RELIAS MEDIA

Clinical Cardiology [ALERT]

Vol. 38, Issue 5, May 2019
ReliasMedia.com

Critical analysis of the latest clinical research in cardiovascular medicine

ABSTRACT & COMMENTARY

Team-Based Approach Associated With Better Outcomes in Cardiogenic Shock

By Van Selby, MD

Assistant Professor of Medicine, University of California, San Francisco Cardiology Division, Advanced Heart Failure Section

Dr. Selby reports he is a consultant for Alnylam Pharmaceuticals and Akcea Therapeutics.

SYNOPSIS: Implementation of a standardized, team-based approach to cardiogenic shock resulted in improved 30-day survival compared to historical controls.

SOURCE: Tehrani BN, Truesdell AG, Sherwood MW, et al. Standardized team-based care for cardiogenic shock. *J Am Coll Cardiol* 2019;73:1659-1669.

Cardiogenic shock (CS) remains a leading cause of cardiovascular mortality. There is growing interest in the use of multidisciplinary "shock teams" to rapidly identify and treat CS using standardized algorithms. While several centers have demonstrated the feasibility of a shock team approach, none have shown whether this is associated with improvements in clinical outcomes.

In 2017, the Inova Heart and Vascular Institute introduced a shock team approach based on a clinical algorithm for the management of CS. The team focused on five primary goals: rapid identification of CS, use of invasive hemodynamic monitoring, minimization of vasopressor and inotrope use, early mechanical circulatory support (MCS), and facilitating cardiac recovery.

CS was defined according to criteria used in previous clinical trials, including systolic blood pressure < 90 mmHg, evidence of end-organ hypoperfusion, and serum lactate > 2 mmol/L. When a patient with suspected cardiogenic shock was identified, the treating team makes a single phone call to gather physicians from interventional cardiology, heart failure, cardiothoracic surgery, and critical care for a multidisciplinary conversation. The patient would be transferred to either the catheterization laboratory for acute myocardial infarction (AMI) or to the cardiac ICU for acute decompensated heart failure

Financial Disclosure: *Clinical Cardiology Alert*'s Physician Editor Michael H. Crawford, MD, Peer Reviewer Susan Zhao, MD, Nurse Planner Aurelia Macabasco-O'Connell, PhD, ACNP-BC, RN, PHN, FAHA, Editor Jonathan Springston, Editor Jesse Saffron, Accreditations Manager Amy M. Johnson, MSN, RN, CPN, and Editorial Group Manager Terrey L. Hatcher report no financial relationships relevant to this field of study.

[INSIDE]

Clinical Cardiology [ALERT]
Critical analysis of the latest clinical research in cardiovascular medicine

Clinical Cardiology Alert (ISSN 0741-4218) is published monthly by Relias LLC, 1010 Sync St., Ste. 100, Morrisville, NC 27560-5468. Periodicals postage paid at Morrisville, NC, and additional mailing offices. POSTMASTER: Send address changes to *Clinical Cardiology Alert*, Relias LLC, 1010 Sync St., Ste. 100, Morrisville, NC 27560-5468.

GST Registration Number: R128870672.

SUBSCRIBER INFORMATION
(800) 688-2421
customerservice@reliasmedia.com
ReliasMedia.com

Subscription Prices
United States
Print: 1 year with ***free*** *AMA PRA Category 1 Credits™*: $349
Add $19.99 for shipping & handling.
Online only, single user: with ***free*** *AMA PRA Category 1 Credits™*: $299

Back issues: $42. Missing issues will be fulfilled by customer service free of charge when contacted within one month of the missing issue's date.

Canada: Add 7% GST and $30 shipping.
Elsewhere: Add $30 shipping.

ACCREDITATION
Relias LLC is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

Relias LLC designates this enduring material for a maximum of 2.25 *AMA PRA Category 1 Credit(s)™*. Physicians should claim only credit commensurate with the extent of their participation in the activity.

Relias LLC is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation. Contact hours [2.25] will be awarded to participants who meet the criteria for successful completion. California Board of Registered Nursing, Provider CEP#13791.

