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Clinical Cardiology [ALERT]

Critical analysis of the latest clinical research in cardiovascular medicine

ABSTRACT & COMMENTARY

Does Late Gadolinium Enhancement on MRI in Atrial Fibrillation Patients Portend a Poor Prognosis?

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Dr. Gerstenfeld does research for Biosense Webster, Medtronic, and Rhythmia Medical.

SOURCE: Neilan TG, et al. The incidence, pattern, and prognostic value of left ventricular myocardial scar by late gadolinium enhancement in patients with atrial fibrillation. *J Am Coll Cardiol* 2013;62:2205-2214.

Late gadolinium enhancement (LGE) of the left ventricle on magnetic resonance imaging (MRI) has been shown to correlate with fibrosis and adverse outcomes in a broad group of patients with cardiomyopathy. However, the prognostic significance in patients with atrial fibrillation (AF) has not been studied.

The authors performed high-resolution MRIs on 720 patients referred for ablation of AF at a single center, including 56 with a prior history of myocardial infarction (MI). LGE was detected in 108 patients (15%) overall, and in 13% of patients when those with prior MI were excluded. Mortality was assessed through use of the social security death index and medical record. Patients with LGE were older and more likely to have heart failure and sleep apnea. There were a total of 68 deaths over a median 42 months of follow-up. Mortality was 8.1%/patient-year in patients with LGE compared with 2.3%/patient-year in those without LGE. Excluding patients with prior MI by ECG or clinic history, the multivariate predictors of mortality included age and the extent of LGE,

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which provided the strongest associations with mortality.

■ COMMENTARY

AF remains the most common supraventricular arrhythmia, with a mortality in AF patients twice that of age-matched controls. However, multiple studies have shown no mortality benefit to a rhythm control strategy of trying to maintain sinus rhythm compared to a strategy of controlling the ventricular rate. Therefore, it is unclear whether the increased mortality in AF patients is related to the presence of AF or if AF is merely a marker of poor prognosis. Predictors of increased mortality in AF patients have been scarce. LGE has been shown to predict mortality in patients with hypertrophic, ischemic, and non-ischemic cardiomyopathies. Although this study includes a unique subgroup of patients referred for AF ablation, the study raises some interesting questions. Many patients undergoing AF ablation undergo computed tomography (CT) or MRI prior to ablation as part of pulmonary vein mapping. Should MRI be the preferred modality? Although the resolution is lower, MRI does not expose the patient to radiation and may give additional prognostic information. Should those with left ventricular LGE be given special attention and more aggressive risk factor modification? Would earlier treatment of AF prevent the progression of LV fibrosis and LGE, or is it merely a marker of adverse prognosis associated with AF? Is there a role for angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, which may have a role in decreasing fibrosis, in these patients? Do the findings in the patients in this study referred for AF ablation extend to the greater population of patients with AF? As with many studies, the results have posed more questions than answers. At a minimum, I think it is reasonable to assess standard cardiac risk factors in those patients with AF who have LGE identified by MRI and perform aggressive risk-factor modification. In a recent study, patients referred for AF ablation who were randomized to aggressive risk factor management, including weight loss, also had a reduction in recurrent AF after ablation.[1] Overall, when approaching the patient with recurrent AF, one should remember that the presence of AF may represent the "tip of the iceberg." While AF may be the presenting complaint, accompanying risk factors such as obesity, hyperlipidemia, diabetes, and coronary artery disease often accompany AF. One should not lose the opportunity to treat all these risk factors. Patients with AF and LGE on MRI may be a group who require heightened attention. ■

REFERENCE

1. Abed HS, et al. Effect of weight reduction and cardiometabolic risk factor management on symptom burden and severity in patients with atrial fibrillation: A randomized clinical trial. *JAMA* 2013;310:2050-2060.

