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Clinical Cardiology [ALERT]

Critical analysis of the latest clinical research in cardiovascular medicine

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ABSTRACT & COMMENTARY

Which Acute Myocardial Infarction Patients Need a Blood Transfusion?

By Michael Crawford, MD, Editor

SYNOPSIS: A randomized trial of a restrictive blood transfusion strategy (hemoglobin < 8 g/dL; goal 8-10 g/dL) vs. a more liberal strategy (hemoglobin < 10 g/dL; goal > 11 g/dL) in patients with acute myocardial infarction and anemia showed the restrictive strategy is noninferior to the liberal strategy for preventing the primary outcome of death, reinfarction, stroke, or emergency revascularization.

SOURCE: REALITY trial presented by Philippe G. Steg at the European Society of Cardiology Virtual Congress, Sept. 1, 2020.

Which patients with cardiac disease will benefit from blood transfusion for anemia is controversial. The authors of the REALITY trial randomized 666 patients with acute myocardial infarction (AMI) and anemia to a restrictive blood transfusion strategy (hemoglobin [Hgb] < 8 g/dL; goal Hgb of 8-10 g/dL (n = 342) or a more liberal strategy (Hgb < 10 g/dL; goal Hgb > 11 g/DL (n = 324). The strategies were maintained until hospital discharge or 30 days, whichever came first. Follow-up was for 30 days after AMI. The patient's mean age was 77 years, and 43% were women.

Both those with and without ST elevation were included if their last ischemic symptoms were less than 48 hours before admission. An elevated troponin also was required. Anemia was defined as Hgb less than 10 g/dL but greater than 7 g/dL. Generally, less than 7 g/dL is regarded as a criterion for transfusion. Patients with cardiogenic shock, elective PCI- or CABG-associated MI, hematologic disease, transfusion in the 30 days preceding the AMI or massive bleeding compromising the patient's prognosis were excluded. The primary composite endpoint was all-cause death, reinfarction, stroke, and emergency revascularization prompted by ischemia. Of note, 70% of patients experienced a non-ST elevation AMI; of those, 80% underwent coronary angiography. Of the coronary angiography group, 59% received a PCI and 4% underwent coronary bypass surgery.

The mean units of packed red blood cells per patient was similar for the restrictive vs. liberal strategies (2.9 vs. 2.8). The primary outcome occurred in 11% of the restrictive group and 14% of the liberal group (HR, 0.77; 95% CI, 0.50-

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1.18; $P < 0.05$ for noninferiority and $P = 0.22$ for superiority). All-cause mortality was 5.6% vs. 7.7%, recurrent MI was 2.1% vs. 3.1%, and emergency revascularization was 1.5% vs. 1.9% (all P = NS). Among secondary outcomes, a restrictive strategy led to lower infection rates (0% vs. 1.5%; $P = 0.03$) and lower acute lung injury rates (0.3% vs. 2.2%; $P = 0.03$). The authors concluded that a restrictive blood transfusion strategy in patients with AMI and anemia is noninferior regarding 30-day outcomes vs. a more liberal strategy.

■ COMMENTARY

Several previous studies in hospitalized medicine patients revealed a Hgb cutoff of 7 g/dL for blood transfusions provides the ideal equipoise regarding outcomes. Thus, many hospitals made this a policy to save money on blood transfusion costs. However, most of those studies included few (if any) patients with acute ischemic heart disease syndromes. Accordingly, there was a concern that ischemic myocardium might perform better with higher Hgb levels. After all, the myocardium cannot extract more oxygen from the blood when it is needed as many other organs can. The myocardium is solely dependent on the oxygen-carrying capacity and the volume of blood it receives. Hence, many argued transfusions should be performed at higher cutoff values (e.g., 10 g/dL). The results of small observational studies of heart failure and postoperative patients supported this hypothesis. Therefore, this randomized study from Europe is important.

The prior studies and the ischemic myocardium hypothesis must have influenced the REALITY trial investigators' study design, since they chose a cutoff value of 8 g/dL for the restrictive group rather than 7 g/dL. The liberal group cutoff was 10 g/dL, which would be supported by some of the previous studies and is the most liberal policy recommended. The lack of superiority of the liberal strategy, the reduced blood utilization, and lower costs of the restrictive strategy make a strong argument for the restrictive policy at a Hgb cutoff of 8 g/dL in AMI patients. Whether this should be the policy for other forms of acute heart disease is unclear. The results of other observational studies of acute heart failure patients with anemia have suggested that 9 g/dL or 10 g/dL may be the ideal cutoff in such patients.