Successful completion of this CME activity, which includes participation in the evaluation component, enables the participant to earn up to 2.25 MOC Medical Knowledge points in the American Board of Internal Medicine's (ABIM) Maintenance of Certification (MOC) program. Participants will earn MOC points equivalent to the amount of CME credits claimed for the activity. It is the CME activity provider's responsibility to submit participant completion information to ACCME for the purpose of granting ABIM MOC credit.

This activity is intended for the cardiologist. It is in effect for 36 months from the date of the publication.

(ADHF). All patients underwent right heart catheterization. Patients were determined to meet hemodynamic criteria for CS when the following were present: cardiac index < 1.8 L/min/m^2 without inotropes or < 2.2 with inotropes, pulmonary capillary wedge pressure > 15 mmHg, cardiac power output (CPO) < 0.6 W, or a pulmonary arterial pulsatility index (PAPi) < 1.0. In patients meeting hemodynamic criteria for CS, the use of early MCS was recommended, with an Impella CP (Abiomed) as the standard support device and others available as appropriate.

During the study period (2017-2018), 204 patients were admitted for CS. The cause of shock was AMI in 82 patients and ADHF in 122 patients. Compared to a baseline 30-day survival of 47% in 2016 (before introduction of the shock team), there was an increase in survival to 58% in 2017 and 77% in 2018 ($P < 0.01$). A clinical risk score was developed that included all variables found to be associated with 30-day mortality: age ≥ 71 years, diabetes, dialysis, use of vasopressors ≥ 36 hours at time of diagnosis, lactate ≥ 3.0 mg/dL, CPO < 0.6 W, and PAPi < 1.0 at 24 hours after diagnosis.

The authors concluded that a standardized team-based approach may improve outcomes in CS. Furthermore, a score that incorporates demographic, laboratory, and hemodynamic variables can risk-stratify patients with CS and guide clinical decision-making.

■ COMMENTARY

Despite advances in revascularization and MCS, data from registries and clinical trials continue to show poor outcomes for patients hospitalized with CS, with mortality rates often around 50%. There are multiple contributing factors, including delayed recognition of CS and wide practice variation that often includes high doses of medications with substantial adverse effects (e.g., vasopressors and inotropes) or support devices that do not provide substantial hemodynamic improvement (intra-aortic balloon pumps). The authors of multiple single-center studies have reported implementation of a standardized "shock team" approach to facilitate rapid identification and treatment of CS. The Tehrani et al study is the first to associate a shock team with improved CS survival. The Inova shock team approach may serve as a template for clinicians at other centers to use when developing their own approach for CS.

There are several important aspects of this program to highlight. First, the importance of an easy-to-activate multidisciplinary shock team. Patients with CS are medically complex and require multispecialty care. In the model used by Inova providers, activate the shock team with a single phone call as soon as CS is suspected (with easy-to-use criteria). The initial providers often were at regional referring hospitals. Contacting the shock team not only helped guide initial management but also facilitated transfer to Inova for more advanced care. This "hub and spoke" system provides prompt access to expert consultation and helps patients move to higher-level care as quickly as possible.

Second: The importance of hemodynamic monitoring in CS. Use of the Swan-Ganz catheter declined after clinical trials failed to show benefit in a general acute heart failure population. However, since then, several observational reports have shown benefit from right heart catheterization in CS. Current American Heart Association guidelines suggest it can be helpful in this situation. Right heart catheterization is essential for identifying hemodynamic abnormalities and guiding decision-making regarding the need for MCS.

Third, the shock team model emphasizes the early use of MCS. The authors found that every 60-minute delay in insertion of MCS was associated with a 9.9% increase in mortality. Generally, the Inova model recommended the Impella CP (Abiomed) as the standard device used for left ventricular support, although several devices were used according to the needs of the patient. In addition to interpretation of standard data obtained during right heart catheterization, practitioners involved in the management of CS should be familiar with the CPO and PAPi. These are novel hemodynamic parameters that are used commonly in contemporary shock algorithms to determine whether left- and/or right-sided mechanical support is needed.