ABSTRACT & COMMENTARY

Improving Risk Prediction in Atrial Fibrillation Patients on Anticoagulants

By Michael H. Crawford, MD, Editor

SOURCE: Hijazi Z, et al. High-sensitivity troponin T and risk stratification in patients with atrial fibrillation during treatment with apixaban or warfarin. *J Am Coll Cardiol* 2014;63:52-61.

Accurate risk prediction in atrial fibrillation (AF) patients is important for the decision to prescribe oral anticoagulants. High-sensitivity troponin T levels (hs-TnT) have augmented prognostic predictions in coronary heart disease and heart failure. These investigators from the Apixaban for the Prevention of Stroke in Subjects with Atrial Fibrillation (ARISTOTLE)

trial assessed the potential additive value of hs-TnT in predicting outcomes in patients with AF in this study of apixaban compared to warfarin. ARISTOTLE randomized more than 18,000 patients with AF and at least one CHADS2 risk factor for stroke to apixaban or warfarin. Study endpoints included stroke systemic embolism, mortality, myocardial infarction (MI), and major bleeding; average follow-up was about 2 years. Outcomes were evaluated in relationship to hs-TnT levels, and the CHADS2 and CHADS2-VASc (CH2V) scores. Measurable hs-TnT levels were found in 94% of the patients. With the exception of hypertension, all the CH2V risk factors were associated with higher hs-TnT levels. Overall, the rate of stroke or embolism was 1.4%/year, all-cause mortality 3.7%/year, cardiac deaths 1.9%/year, MI 0.5%/year, and major bleeding 2.6%/year. There was no difference in these events in relation to hs-TnT levels in the two treatment groups, so they were combined for this analysis. Higher hs-TnT levels were significantly related to outcome events, even when adjusted for baseline characteristics. A similar relationship was observed for the CH2V score. The predictive ability of the CH2V score was increased by 23% when the hs-TnT was added. However, stroke was predicted better by CH2V, and cardiac death and major bleeding by hs-TnT. The authors concluded that hs-TnT is almost always elevated in patients with AF, is independently associated with adverse events, and improves the risk prediction for cardiovascular (CV) events as compared to the CH2V score.

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This study derived from the ARISTOTLE trial of apixaban vs warfarin in non-valvular AF patients makes several interesting observations. In these patients, all of whom were treated with an effective oral anticoagulant, mortality and major bleeding were more common than stroke and MI. When CH2V and troponin levels were assessed for their predictive ability, hs-TnT was better at predicting cardiac mortality, MI, and major bleeding, and CH2V was better at predicting stroke. This is not surprising since CH2V was designed to assess the risk of stroke in AF patients to guide preventive therapy. However, CV events are frequent in this population and hs-TnT does a better job of predicting these outcomes. In fact, in patients with low CH2V scores (0-2), hs-TnT culls out patients at higher risk of CV events and major bleeding on anticoagulants. Since troponin testing is widely available, this is an attractive option to further risk stratify AF patients on oral anticoagulants (OACs).

Unfortunately since all the patients in this study were on OACs, the results cannot be used to make decisions regarding starting anticoagulation therapy. Whether troponin testing would improve this decision needs to be tested. However, the ability of hs-TnT to improve the prediction of who is at risk for major bleeding could alert one to those patients who need to be followed more carefully. Whether troponin is better than the HASBLED scoring system for bleeding risk was not tested in this study, but other studies have shown that higher CH2V scores also predict bleeding risk about as well as HASBLED does, and troponin was additive to CH2V for predicting major bleeding. Also, the results of this study are consistent with those of a similar analysis of the RELY trial and if you combine both studies, the population tested is more than 21,000 patients.