We have all seen heart failure patients markedly improve after anemia is treated, but the target Hgb level to transfuse and achieve with transfusion is poorly defined. In the REALITY trial, there was a trend toward more acute kidney injury in the restrictive group (9.7% vs. 7.1%; $P = 0.24$). One can imagine this could be a bigger problem in heart failure patients, especially those with ischemic cardiomyopathy. I hope the REALITY trial researchers are planning a similar study of an acute heart failure cohort. ■

ABSTRACT & COMMENTARY

Ticagrelor in the Elderly: More Potent Platelet Inhibition Not Always Better

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 a study of 14,000 elderly patients with acute myocardial infarction, treatment with ticagrelor was associated with higher risks of bleeding and all-cause death vs. clopidogrel.

SOURCE: Szummer K, Montez-Rath ME, Alfredsson J, et al. Comparison between ticagrelor and clopidogrel in elderly patients with an acute coronary syndrome: Insights from the SWEDEHEART registry. *Circulation* 2020; Sep 1. doi: 10.1161/CIRCULATIONAHA.120.050645. [Online ahead of print].

What a difficult year it has been for ticagrelor. Ten years ago, the PLATO trial (*Am Heart J* 2009;157:599-605) demonstrated the superiority of ticagrelor over clopidogrel in patients with acute coronary syndromes. Those authors reported a decrease in all-cause death without an increase in the rate of overall major bleeding. Since then, ticagrelor has taken a significant share of the P2Y12 inhibitor market in acute coronary syndrome (ACS) based primarily on this trial data. Current guidelines specifically recommend using ticagrelor instead of clopidogrel in patients with myocardial infarction, unless it is contraindicated. Recent comparative data between the more-potent agents has not come out in ticagrelor's favor. In late 2019, the ISAR-REACT 5 trial, designed to show the superiority of ticagrelor over rival prasugrel in ACS patients, showed just the opposite (*N Engl J Med* 2019;381:1524-1534).

Szummer et al raised more questions about the accepted superiority of ticagrelor over clopidogrel in this class of patients with ACS. This registry included data from all consecutive coronary care unit admissions in Sweden for symptoms suggestive of ACS. The authors compared the effects of ticagrelor and clopidogrel in an elderly population. They analyzed data from 14,005 patients who were age 80 years or older and presented to the hospital with a new diagnosis of MI between 2010 and 2017. This period encompassed the introduction of clopidogrel in 2011 and saw the use of ticagrelor increase from 0% to 72% of all ACS cases. Among the entire cohort, 8,434 were prescribed clopidogrel, while 5,571 were given ticagrelor. Fewer than one-third of all patients presented with STEMI, while the remainder carried diagnoses of non-STEMI.

Because patients prescribed ticagrelor were overall younger and presented with fewer comorbidities compared with the clopidogrel group, inverse probability treatment weighting (IPTW) was used to correct for differences in demographics and treatment. As expected, patients treated with ticagrelor were at lower risk for experiencing a new MI (HR, 0.80; 95% CI, 0.70-0.92) or stroke (HR, 0.72; 95% CI, 0.56-0.93). However, this occurred at the expense of a 17% higher risk of death (HR, 1.17; 95% CI, 1.03-1.32) and a 48% higher risk of hospitalization with a new bleeding event (HR, 1.48; 95% CI, 1.25-1.76). As a comparator, the authors analyzed the 58,671 patients in the registry younger than age 80 years. In this group, 62% were treated with ticagrelor, while 38% were given clopidogrel. Treating this younger group with ticagrelor was associated with a mortality benefit, in addition to lower risks of new MI and stroke vs. treatment with clopidogrel. However, there also was a 32% higher risk of new bleeding events. The authors concluded elderly patients presenting with acute MI, compared with younger patients, demonstrate differential safety and efficacy of ticagrelor. This translates to higher risks of bleeding and death compared with clopidogrel in this population. They recommend other researchers conduct a randomized trial that includes elderly patients to guide future therapy.

