI in sarcoidosis.

The study by Kouranos et al represents the largest published cohort to date of cardiac MRI in sarcoidosis patients and clearly demonstrates the superiority of cardiac MRI over echocardiography and other testing for both diagnosing cardiac sarcoid and determining prognosis in patients with extracardiac sarcoidosis. In particular, cardiac MRI is a valuable tool for determining

the risk of adverse events in patients with sarcoidosis and either abnormal ECG or cardiac symptoms. On the other hand, in patients with normal ECG and no symptoms, the utility of cardiac MRI is less clear; in this group, LGE was identified in some patients, but its presence was not associated with increased risk of adverse events.

The study also highlights the poor sensitivity of routine echocardiography for the diagnosis of cardiac involvement in patients with sarcoidosis. Current guidelines from the Heart Rhythm Society recommend screening all patients with echocardiography, but adding echocardiography to clinical history and ECG added little diagnostic utility in this study. It is important to note that newer echocardiographic techniques, including strain imaging, may improve accuracy for diagnosing cardiac sarcoidosis. These techniques were not included in this study, and based on the findings, we can only conclude that a standard echocardiographic examination has poor sensitivity for the identification of cardiac involvement in patients with extracardiac sarcoidosis.

Although the study convincingly demonstrated the strengths of cardiac MRI in the evaluation of suspected cardiac sarcoidosis, widespread expansion will be limited by both cost and availability of cardiac MRI. There also was significant interobserver variability in the interpretation of cardiac MRI studies (all images were reviewed by two radiologists). This highlights the importance of performing cardiac MRI in a center with experienced radiologists skilled in the interpretation of LGE. The patients studied were all Caucasian, and, therefore, it is unknown how the findings will translate to the United States, where the sarcoidosis population is racially diverse.

Cardiac sarcoidosis can be missed easily using standard diagnostic testing. When available, cardiac MRI should be strongly considered for further evaluation and estimation of prognosis in patients with known extracardiac sarcoidosis. Future studies will further clarify the use of cardiac MRI in these patients, including how often screening should be performed and how cardiac MRI findings can guide clinical therapy. ■

ABSTRACT & COMMENTARY

# Patent Foramen Ovale Closure Falls Short in Treatment of Migraines

***By Jeffrey Zimmet, MD, PhD***

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**Dr. Zimmet reports no financial relationships relevant to this field of study.**

SYNOPSIS: This randomized trial of patent foramen ovale closure in severe refractory migraine showed no significant difference in responder rate compared to sham control.

SOURCE: Tobis JM, Charles A, Silberstein SD, et al. Percutaneous closure of patent foramen ovale in patients with migraine: The PREMIUM Trial. *J Am Coll Cardiol* 2017;70:2766-2774.

Migraines are common. Patent foramen ovale (PFO) is common. Numerous observational studies have suggested an association between PFO and migraine, especially for migraine with aura. Similarly, observational data previously have supported the idea that closure of right-to-left shunt, including PFO, can reduce the frequency and severity of migraines. However, not every person with migraines has a PFO, and not every PFO is associated with migraines.

The key to a successful trial of PFO closure in migraines is to identify the subset of migraine patients who are most likely to benefit. This key point partially explains the success of PFO closure in three recent trials that included patients with cryptogenic stroke: RESPECT, Gore REDUCE, and CLOSE, in which the enrollment of younger patients with significant shunts in whom other causes of stroke had been excluded resulted in measurement of a significant treatment effect.

The PREMIUM trial was envisioned as the migraine counterpart to these trials. The authors of PREMIUM enrolled highly symptomatic patients with between six and 14 headache days per month who had failed at least three different preventive medications. All patients were required to have a large shunt, assessed as grade 4 or 5 (more than 100 bubbles per minute) by transcranial Doppler. Although prominent aura had been identified as a possible predictor of a positive treatment effect of PFO closure, limiting enrollment to this group turned out to be impractical; thus, patients both with and without aura were included. Despite this, the authors needed more than seven years to enroll the 230 patients required. Out of 1,653 patients who were screened and

consented, 1,423 did not meet the inclusion criteria; most of these did not have a large enough shunt. In the end, 123 patients were randomized to receive a PFO closure device, while 107 patients were randomized to the control group. All enrolled patients underwent right heart catheterization while under deep sedation. Randomization was performed only after the PFO was crossed with a wire. Those randomized to intervention received an Amplatzer PFO Occluder, which was implanted successfully in all but four patients. Both the subjects and their treating neurologists were blinded to the treatment assignment.