This was a single-center observational study with the usual associated limitations; the

use of a historical control group is suboptimal. Future multicenter studies will help refine the optimal use of shock teams. Despite these limitations, the study by Tehrani et al represents a major advancement in our understanding of the optimal approach to treating cardiogenic shock. ■

ABSTRACT & COMMENTARY

Early Cardiac Catheterization After Resuscitation From Cardiac Arrest

By Jeffrey Zimmet, MD, PhD

Associate Professor of Medicine, University of California, San Francisco; Director, Cardiac Catheterization Laboratory, San Francisco VA Medical Center

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

SYNOPSIS: In this first-ever randomized trial about comatose patients without ST-segment elevation who have been resuscitated from cardiac arrest, immediate coronary angiography showed no benefit over delayed coronary angiography in terms of 90-day survival.

SOURCE: Lemkes JS, Janssens GN, van der Hoeven NW, et al. Coronary angiography after cardiac arrest without ST-segment elevation. *N Engl J Med* 2019;380:1397-1407.

It is just after midnight, and the ED is calling. A 65-year-old patient has just been brought in after successful resuscitation from cardiac arrest, with an initial rhythm of ventricular fibrillation that responded to a shock in the field. The patient is hemodynamically stable on a ventilator, and the ECG shows only nonspecific ST changes. Do you take the patient to the cath lab overnight?

Until now, this question has come with plenty of controversy and few data. Enter the COACT study, a prospective randomized trial comparing immediate with delayed coronary angiography in patients who remain comatose after cardiac arrest with an initial shockable rhythm (ventricular fibrillation or tachycardia). Patients who showed ST elevation on ECG, were in shock, or had a clear noncardiac cause for arrest were excluded from the trial. Over the 3.5-year course of the trial, 552 patients were enrolled at 19 centers in the Netherlands and were randomized 1:1 to one of the two treatments. Patients in the immediate angiography group had a median time from arrest to cardiac cath of 2.3 hours vs. 121.9 hours in the delayed angio group. Ultimately, investigators performed cardiac cath in 97.1% of patients in the immediate group vs. 64.9% of patients in the delayed group. Similar to prior observational studies, obstructive coronary disease was found in approximately 65% of patients. However, an acute thrombotic occlusion was found in only 3.4% of patients in the immediate angiography group and in 7.6% of patients in the delayed angiography group. Researchers performed percutaneous coronary intervention in 33% of patients in the immediate angio group and in 24.2% of patients in the delayed group. Coronary artery bypass grafting was performed in 6.2% and 8.7%, respectively. Patients in the delayed angio group were more likely to receive aspirin and P2Y12 inhibitors, while those in the immediate angio group were more likely to receive glycoprotein IIb/IIIa inhibitors.

Crossovers were uncommon, with 13 patients assigned to immediate angiography treated with a delayed approach and three patients in the delayed group treated with an immediate approach. In addition to these, 38 patients in the delayed group ended up with clinically indicated urgent cardiac catheterization prior to their planned procedure for reasons including the development of ST elevation, recurrent ventricular arrhythmia, and cardiogenic shock.

Regarding the primary outcome of survival at 90 days, there was no difference between the two groups. A total of 176 of 273 patients in the immediate angiography group and 178 of 265 patients in the delayed angiography group were alive at 90 days (odds ratio, 0.89; 95% confidence interval, 0.62-1.27; $P = 0.51$). Sensitivity analyses suggested that only older age ($P = 0.007$ for interaction) and history of coronary artery disease ($P = 0.009$ for interaction) were associated with a higher likelihood of benefit from early invasive angiography.

Ninety percent of patients in the trial were treated with cooling in accordance with treatment guidelines. Time to reach target temperature was delayed significantly in patients assigned to the immediate angiography group, with median time to target temperature of 5.4 hours in the immediate group vs. 4.7 hours in the delayed angiography group. Life-sustaining treatment was withdrawn in approximately equal numbers of patients in each group. The authors concluded that among patients who

remain comatose after resuscitation from out-of-hospital cardiac arrest without ST elevation, immediate cardiac catheterization produced no benefit vs. delayed angiography regarding survival at 90 days.