■ COMMENTARY

The observational, retrospective SWEDEHEART carries all the limitations that design suggests. Despite those limitations, this is by far the largest investigation of its kind and was well-done. Among younger patients, ticagrelor showed similar benefits to what had been seen in PLATO, in which the average age of subjects was only 62 years. This suggests a validity to these methods when compared with randomized, controlled trials performed in this space. Bleeding itself clearly also was more common in ticagrelor-treated patients vs. clopidogrel-treated patients in the younger cohort (HR, 1.32). However, the risk of all-cause death was lower. The fact that younger patients showed a similar ticagrelor-related hazard of bleeding but opposite effects on all-cause death suggests a differential effect of bleeding itself in elderly patients. Current guideline recommendations in both the United States and Europe suggest preferential use of the more potent P2Y12 inhibitors ticagrelor and prasugrel over clopidogrel in treatment of ACS, without respect to age or other comorbidities. Real-world patients often are older, and the best therapy may vary for different patient subsets. Elderly patients are common; in this registry, just under 20% of all MI patients were older than age 80 years. Approximately one-third of MI patients in similar registries are older than age 75 years. In this study, age alone, without respect to other recognized risk factors for bleeding, was enough to tilt the risk:benefit balance of ticagrelor.

It is worth noting that among patients older than age 80 years in SWEDEHEART, clopidogrel was used in most cases, whereas in younger patients the proportions are reversed (~60% clopidogrel use in the older than age 80 years population vs. ~60% ticagrelor use in younger patients). Clearly, there already is some recognition of the hazards of more potent antiplatelet agents in the elderly. For now, despite current guidelines, cardiologists should not take a one-size-fits-all approach in the treatment of ACS and should consider the potential downside of more potent antiplatelet agents in older patients. ■

ABSTRACT & COMMENTARY

When Is TAVR Futile?

By Michael Crawford, MD, Editor

SYNOPSIS: A study of all patients who underwent transcatheter aortic valve replacement over eight years in France was used to develop a futility score that would help predict who would not live one year after the procedure. This simple clinical score based on comorbidities predicted who would live one year with 95% specificity.

SOURCE: Lantelme P, Lacour T, Bisson A, et al. Futility risk model for predicting outcome after transcatheter aortic valve implantation. *Am J Cardiol* 2020;130:100-107.

Transcatheter aortic valve replacement (TAVR) is a mature technology that carries solid success rates in high-risk surgical patients. However, some patients survive less than a year despite a technically successful procedure.

Lantelme et al identified such patients using simple clinical variables to establish a futility score (FS). Using a national database, they studied all patients in France who underwent TAVR between 2010 and 2018. The resulting population of 20,443 patients was divided into a derivation cohort (10,221) and a validation cohort (10,222). The primary outcome was all-cause death. Procedural futility was defined as death occurring less than one year after TAVR. Those who died during the first year were compared to those who did not.

From 33 clinical variables, the authors constructed a FS using multivariate logistic regression. The mean age of the population was 83 years, and the mean follow-up interval was two years. The annual death rate was 15% (53% of deaths occurred during the first year, which was 18% of all TAVR patients). The final FS consisted of 14 clinical characteristics: age, heart failure, pulmonary edema, stroke, atrial fibrillation, vascular disease, chronic kidney disease, liver disease, lung disease, anemia, cancer in the last five years, metastatic cancer, depression, and poor nutrition. The maximum point score was 17, with all but pulmonary edema (3) and metastatic cancer (2) representing one point each. The scores were divided into three segments: low risk (0-4), moderate risk (5-8), and high risk (> 8).

The low-risk group was 47% of the population, the moderate-risk group was 46% of the population, and the high-risk group was 7% of the population. The one-year death rate among the three groups was 11% (low risk), 22% (moderate risk), and 43% (high risk). The FS (AUC, 0.67) outperformed the EuroSCORE II (AUC, 0.63), the Charlson Comorbidity Index (AUC, 0.56), and the Frailty Index (AUC, 0.49) for identifying futility. Similar results were obtained in the derivation and validation cohorts. The authors concluded the FS could be a relevant tool for helping identify patients unlikely to benefit from TAVR.

■ COMMENTARY

A mentor of mine once said that just because you can do something does not mean you have to. Another way of expressing this is asking whether it is acceptable to die without a TAVR if you suffer from severe aortic stenosis. Accordingly, the European Society of Cardiology guidelines do not recommend aortic valve replacement if the patient's life expectancy is less than one year. This sounds reasonable, but predicting death is not easy. Other investigators have proposed various approaches to identifying those with a high risk of futility.