Mortality was the most common endpoint observed in these patients on OACs for AF and it was best predicted by troponin levels. This implies that most AF patients on OACs die of cardiac causes rather than systemic embolic events. This makes sense since many patients with non-valvular AF have risk factors for atherosclerotic CV disease, such as hypertension. It also raises the question as to whether other markers of CV risk, such as brain natriuretic peptide or hs-CRP, would be useful predictors in this population. The difficulty in using hs-TnT to risk stratify patients in this trial is that almost all of them had levels above normal. So, you would need to compare your patients' level with the data in the paper to make a risk prediction. In addition, the cutoff values may vary with different assays for hs-TnT. ■

ABSTRACT & COMMENTARY

Inpatient STEMIs: Are They as Complicated as They Seem?

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

SOURCE: Garberich RF, et al. ST elevation myocardial infarction diagnosed after hospital admission. *Circulation* Jan 3, 2014. [Epub ahead of print.]

The link between time to reperfusion and mortality in ST-elevation myocardial infarction (STEMI) is well-established, and has led to a national initiative to improve prehospital and hospital systems to speed recognition of STEMI and delivery of primary percutaneous coronary intervention (PCI). Much of the emphasis in the door-to-balloon initiative has focused on earlier identification of these patients by emergency medical services (EMS) in both the ambulance and emergency department (ED) settings. Pathways for STEMI recognition and activation of the cath lab have greatly improved time to treatment for these patients. However, patients who are already in the hospital at the time of STEMI development have been specifically excluded from most analyses. The reasons for this seem appropriate to those of us involved in the care of these patients. The ED admission who was well until the sudden development of chest pain an hour ago is in most cases more straightforward than the sick inpatient with multiple comorbidities who develops STEMI as a complication of another illness. Does this mean that inpatients have been left behind in the door-to-balloon revolution? Who are these patients anyway?

The authors of the current study, who are leaders in development of systems of acute MI care, have developed a comprehensive, prospective program database of patients treated using the Minneapolis Heart Institute regional STEMI program. Like many other systems, their program initally excluded inpatients from the regional protocol established in 2003. In 2010, the standard protocol was expanded to include inpatients. Of the 3795 consecutive STEMI patients treated under this program from 2003-2013, 990 presented directly to the PCI center. Of these, 640 were taken via EMS, 267 arrived driven by themselves or family, and only 83 were already inpatients at these facilities. Notably, only 26 inpatients with STEMI were identified in the 7 years prior to implementation of the standard protocol in 2010, while 57 were detected after implementation. In total, inpatients represented 8.4% of all patients presenting with STEMI during the 10-year period.

Were inpatients presenting with STEMI more complex than outpatients? Of the recorded variables, patient age, body mass index, and rates of hypertension and coronary disease were all greater in the inpatient group. Patients already admitted to the hospital at the time of STEMI presentation also were more likely to present with cardiac arrest or cardiogenic shock, and had a higher average Killip score than those presenting to the ED. Perhaps more telling is the effect of inpatient status on indices of acute MI care. Time from diagnostic ECG to reperfusion was greater for inpatients when compared with door-to-balloon times for patients presenting via EMS (76 minutes [53, 100] vs 51 minutes [38, 71]; $P < 0.001$), although there was only a nonsignificant trend when compared with those patients arriving by themselves or with family (76 minutes [53, 100] vs 66 minutes [41, 78]; $P = 0.13$). Only 68.3% of inpatients were reperfused within 90 minutes of the diagnostic ECG, compared with 94% of those arriving by EMS and 85.7% of those arriving by self or family. There was a trend toward greater in-hospital mortality among the inpatient group (8.4% vs 5.5% vs 2.6%; $P = 0.061$), and an increased rate of death for these patients at 1 year.

Who were these patients? Of the 83 patients identified, only 25 had been admitted with acute coronary syndrome prior to developing ST elevation. Eight had been admitted for PCI and subsequently had either stent thrombosis or a post-PCI dissection. The remainder was a heterogeneous group, and included patients who were post-surgery, admitted for respiratory failure, and patients with cancer or gastrointestinal illness. Unsurprisingly, when compared with the non-cardiac patients, those admitted for primary cardiac reasons showed a trend toward shorter ECG-to-balloon times and had lower in-hospital mortality as well as mortality at 30 days and 1 year. Although the numbers for comparison

are small, inpatients who developed STEMI after implementation of the standard protocol had decreased mortality at 1 year compared to patients who developed STEMI prior to the protocol being in place (10.5% vs 30.8%; $P = 0.022$).