■ COMMENTARY

Patients who have been resuscitated from out-of-hospital cardiac arrest represent a large dilemma for clinical decision-making, with multiple competing priorities in early management. The authors of prior observational studies have reported that as much as 45% of out-of-hospital cardiac arrest patients without STEMI have acute coronary occlusion or stenosis. Further, those authors have suggested that early coronary angiography and percutaneous coronary intervention may produce a survival benefit. The authors of COACT arrived at the opposite conclusion. According to this analysis, in the average patient with resuscitated out-of-hospital cardiac arrest without STEMI, immediate angiography does not produce a concrete benefit in terms of survival at 90 days.

Why the discrepancy? The obvious initial explanation is the selection bias inherent in earlier observational studies in which patients who are presumed to have a better chance at survival are selected for early cardiac cath. While the fraction of patients with obstructive coronary disease mirrors earlier reports (at approximately two-thirds), only 5% of the total population in COACT showed acute thrombotic occlusions. Most deaths in this patient group result from neurologic complications rather than from cardiovascular sequelae. More than 60% of deaths in COACT were due to neurologic injury, which frequently led to discontinuation of treatment. The delay in time to target temperature inherent in taking patients immediately for angiography may reduce any putative benefits of this approach.

For the first time, there are randomized data to reference when presented with patients of this type. In such out-of-hospital cardiac arrest patients who are comatose and hemodynamically stable without ST elevation, the results of this study suggest that activation of the cardiac catheterization laboratory after hours is not beneficial in the average case. Thus, more time will be available to collect information about the patient that may affect decision-making in the lab. Although only 5% of patients overall exhibited an acute thrombotic lesion, percutaneous coronary intervention was performed in more than 30%. Waiting for basic labs and clinical information makes sense before committing patients to this treatment.

Keep in mind that different patient selection may have produced a different result. Patients older than 70 years of age and those with a known history of coronary disease appeared to be more likely to benefit from immediate coronary angiography. In at least two ongoing studies (the ACCESS trial and the Direct or Subacute Coronary Angiography in Out-of-hospital Cardiac Arrest trial), researchers are investigating the timing of coronary angiography after cardiac arrest. Until those studies become available, COACT provides the best available guidance. ■

ABSTRACT & COMMENTARY

Transcatheter Mitral Valve Replacement

By Michael H. Crawford, MD, Editor

SYNOPSIS: A large registry study of transcatheter mitral valve replacement showed excellent results in failed bioprostheses but less overall success in failed mitral valve repairs with rings and conditions associated with mitral annular calcium.

SOURCES: Yoon SH, Whisenant BK, Bleiziffer S, et al. Outcomes of transcatheter mitral valve replacement for degenerated bioprostheses, failed annuloplasty rings, and mitral annular calcification. *Eur Heart J* 2019;40:441-451.

Maisano F, Taramasso M. Mitral valve-in-valve, valve-in-ring, and valve-in-MAC: The good, The bad, and the ugly. *Eur Heart J* 2019;40:452-455.

Surgery remains the gold standard for patients with mitral valve regurgitation (MR). Transcatheter valves have yet to be developed that are successful in degenerative or functional MR. However, degenerated mitral bioprostheses, failed mitral valve repairs, and mitral annular calcium (MAC) problems are associated with high surgical morbidity and mortality. The use of transcatheter valve replacement in these situations is increasing, but little has been reported about the procedural and clinical outcomes of this practice. An international transcatheter mitral valve replacement (TMVR) registry was created for patients undergoing TMVR for degenerated bioprostheses (valve in valve, or ViV), failed annuloplasty rings (ViR), or severe MAC (ViMAC). The transcatheter valves used were those available for aortic valve replacement. The primary endpoint was all-cause mortality at 30 days and one year. Several technical and clinical secondary

endpoints also were evaluated. Among 521 patients from 40 centers studied between February 2008 and April 2018, 62% underwent TMVR for ViV, 27% for ViR, and 11% for ViMAC. The majority were high risk for valve re-operation, with a Society of Thoracic Surgeons score average of 9%. Baseline characteristics differed among the three groups. ViMAC patients were more likely women with stenosis of the mitral valve. ViR patients were more likely to have undergone prior coronary bypass with mitral regurgitation due to failed repair.