After 12 months of follow-up, there was no significant difference between the device arm and the sham controls in the primary efficacy endpoint: 38.5% of device patients and 32% of the control subjects demonstrated a 50% reduction in migraine attacks ($P = 0.32$). Among secondary endpoints, patients in the device arm showed a statistically significant decrease in mean migraine days per month, but the reported difference was very modest: -3.4 ± 4.4 days vs. -2.0 ± 5.0 days ($P = 0.025$). Interestingly, 10 of 117 patients in the device arm stopped experiencing migraine attacks completely vs. only one control patient. Six of the 10 complete responders were patients with aura. In a subgroup analysis that included only the patients with aura (79 patients out of the trial population of 230), the responder rate was 49% in device patients vs. 23% for controls ($P = 0.015$).

The authors reported that PFO closure in patients with migraine and significant shunt did not change the responder rate significantly. Therefore, their results do not support the use of PFO closure as a preventive therapy for migraine. The authors noted that the significant results in the subgroup of patients with aura leaves open the possibility of a role for this therapy in a subset of patients.

### ■ COMMENTARY

Migraines can be incredibly debilitating, especially when the symptoms are frequent and not responsive to available therapies. The PREMIUM trial, like other studies before it, gives tantalizing evidence that there is the possibility of a treatment effect for PFO in migraines, if only we could identify the patients who would benefit. In the overall population of the trial, there was a measurable and significant difference in migraine days per month, but the magnitude of this effect was quite small.

More encouraging were the results in the subset of patients with migraine with aura, who make up a minority of all patients with migraine. This trial was relatively enriched in this population. An optimist would say that there is a link between migraine with aura and PFO, and the requirement of a large shunt selected more of these patients into the study. However, the fact that this was a non-prespecified subgroup means that these findings are at best hypothesis-generating and may form the basis for future studies.

In the same vein, the finding that more patients in the device arm achieved complete remission of migraine over a year of follow-up is encouraging and generates hope of successful therapy for some proportion of migraine patients. However, the percentage of patients who achieved this result (8.5%) was too small to suggest PFO closure as a non-investigational treatment today. Undoubtedly, some patients will continue to be offered PFO closure for this indication, but until better data indicate which patients are likely to benefit, this will remain on the fringes of clinical practice. ■

## ABSTRACT & COMMENTARY

# CT Calcium Score vs. Stress Testing

***By Michael H. Crawford, MD, Editor***

SYNOPSIS: A subgroup analysis of the PROMISE trial showed that CT coronary calcium scores in symptomatic patients at low to intermediate risk for coronary artery disease are more sensitive but less specific for major adverse cardiac events over a two-year follow-up period than stress testing. Consequently, both approaches exhibited similar but modest discriminatory ability.

SOURCES: Budoff MJ, Mayrhofer T, Ferencik M, et al. Prognostic value of coronary artery calcium in the PROMISE Study (Prospective Multicenter Imaging Study for Evaluation of Chest Pain). *Circulation* 2017;136:1993-2005.

Newby DE. Computed tomography or functional stress testing for the prediction of risk: Can I have my cake and eat it? *Circulation* 2017;136:2006-2008.

The diagnostic accuracy of stress testing for detecting significant coronary artery disease (CAD) in low-risk patients that clinicians encounter frequently is reduced compared to that in intermediate-risk patients. Thus, investigators from the PROMISE trial (Prospective Multicenter Imaging Study for the Evaluation of Chest Pain) hypothesized that CT coronary artery calcium score (CAC) would be superior to stress testing for predicting

major adverse cardiac events (MACE) in symptomatic but low to intermediate risk patients. Among the more than 10,000 patients enrolled in PROMISE at 193 North American medical centers, 4,209 received CAC as their first test and 4,602 received stress testing first, as randomized. Stress testing included exercise or pharmacologic stress plus either ECG alone, nuclear myocardial perfusion imaging, or echocardiography. CAC was determined on at least a 64-slice multidetector CT machine. Studies were classified as normal (CAC = 0), mildly abnormal (CAC = 1-99), moderately abnormal (CAC = 100-400), and severely abnormal (CAC > 400). The stress tests were rated similarly based on the perceived extent of ischemia. There were no clinically meaningful differences in baseline characteristics between the patients in each group. The average age was 61 years, slightly more than half were women, and about half were low risk. Median follow-up was 26 months. Moderate or severely abnormal results in both tests robustly predicted MACE (moderate CAC = hazard ratio, 3.14; 95% confidence interval, 1.81-5.44, and stress test 2.65 [1.46-4.83]; severe CAC = 3.56; 1.99-6.36 and stress test, 3.88 [2.58-5.85]). Any CAC abnormality detected 84% of the patients experiencing a MACE, whereas a positive stress test only detected 43%. However, an abnormal stress test was significantly more specific in predicting MACE (78.6% vs. 35.2%; $P < 0.001$). Thus, overall discriminatory ability was similar and modest for both tests (C statistic for CAC = 0.67 and for stress testing = 0.64). In a separate analysis of those in the CAC group who also underwent CT angiography (CTA), CTA demonstrated better discriminatory ability (C = 0.72).