■ COMMENTARY

Patients already admitted to the hospital who present with STEMI are indeed complex. Recent examples from my own experience have included a patient with disseminated cancer and HIT, as well as another who was just hours post major vascular surgery. This study does the field a significant service by characterizing these patients. As compared to patients presenting to the emergency department, inpatients clearly have more comorbidities and longer times to reperfusion. Patients admitted with cardiac diagnoses generally had better outcomes. As seen here, although tracking of inpatient STEMIs is generally not done in most systems, it can be highly illustrative.

Importantly, this study is limited in that it only tracked patients who were ultimately brought to the cath lab. Prior studies that were not focused on the procedure have shown that a significant proportion of inpatients are ineligible and are never offered reperfusion.

More importantly, however, this study demonstrates that implementation of standardized STEMI protocols for inpatients can have tangible results, despite the greater complexity and illness severity of these patients. ■

ABSTRACT & COMMENTARY

Adoption of Internal Mammary Artery Bypass Grafts in the United States

By Michael H. Crawford, MD, Editor

SOURCE: Hlatky MA, et al. Adoption and effectiveness of internal mammary artery grafting in coronary artery bypass surgery among medicare beneficiaries. *J Am Coll Cardiol* 2014;63:33-39.

In 1986, Floyd Loop reported that the use of the internal mammary artery (IMA) as a conduit in coronary artery bypass surgery (CABG) reduced 10-year mortality by 38%. Other observational trials confirmed these results, but a randomized trial has never been done. Hlatky and colleagues evaluated the adoption of IMA graft use in CABG in Medicare beneficiaries undergoing multivessel CABG between 1988 and 2008. They excluded patients who had concomitant valve operations, prior revascularization, or had end-stage renal disease. In those having CABG after 1992, they also evaluated clinical outcomes. The primary outcome endpoints were all-cause mortality, acute myocardial infarction (MI), and repeat CABG. The CABG subjects with IMA grafts were propensity matched by baseline clinical characteristics to a group not receiving IMA grafting. Among 374,918 patients undergoing CABG, 69% received IMA grafts, whose use increased steadily over time from 31% in 1988 to 91% in 2008. Use of IMA grafts varied from region to region in the United States, but improved over time. Also, IMA use varied by age, being used more in those < 70 years of age as compared to those > 86 years of age, but this difference also decreased over time. In addition, those with IMA use were more often male and white and less often diabetic. Over a median follow-up of almost 7 years, mortality was 46% in the IMA patients and 53% in the matched controls (hazard ratio [HR], 0.77; 95% confidence interval [CI], 0.75-0.79; $P < 0.001$). Death or MI was also less with IMA (HR, 0.78; 95% CI, 0.76-0.80) as was repeat revascularization (IMA 8% vs 9%, $P < 0.001$). Five-year survival was higher with IMA use (76% vs 70%, $P < 0.001$). The survival advantage of IMA was attenuated by diabetes, older patients, women, and those with peripheral artery disease (PAD). The authors concluded that IMA grafting was slowly adopted and there were regional variations in use. Also, IMA use is associated with lower rates of death, MI, or repeat CABG.