Overall technical success was 87%, but was higher for ViV patients than for ViR and ViMAC patients (94% vs. 81% vs. 62%; $P < 0.001$). Left ventricular outflow tract obstruction (LVOT) was more common in ViMAC patients compared to ViR and ViV patients (40% vs. 5% vs. 2%; $P < 0.001$). Thirty-day mortality was highest in the ViMAC group compared to the ViR and ViV groups (35% vs. 10% vs. 6%; $P < 0.001$). One-year all-cause mortality was highest in the ViMAC group, followed by the ViR and ViV groups (63% vs. 31% vs. 14%; $P < 0.001$). Patients with post-procedure moderate or worse MR were twice as likely to die vs. those with mild or no MR (42% vs. 21%; $P = 0.01$). The authors concluded that in patients with high surgical risk, TMVR was associated with excellent outcomes when used for degenerated bioprosthetic mitral valves. ViR and ViMAC patients experienced significantly higher rates of complications and mortality.

■ COMMENTARY

The principle message of this observational registry study is that TMVR probably is the treatment of choice for failed mitral valve bioprostheses. The implication of this conclusion is that there are few reasons to ever place a mechanical prosthesis in the mitral position, even in young patients. The 30-day mortality rate for ViV patients (6%) compares favorably to the 9-12% mortality rate reported previously for redo mitral valve surgery. The centers in this study used the transatrial-septal approach in 60% of patients, and there were no differences in outcomes compared to the patients who underwent TMVR via the apical approach. Thus, there is no reason not to use the less traumatic septal approach. Also, most patients received oral anticoagulation after TMVR (70%); the rest received antiplatelet therapy. Valve thrombosis occurred in 3% of ViV patients over two years; most were not on anticoagulants. Based on this limited nonrandomized experience, the authors recommended oral anticoagulation after mitral ViV.

The results for ViR patients were much less robust. Paravalvular leaks were common with post-procedure moderate or worse MR (18%). Often, these leaks were plugged via other catheter-delivered devices. When all complications were considered, procedural success was only 57%, with 12% of patients needing a second valve insertion. Also, the 30-day mortality rate for ViR patients is similar to reported surgical mortality for failed repairs (9%). Considering these results, the authors of an accompanying editorial suggested that mitral leaflet clipping may be a better option. Of course, a device designed for the aortic valve was used here. Future devices designed for the mitral valve may alleviate some of these issues.

When it came to TMVR for ViMAC patients, the results were even worse. The major complication was LVOT obstruction, which occurred in 40% of patients, necessitating subsequent alcohol septal ablation in 12% of patients. Overall procedural success was 41%. The 30-day mortality rate was a whopping 35%. These results are especially disappointing since MAC patients showed the highest surgical mortality rate of the three groups. A new study has been launched to see whether percutaneously lacerating the anterior leaflet can abrogate the obstruction issue. Also, new low-profile devices that are fully retrievable for the mitral position are in development.

The results from this large international registry are a snapshot of time in a fast-moving field with several new studies of alternative techniques and devices underway. At this time, only TMVR for degenerated bioprosthetic valves appears to be a clear alternative to surgery. ■

ABSTRACT & COMMENTARY

New Insights Into Young Acute Myocardial Infarction Patients

By Michael H. Crawford, MD, Editor

SYNOPSIS: A retrospective contemporary review of STEMI patients younger than 35 years of age shows that these patients are predominantly overweight men who smoke (some abuse drugs and present with dyslipidemia).

SOURCE: Ruiz Pizarro V, Palacios-Rubio J, Cruz-Utrilla A, et al. ST-elevation myocardial infarction in patients ≤ 35 years of age. *Am J Cardiol* 2019;123:889-893.

Although infrequent, acute ST-elevation myocardial infarction (STEMI) in patients younger than 35 years of age can devastate quality of life. To better understand clinical profile and prognosis of such patients, investigators from Madrid evaluated STEMI patients ≤ 35 years of age from three urban hospitals between 2004 and 2016. All three hospitals were percutaneous coronary intervention (PCI) centers. The authors performed an extensive initial determination of clinical factors and followed patients for major adverse cardiac events (MACE) over an average of six years.