The authors concluded that in symptomatic outpatients at low to intermediate risk of CAD, most with subsequent events registered a CAC > 0, but only less than half exhibited an abnormal stress test. On the other hand, an abnormal stress test was much more specific for predicting events. Consequently, both tests demonstrated a similar but modest discriminatory ability.

## ■ COMMENTARY

This post-hoc subgroup analysis of the PROMISE trial, which compared CTA to stress testing, is really an apple-oranges comparison. CAC detects the presence of advanced atherosclerosis (young plaques are not detected) and is not directly related to luminal stenosis or plaque status. In fact, the presence of calcium may be a stabilizing event in atherosclerosis. So, it is not surprising that CAC > 0 detects 84% of patients who experience a MACE over two years. Presumably, the other 16% exhibited non-calcified plaques, which could be detected by CTA. However, CTA is not perfect, as it cannot image the vessel lumen through heavy calcification and there are contradictions to its use, such as advanced kidney disease and tachycardia, that cannot be eliminated safely. CAC imaging has no contraindications, but it carries a low specificity for predicting MACE, especially if the CAC value of > 0 is used (35%). Specificity increased with higher cutoff values (> 100, 67%; > 400, 85%) but at the expense of sensitivity (61% and 31%, respectively). Stress testing detects the functional consequences of atherosclerosis but does not diagnose atherosclerosis because myocardial ischemia can be caused by other conditions such as microvascular disease or left ventricular hypertrophy. Also, it cannot detect non-flow-limiting plaques. Most cardiac events occur with the disruption of such plaques. However, stress testing is superior for detecting those at the highest risk and those who may benefit from revascularization. CAC scores > 400 are associated with a yearly MACE rate of 6% vs. 10% with a markedly positive stress test. Also, a positive stress test is more specific (79% vs. 35%) and a normal stress test is associated with a MACE rate of < 1% per year.

So, how should cardiologists deploy these tests in a low- to intermediate-risk patient with symptoms suggestive of CAD? The authors noted that CAC is a rapid test that can be performed on any CT scanner with low radiation exposure. Also, it is relatively inexpensive and produces no real contraindications. Additionally, studies have shown that knowledge of the presence of calcium can motivate patients to improve their risk profile. So CAC may represent an ideal first screening test, which then could be followed by a second test if CAC crosses some threshold. Traditionally, the second test has been stress testing, but the results of the main PROMISE study suggest it could be CTA, since compared to stress testing it was better at predicting future MACE. CTA may perform better at the lower CAC score range (1-400), but a CAC score > 400 will make lumen visualization by CTA problematic. Perhaps stress testing would be better if a CAC score is > 400. We will need further studies to sort this out. ■

ABSTRACT & COMMENTARY

# Accuracy of Right Atrial Pressure Estimates by Echocardiography

*By Michael H. Crawford, MD, Editor*

SYNOPSIS: Researchers compared echocardiographically determined right atrial pressure and characteristics of the inferior vena cava to right heart catheterization-measured values. They concluded that echo estimates reached through this technique should not be used clinically to estimate pulmonary artery pressure.

SOURCE: Magnino C, Omedè P, Avenatti E, et al. Inaccuracy of right atrial pressure estimates through inferior vena cava indices. *Am J Cardiol* 2017;120:1667-1673.

Several echocardiographic-based methods for estimating right atrial pressure (RAP) have been proposed, but external validation of their accuracy is limited. Thus, investigators from Turin, Italy, conducted a prospective, blinded study of several echo methods as compared to the results of right heart catheterization in 190 patients. Exclusion criteria included vasoactive drug infusions, known pulmonic stenosis, and respiratory ventilator support. An echo was performed either just before (63%) or just after the catheterization during normal respiration recorded on a respirometer. When necessary, deeper respiration rather than sniffing was used to enhance the measurements. Six echo methods based on measuring the inferior vena cava (IVC) for estimating RAP were compared to the hemodynamic data.

IVC evaluation was not possible in 19% of patients. In the rest, end-expiration IVC diameter and IVC collapsibility were significantly correlated with invasive RAP, but the strength of the correlations was low (c = 0.35-0.40). All methods of RAP estimation were associated significantly with invasive RAP, but accuracy was low (average = 34%). No method was clearly superior to the others, and no clinical or echo data seemed to affect the observed error, including tricuspid regurgitation, the level of invasive RAP, the time between studies, the pulmonary artery pressure, or body size. The authors concluded that all currently described methods of estimating RAP are highly inaccurate and should not be used in the estimation of pulmonary artery pressures.