■ COMMENTARY

It is remarkable that it took 20 years for IMA graft use in CABG to exceed 90%. By contrast, as the authors point out, it took only 6 months for drug-eluting stent use to reach 50%. The wide regional variation in the early years suggests that it was driven by surgical practice style. Having lived through this transition, I can confirm this impression. Rarely is the IMA unsuitable or is it harmed during harvest. The observation that in diabetics its use impaired sternal wound healing

may have been a factor, but the main reason was that it took more time and for most surgeons, time is money. In the 1990s, health maintenance organizations were decreasing their use of specialists, so services like CABG were often contracted out. I heard about a surgical group based at one hospital during that time that was contracted by another hospital to do their cardiac surgery. The surgeons used a high percentage of IMA grafts at their main hospital, but at the other hospital the patients mainly received saphenous vein grafts. Why, because they wanted to complete surgery quickly at the other hospital, which paid them a fixed amount per case. If economics is the driver, why has usage finally increased substantially all over the country? Several years ago, IMA use became a CMS quality measure and this has accelerated its use.

Other factors probably played a role as well. For example, there was never a randomized, controlled trial of IMA grafting. However, several smaller observational studies done earlier all showed the superiority of IMA grafts. IMA use did not have a commercial entity supporting it as did drug-eluting stents. Also, the extra time needed for IMA use was considered risky in unstable patients and those with significant lung disease.

This large study permitted subgroup evaluation, and only those aged > 86 years favored no IMA use. In all other subgroups it was superior, but less so in some groups such as diabetics, women, and those with PAD. The 5-year survival of patients with IMA graft use was 73%, which is lower than the survival observed in large trials of CABG vs coronary artery stenting of about 90%. However, this study is an unselected Medicare population with surgery performed at a large cross-section of hospitals. Also, these types of database studies have no clinical details, such as where the grafts were placed and what the left ventricular function was. So, comparing these results to other studies is difficult. This study confirms the superiority of IMA graft use and supports employing this use as a quality measure. Thus, a randomized trial is unlikely to ever be done. ■

ABSTRACT & COMMENTARY

Endocarditis Outcomes in the Elderly

By Michael H. Crawford, MD, Editor

SOURCE: Bikdeli B, et al. Trends in hospitalization rates and outcomes of endocarditis among medicare beneficiaries. *J Am Coll Cardiol* 2013;62: 2217-2226.

Infective endocarditis hospitalization rates have increased during the 1990s and early 2000s. Whether such trends are continuing may reflect recent guideline changes and potential increases in susceptible patients due to increased use of electrophysiologic devices. Thus, these investigators studied Medicare data on hospitalizations from 1900-2010. Patients with a primary or secondary diagnosis of endocarditis were examined. The primary endpoints were in-hospital, 30-day, 6-month, and 1-year all-cause mortality. A secondary objective was to compare the hospitalization rates for endocarditis before and after the 2007 change in the prophylactic antibiotic guidelines of the American Heart Association (AHA). There were 262,658 patients age ≥ 65 years hospitalized for valvular endocarditis over these 12 years, and the mean age remained constant at 79 years. The hospitalization rate was 72 per 100,000 person years in 1999, which increased gradually to a high of 84 in 2005 and then declined to 71 in 2010. Those with a principal diagnosis of endocarditis remained stable until 2005 (16-17) and then declined progressively (11 in 2010). There were no consistent changes in adjusted mortality rates: 30-day (14.2-16.5%), in-hospital (8.8-11.4%), 6 months (28.4-31.8%), and 1 year (33.1-36.2%). Mortality rates for the principal diagnosis of endocarditis were somewhat higher but trended downward starting in 2005. No subgroups showed significantly different results and nor did including device-related cases. The authors concluded that there is substantial mortality among older patients hospitalized for endocarditis and there was no increase in hospitalizations or mortality after the 2007 guideline changes.

■ COMMENTARY

In the last decade, two major developments could have changed the incidence and mortality from infective endocarditis: the change in the AHA guidelines and the increased use of intracardiac devices, mainly electrophysiologic devices. Thus, this new analysis of the hospitalization rate and mortality from endocarditis in the Medicare population is of interest. Although there has been a downward trend in mortality, it still is a lethal disease, as this study

shows: approximately 10% in hospital, 15% at 30 days, 30% at 6 months, and 35% at 1 year. This study also shows that the incidence as measured by hospitalizations increased until 2005 and then began a progressive decline. This has occurred despite an increase in device placements. Perhaps this is due to more attention being paid to preventing catheter-related bloodstream infections, but the cause could not be determined from this study.