The FS derived from this study is one approach that performed well, but none of the proposed approaches carries an AUC higher than about 0.7 for identifying those who will not survive a year. Lantelme et al found 18% of their TAVR patients died within one year. An FS score of > 8 translated to a one-year death rate of 43%, which is similar to that reported for medical therapy of severe aortic stenosis.

The FS includes important comorbidities, but clinicians are going to struggle to remember the 14 included in the score. Most of the comorbidities are only worth one point, except for pulmonary edema and metastatic cancer. If those conditions are present, it would not take much more to cross 8 points. Without those two conditions, it would take at least eight comorbidities to hit the high-risk point. Thus, it is not surprising that only 7% of patients were high risk. Outside the high-risk group, the specificity of surviving one year was 95%. However, 22% of the one-year deaths occurred in moderate-risk patients who cardiologists probably would not exclude from TAVR. Therefore, no score is going to be an absolute cutpoint for not offering TAVR. There remains plenty of room for the collective clinical judgment of the heart team.

There were weaknesses to this study. It was retrospective and observational, and the authors used administrative data they did not check against the

clinical record. There are no data available about left ventricular function, valve characteristics, or medical therapy. Also, it may be reasonable in a high-risk FS patient to consider TAVR to reduce or eliminate symptoms that are interfering with the patient's enjoyment of his or her last year. This is a complex issue, but this simple comorbidity score concept may help with these difficult decisions. ■

ABSTRACT & COMMENTARY

TAVR Outcomes in Patients on Chronic Corticosteroid Therapy

By Michael Crawford, MD, Editor

SYNOPSIS: A 12-year experience with transcatheter aortic valve replacement at one Paris hospital demonstrated chronic systemic corticosteroid use increases the incidence of major 30-day complications and all-cause mortality at one year.

SOURCE: Gautier A, Urena M, Chong-Nguyen C, et al. Outcomes of transcatheter aortic valve implantation in patients receiving chronic systemic corticosteroid treatment. *Am J Cardiol* 2020;130:108-114.

Chronic systemic corticosteroid therapy (SCT) can lead to cutaneous and vascular fragility as well as delayed wound healing. It is known to increase the risk of percutaneous coronary intervention complications, but little is known about the effect on outcomes with transcatheter aortic valve replacement (TAVR).

Gautier et al interrogated Paris' Bichat-Claude Bernard Hospital TAVR database for chronic SCT from late 2006 through 2018. Chronic SCT was defined as use for at least 30 days before the procedure. The authors compared these patients to TAVR patients not taking steroids. Researchers followed both groups through outpatient visits or phone calls at 30 days and 12 months after TAVR.

The primary endpoints were 30-day vascular and bleeding complications, permanent pacemaker implantation, acute kidney injury, stroke, cardiac tamponade, and one-year all-cause mortality. Among 1,299 patients who underwent TAVR, 48 were on chronic SCT. The mean age of the entire population was 81 years. The major difference in baseline criteria between the two groups was hemodialysis in 12% of the SCT patients and 3% of the controls ($P = 0.002$). Procedural outcomes were not different between the two groups.

At 30 days, the steroid group had experienced more major vascular complications (17% vs. 7%; $P = 0.02$), more major bleeds (23% vs. 12%; $P = 0.04$), and cardiac tamponade caused by left ventricular puncture or rupture (8% vs. 2%; $P = 0.03$). At one-year follow up, 37% of the SCT group had died vs. 12% of the control group ($P < 0.0001$). Of note, a cardiovascular death was more common in the non-SCT group (78% vs. 55%; $P = 0.047$), and a non-cardiovascular death was more common in the SCT group (44% vs. 22%). The authors concluded chronic SCT use in patients undergoing TAVR increases the incidence of vascular complications, life-threatening bleeding, and cardiac tamponade at 30 days and all-cause mortality at one-year follow-up.