Out of 3,883 STEMI patients at the three hospitals, 61 were ≤ 35 years of age, with a mean age in this cohort of 32 years. Most were men (88%), smokers (80%), and overweight (67%). Only 3% did not exhibit conventional risk factors. Compared to a similar-aged reference group from the Spanish population, young STEMI patients more often were diabetic, exhibited dyslipidemia, were overweight, and smoked. Drug abuse was discovered in 26% of these patients. Almost all patients underwent primary PCI (87%); the rest underwent thrombolysis before PCI. Although complications during hospitalization were infrequent, the hospital mortality rate was 5%. The long-term survival rate was 97%, and the MACE rate was 17%. The authors concluded that despite the rarity of STEMI in patients ≤ 35 years of age, such patients present with modifiable predisposing conditions and an excellent long-term prognosis.

■ COMMENTARY

This study is important because it is a contemporary cohort of young patients with STEMI treated at large urban PCI centers. Perhaps not surprisingly, such young patients are rare, comprising 1-2% of all STEMIs. However, these young STEMI patients feature a unique clinical profile. They are mostly male smokers who are overweight. The only other clinical factors that rise above a prevalence of one-quarter of the cohort are dyslipidemia (32%) and drug abuse (26%). Common risk factors found in older patients were uncommon in this cohort: diabetes (15%) and hypertension (16%). Unusual causes in older patients, which one would assume to be more common in this young cohort, were surprisingly low: familial hypercholesterolemia (5%) and HIV (3%).

Despite experiencing a STEMI, which was caused by an occlusion of the left anterior descending coronary artery in two-thirds of this young cohort, complications were infrequent. Most were Killip class I (85%); a majority exhibited left ventricular ejection fraction > 50%. The hospital mortality rate was 5%, while the total mortality rate over the six-year follow-up was 8% (includes hospital mortality). The MACE rate was 17%.

[These data inform a public health opportunity since the major factors predisposing these patients to STEMI are largely modifiable.]

There are some limitations to this study. The authors did not include patients with spontaneous coronary artery dissection or MI with normal coronary arteries. They also excluded patients with non-STEMI and type II MI. In addition, this was a homogeneous population of Mediterranean people; thus, the results may not be applicable to other populations. Finally, the authors reported no data on the subsequent management of these patients.

Although as a group these young patients performed well, some died; others were left with impaired left ventricular function. Thus, these data inform a public health opportunity since the major factors predisposing these patients to STEMI are largely modifiable. Young men should not smoke, should maintain a normal weight, should keep their lipid values in the desirable range, and should not abuse drugs. If these goals are accomplished, the number of STEMI episodes in young men could approach zero. ■

ABSTRACT & COMMENTARY

The Right Ventricle During Heart Failure With Preserved Left Ventricular Ejection Fraction

By Michael H. Crawford, MD, Editor

SYNOPSIS: A retrospective longitudinal study of heart failure with reduced left ventricular ejection fraction shows that right ventricular function deteriorates more rapidly than left ventricular function and is associated with increased mortality.

SOURCES: Obokata M, Reddy YNV, Melenovsky V, et al. Deterioration in right ventricular structure and function over time in patients with heart failure and preserved ejection fraction. *Eur Heart J* 2019;40:689-697.

Gorter TM, van Veldhuisen DJ, Voors AA. Rapid right-sided deterioration in heart failure with preserved ejection fraction. *Eur Heart J* 2019;40:699-702.

The authors of previous cross-sectional studies have shown that right ventricular (RV) dysfunction in patients with heart failure with preserved left ventricular ejection fraction (HFpEF) is a strong predictor of morbidity and mortality. However, little is known about why some patients with HFpEF develop RV failure and some do not.

Investigators from the Mayo Clinic performed a retrospective, longitudinal, observational study of patients with HFpEF confirmed by cardiac catheterization evidence of left heart filling pressures or HF symptoms (left ventricular ejection fraction ≥ 50%) and a previous hospitalization for pulmonary edema that resolved with diuretic therapy. Patients with significant valve disease, pulmonary disease, recent acute coronary syndrome, constrictive pericarditis, high output HF, or cardiomyopathy were excluded. Also, each patient had to have undergone two or more echocardiograms at least six months apart. In addition, 27 controls who demonstrated normal rest-exercise pulmonary capillary wedge pressures were used as a comparator group. Follow-up commenced after echo 2 in the 271 patients who met inclusion criteria. The median time between echo 1 and echo 2 was four years.