## ■ COMMENTARY

An estimate of RAP is desirable to provide a more accurate estimation of pulmonary artery pressure from the tricuspid regurgitation jet velocity-measured pressure gradient. Older studies showed that IVC imaging estimates of RAP are superior to using the physical examination-derived jugular venous pressure or using a fixed value (10 mmHg) for every patient. This concept has morphed out of the echo lab into other areas of the hospital with the availability of small, hand-held echo machines. The ED, ICUs, and enterprising residents all report RAP values, use the information to determine the fluid status of patients, and treat accordingly. It will be more pervasive soon, as some medical schools are issuing hand-held echo machines to all their students and as devices that interface with smartphones or other devices are perfected. Thus, knowing the accuracy of echo RAP estimation is important.

The few small studies that assessed the accuracy of this method of estimating RAP have shown conflicting results. Consequently, various modifications to the basic technique have been suggested, not all of which have been studied adequately. Thus, this study is of interest. Magnino et al compared all the recommended techniques to right heart catheterization and found that all were unreliable and none were superior to the others. Also, there was no cutoff that accurately distinguished high vs. low values of RAP. There was a general trend to underestimate the value. Additionally, there were no clinical features that, if excluded, significantly improved the group prediction, including significant tricuspid regurgitation and body surface area.

There were limitations to this study. Although larger than most studies in this area, the authors only studied 190 patients. These were patients with considerable comorbidities, so the results may not apply to a healthier population. The right heart cardiac catheterization and the echo were not performed simultaneously because it is more difficult to obtain excellent quality echoes in the cath lab setting. However, these tests were performed as close as feasible. Magnino et al used deep inspiration rather than a sniff to assess IVC collapsibility because sniffing cannot always be performed correctly and it can change the imaging plane. The most recent guidelines (2015) recommend measuring the IVC diameter by m-mode echocardiography (from a 2-D image) in the long axis subcostal view perpendicular to the IVC and 1-2 cm inferior to the junction of the IVC and the RA. The percent collapse with normal respiration or a sniff, if there is no collapse with quiet respiration, is calculated. The upper limit of normal is 2.1 cm and the normal collapse is > 50%. Measures below 2.1 cm and above 50% represent a RAP of 3 mmHg. Values > 2.1 cm and

below 50% represent 15 mmHg. Measurements not conforming to these combinations are considered 8 mmHg. Excluded are athletes and those on a ventilator. Interestingly, these guideline recommendations from a committee have never been tested, and since this study did not use sniffing, Magnino et al did not really test them, either. So, how should echo labs act?

The European Society of Cardiology Pulmonary Hypertension guidelines advise against using echo estimates of RAP to determine pulmonary pressures. My pulmonary hypertension group uses echo as a screening tool, but does not rely on it to make treatment decisions, preferring right heart catheterization. The rest of us should do the same. ■

## CME QUESTIONS

1. **Therapy with sacubitril-valsartan compared to an angiotensin-converting enzyme inhibitor or angiotensin II receptor blocker alone in patients with congestive heart failure due to reduced ejection fraction showed:**

   a. fewer implantable cardioverter defibrillator shocks.

   b. reduced mortality.

   c. increased blood pressure.

   d. decreased heart rate.

2. **Patients with low to intermediate risk of coronary artery disease and chest pain, coronary calcium score vs. stress testing for predicting major cardiac adverse events (MACE) showed:**

   a. more robust discriminatory ability.

   b. a high sensitivity for MACE.

   c. a high specificity for MACE.

   d. that only patients with scores > 400 experienced MACE.

3. **Which of the following tests registers the highest sensitivity for detecting cardiac involvement in symptomatic patients with extracardiac sarcoidosis?**

   a. ECG

   b. Echocardiography

   c. Cardiac MRI

   d. Myocardial biopsy

4. **The most recently published trial of patent foramen ovale closure vs. a sham procedure for migraine headaches showed:**

   a. no difference in the overall frequency of headaches.

   b. more migraine-free days.

   c. more patients with complete cessation of migraines.

   d. All of the above

5. **Which of the following is most correct concerning the echocardiographic estimation of right atrial pressure?**

   a. It is accurate in non-intubated patients.

   b. Echo usually overestimates the right atrial pressure.

   c. The guideline-recommended technique is superior to other methods.

   d. It is unreliable.

## CME OBJECTIVES

Upon completion of this educational activity, participants should be able to:

- discuss the most current information related to cardiac illness and the treatment of cardiac disease;
- explain the advantages and disadvantages, as well as possible complications, of interventions to treat cardiac illness;
- discuss the advantages, disadvantages, and cost-effectiveness of new and traditional diagnostic tests in the treatment of cardiac illness; and
- discuss current data regarding outpatient care of cardiac patients.