■ COMMENTARY

This was a relatively small observational study from one center in France exploring the effect of chronic SCT therapy (> 30 days) on major TAVR complications at 30 days and all-cause mortality at one year. Not surprisingly, both were significantly higher with robust hazard ratios (HR) by multivariate analysis of > 2.0: major vascular complications (HR = 2.52), major bleeds (HR = 2.02), cardiac tamponade (HR = 4.05), and one-year mortality (HR = 2.29). Presumably, these complications were caused by the vascular and tissue fragility induced by chronic SCT. The latter is supported by the cases of cardiac tamponade caused by left ventricular puncture and annular rupture. The multivariate analysis of the patients' comorbidities showed chronic SCT was the only predictor of all-cause mortality with a HR > 2. This analysis did not list the reasons for SCT therapy, which included vasculitis in 14 patients, kidney or liver transplant in 10, chronic arthritis in eight, and other autoimmune disease in 11. Considering 44% of patients on chronic SCT died from non-cardiac reasons at one year, the importance of non-cardiac disease in the outcome of TAVR is clear.

One-year survival in the entire population was 86%, which is similar to that reported from other databases. Other studies of SCT in TAVR patients have shown lower complication rates, but these

studies included patients on inhaled steroids for chronic lung disease, which has been shown to lead to few complications. Gautier et al excluded such patients from their study. Unfortunately, this study was too small to stratify the patients by steroid dose or the underlying indication. There was a trend toward less pacemaker use in the SCT group (17% vs. 23%). One potential cause of heart block after TAVR is mechanical compression damage to the conduction system, resulting in acute inflammation. It has been observed that patients given corticosteroids periprocedurally for angiographic dye allergy are less likely to need pacemakers. These observations will need to be tested in larger populations before any recommendations for this therapy in TAVR can be made.

This study, although hypothesis-generating because of its observational nature, suggests chronic SCT should be added to the list of comorbidities to consider when deciding whether TAVR is likely to be futile because of a high incidence of mortality in one year, mainly because of the underlying diseases treated. This study's results were not strong enough to lead cardiologists to use SCT as a yes or no criterion for TAVR, but certainly should occasion a consideration of the prognosis of the underlying disease treated. ■

ABSTRACT & COMMENTARY

U.S. Readmission Rates for TAVR

By Michael Crawford, MD, Editor

SYNOPSIS: An analysis of the Nationwide Readmission Database revealed one-fifth of transcatheter aortic valve replacement patients are readmitted a median of 31 days after discharge. Medical comorbidities are the most common reason.

SOURCE: Tripathi B, Nerusu LA, Sawant AC, et al. Transcatheter aortic valve implantation readmissions in the current era (from the National Readmission Database). *Am J Cardiol* 2020;130:115-122.

The rate of transcatheter aortic valve replacement (TAVR) is increasing exponentially in the United States. Hospitals are concerned Medicare will start scrutinizing readmissions following this procedure. This report derived from the Healthcare Cost and Utilization Project (HCUP) Nationwide Readmission Database (NRD) from 2016-2017 is of interest.

Time to readmission was calculated by subtracting the length of stay of the index TAVR admission from the interval between two admissions. From 73,784 TAVR admissions, 16,343 were readmitted within 90 days, which is the endpoint of this study. The secondary endpoints were the predictors of readmission, etiology of readmission, and in-hospital outcomes by using ICD-10 codes for the primary readmission diagnosis. Comorbidities were determined in a similar fashion, and NRD variables were used to identify demographic characteristics of the patients. Hospitalization costs were derived from HCUP data adjusted for inflation. Most TAVR patients were octogenarians (61%) and men (55%). About 44% were discharged within 48 hours, and only 31% stayed longer than five days. However, these patients recorded a higher readmission rate (47% vs. 33%; $P < 0.001$).

The median time to readmission was 31 days. Congestive heart failure was the most common reason for readmission (77%). Readmitted patients exhibited a higher prevalence of medical comorbidities, were more likely to have been discharged to a skilled nursing facility (SNF) compared to non-readmitted patients (22% vs. 12%; HR, 1.58; $P < 0.001$), and record a length of stay longer than two days (67% vs. 53%; HR, 1.4; $P < 0.001$). Non-cardiac conditions accounted for 64% of readmissions, most commonly infections (13%), GI complications (7%), neurological complications (6%), and pulmonary complications (6%).