Between the two exams, blood pressure decreased, probably due to medication changes, but measures of LV diastolic function worsened. There was a small decline in LVEF, but LV volumes were unchanged. However, RV structure and function worsened significantly. RV diastolic area increased 20% and RV fractional area change (FAC) decreased 10%, such that there was a 2.5-fold increase in patients with RV dysfunction (FAC < 35%). Also, right atrial area increased, and the prevalence of moderate-to-severe tricuspid valve regurgitation (TR) increased from 20% to 29% ($P = 0.003$), despite no change in estimated RV systolic pressure. No significant changes occurred in the control group in these measures over the same period.

Comparing those who maintained RV function to those who developed RV dysfunction, the latter group of patients were more likely to be overweight and diabetic. Atrial fibrillation, coronary artery disease, and higher RV systolic pressure (SP) and RV area also all were more common. However, there were no significant changes in LV systolic or diastolic function between the two groups. Over a median follow up of 15 months, patients who exhibited RV dysfunction at exam 1 or who developed RV dysfunction between exam 1 and exam 2 were more likely to die (hazard ratio, 1.82; 95% confidence interval, 1.01-13.4; $P = 0.04$). The authors concluded that in patients with HFpEF, RV structure and function deteriorate to a much greater extent over time vs. LV structure and function.

■ COMMENTARY

This is the first longitudinal study of the RV in patients with HFpEF using a unique retrospective design in selected patients with at least two echoes from the Mayo Clinic cardiology database. The authors confirmed that the development of RV dysfunction increases mortality in HFpEF patients; surprisingly, this was not accompanied by a similar magnitude of worsening LV function. There are factors associated with this decline in RV function that are potentially modifiable (atrial fibrillation, obesity, and coronary artery disease). Although estimated RVSP was associated with worse RV function, as expected, it did not change significantly between the two exams despite markedly declining RV function.

What emerges from this study are three avenues for preventing RV dysfunction from developing in HFpEF patients. First, keep RV pressure as low as possible by aggressive diuresis, perhaps guided by an implantable pulmonary artery pressure sensor. It is noteworthy in this study that only 40% of patients were on loop diuretics and 10% on aldosterone antagonists. Pulmonary vasodilators have been tried in pilot (Phase II) studies, which were negative to potentially harmful. In some

situations, lowering pulmonary artery resistance results in too much blood flow to the lungs, which cannot be accommodated by the stiff LV resulting in acute pulmonary edema.

Second, aggressively addressing the risk factors identified in this study could help. Third, there was significant progression of TR between the two exams without significant changes in RVSP. Procedures such as transcatheter clipping of the tricuspid valve leaflets may play a role in selected patients with moderate to severe TR and HFpEF.

Encourage patients to lose weight, try to keep them in sinus rhythm, and treat any myocardial ischemia. Further prospective data will be needed to establish the efficacy of these interventions, but there is little potential harm in trying them now. ■

CME/CE QUESTIONS

1. The risk factor for myocardial infarction in patients ≤ 35 years of age that could make the biggest difference if corrected is:

a. dyslipidemia.

b. stimulant drug abuse.

c. smoking.

d. obesity.

2. A major advantage of the proposed multidisciplinary shock team approach to cardiogenic shock is the early use of:

a. vasopressors.

b. inotropes.

c. intra-aortic balloon pump.

d. mechanical circulatory support.

3. The advantage of immediate catheterization for resuscitated cardiac arrest in non-STEMI patients is:

a. there is no benefit.

b. more judicious application of cooling.

c. salvaging jeopardized myocardium.

d. placing a prophylactic intra-aortic balloon pump.

4. Which of the following changes most rapidly during follow-up of patients with heart failure with preserved left ventricular ejection fraction?

a. Left ventricular diastolic function

b. Left ventricular systolic function

c. Right ventricular systolic function

d. Right ventricular systolic pressure

5. The best procedural and one-year outcomes of transcatheter mitral valve replacement are in patients with:

a. failed mitral valve ring and repair.

b. failed bioprosthesis.

c. mitral annular calcification-associated disease.

d. native mitral valve degeneration.

CME/CE 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.