Multivariate predictors of 90-day readmission included transapical approach (HR, 1.19), age older than 90 years (HR, 1.22), diabetes (HR, 1.15), heart failure (HR, 1.17), atrial fibrillation/flutter (HR, 1.39), prior stroke (HR, 1.15), prior pacemaker/defibrillator (HR, 1.09), anemia (HR, 1.13), chronic obstructive pulmonary disease (HR, 1.26), chronic kidney disease (HR, 1.33), liver disease (HR, 1.24), acute kidney injury (HR, 1.2), and major bleeding (HR, 1.16). The cost of index hospitalization for those readmitted was higher than those not readmitted ($57,066 vs. $52,204; $P < 0.001$). The authors concluded that one out of five TAVR patients is readmitted within 90 days, mostly for non-cardiac causes.

■ COMMENTARY

The Hospital Readmissions Reduction Program (HRRP) has been using 30-day readmission rates for certain diagnoses as a performance measure, penalizing hospitals with higher rates. Also, Medicare's bundled payment care initiative makes hospitals assume care for 90 days for certain diagnoses, and

penalizes hospitals with high costs, which include the cost of readmissions within 90 days. Cardiac conditions targeted by HRRP (e.g., myocardial infarction and percutaneous coronary interventions) have exhibited a decrease in readmission rates and costs. In August 2020, voluntary outcome reporting for TAVR started, which includes volume of cases as well as risk-adjusted hospital and 30-day mortality. Bundled payments for TAVR are sure to follow. Currently, there are more than 25,000 TAVRs performed in more than 400 centers in the United States. As more low-risk surgical patients undergo TAVR, this number is likely to grow exponentially. Thus, this analysis of TAVR readmissions is of interest because it sheds light on the magnitude and potential causes of TAVR readmissions. Also, the NRD database is relevant because it represents 58% of hospitals in the United States, includes all payors, and covers 36 million discharges.

The Tripathi et al study demonstrated that one-fifth of TAVR patients are readmitted within a median of 31 days, and noncardiac conditions account for nearly two-thirds of the readmissions. The strongest predictors of readmission are discharge to a SNF (HR, 1.58) and length of stay of the index hospitalization (HR, 1.4). Also, readmitted patients carried a higher burden of comorbidities and were more likely to experience a serious complication, which prolonged hospital stay and resulted in SNF placement. The top five diagnoses for readmission were infections, along with GI, neurologic, pulmonary, and bleeding complications. Efforts to reduce readmissions will need to use a multidisciplinary team approach that includes internists to manage these patients after discharge. Also, judicious patient selection may be necessary to shorten lengths of stay and prevent patients from likely readmission for their comorbid conditions. In addition, patients with appropriate anatomy for a successful procedure and meticulous procedural technique will be required to reduce complications. Hail Mary TAVRs likely will be discouraged.

Because this work was based on administrative data, that represents a major limitation. There were no patient-level clinical data or data on socioeconomic status, education levels, or race. These variables likely would affect readmission rates and would need to be considered in planning readmission prevention efforts. Also, death outside the hospital, which would be a competitor to readmissions, is unknown. Finally, the NRD includes only 21 states, so the results may not apply to all U.S. locales. Very elderly, frail patients with multiple comorbidities and TAVR procedural complications are at the highest risk for readmission. Future Medicare payment programs may necessitate a more selective approach to such patients. ■

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CME/CE QUESTIONS

1. **A recent study of restrictive vs. more liberal blood transfusion strategies in acute myocardial infarction patients with anemia revealed the ideal cutpoint for transfusion is a hemoglobin concentration of:**
   a. 7 g/dL.
   b. 8 g/dL.
   c. 9 g/dL.
   d. 10 g/dL.

2. **A nationwide study of TAVR in France revealed what percentage of these patients lived less than one year?**
   a. 18%
   b. 27%
   c. 35%
   d. 43%

3. **Compared to younger patients, a study comparing ticagrelor to clopidogrel for one year post-acute myocardial infarction showed those older than age 80 years had a higher rate of:**
   a. stroke.
   b. recurrent infarction.
   c. thromboemboli.
   d. major bleeding.

4. **An experience in one French hospital with TAVR in patients on chronic, systemic corticosteroid therapy compared to those not on steroids showed a high incidence of 30-day:**
   a. mortality.
   b. left ventricular perforation.
   c. stroke.
   d. puncture site infection.

5. **A multivariate analysis of hospital readmission after TAVR revealed the most powerful predictor of readmission within 90 days of discharge after TAVR is:**
   a. transapical approach.
   b. age older than 90 years.
   c. discharge to a skilled nursing facility.
   d. length of index hospital stay.

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.