The fact that the change in the AHA guidelines did not increase the incidence of endocarditis is interesting and supported by other studies. There are several possible explanations for this finding: the widespread use of prophylactic antibiotics was having no effect on incidence, the new guidelines were largely being ignored, or there were other factors profoundly affecting endocarditis hospitalizations. Whatever the reason, the lack of any evidence of a deleterious effect of markedly reducing the use of prophylactic antibiotics is encouraging. However, it must be realized that this study is not the ideal way of assessing the effect of guideline changes per se.

The major strengths of this study are that it is a national database with a large number of cases, it includes the highest-risk individuals due to advanced age, and the results were consistent across all subgroups. One could argue that by including only those ≥ 65 years of age that the study is not representative of the whole population of endocarditis patients. However, these tend to be the sickest patients with frequent comorbidities, so they would likely reflect the experience in the whole population. Other weaknesses include that this is a study of administrative data and few clinical details that are not translatable in ICD codes are available. Also, the change in guidelines would be expected to mainly affect streptococcal endocarditis due to the decrease in dental prophylaxis and this study included all endocarditis from a variety of organisms. Finally, hospitalizations are not a true incidence, but since almost all patients with endocarditis are admitted, this is a close approximation of incidence.

My conclusion is that the incidence of endocarditis is decreasing and we need to continue to deploy preventive measures against catheter and line infections and other proven prophylactic practices, not the useless practice of mass antibiotics for minor procedures. Also, death rates, although historically low, remain relatively high and we must continue to improve early recognition and encourage aggressive treatment of endocarditis. ■

ABSTRACT & COMMENTARY

ECG Frontal Plane QRS-T Angle

By Michael H. Crawford, MD, Editor

SOURCE: Walsh JA, et al. Prognostic value of frontal QRS-T angle in patients without clinical evidence of cardiovascular disease (from the Multi-Ethnic Study of Atherosclerosis). *Am J Cardiol* 2013;112:1880-1884.

The difference in degrees between the QRS axis and the T-wave axis has been shown to predict cardiovascular disease (CVD) events and mortality. However, most studies have used the spatial QRS-T angle derived from vectorcardiography, which is not available on a routine ECG. Thus, these investigators from the Multi-Ethnic Study of Atherosclerosis (MESA) evaluated the frontal plane QRS-T axis from standard 12-lead ECGs and its association with CVD in this patient population. MESA subjects were 45-84 years old and free of apparent CVD. The frontal plane QRS-T angle was the absolute difference between the QRS axis and the T-wave axis in degrees. They excluded subjects with paced rhythms, WPW, or bundle branch block. The subjects were followed at 9-12 month intervals for up to 8 years. The primary endpoint was a composite of CVD events: CV death, myocardial infarction, angina, or heart failure. The subjects were divided into three groups depending on their QRS-T angle: normal (< 75th percentile), borderline (75th-95th percentile), or abnormal (> 95th percentile). The borderline and abnormal groups were older, and had more comorbidities and other ECG abnormalities. Also, they were more likely to have evidence of subclinical atherosclerosis by CT scan and carotid ultrasound. When adjusted for age, race, and sex, the borderline and abnormal groups had more CVD events (hazard ratio [HR], 1.37; 95% confidence interval [CI], 1.10-1.70; and HR, 2.2; 95% CI, 1.63-2.97, respectively). Modest attenuation of these results occurred with adjustments for clinical covariants, but after adjustment for other T-wave abnormalities, the association of QRS-T angle with CVD events was lost. The authors concluded that an abnormal

frontal plane QRS-T angle predicts CVD events in a multiethnic population and that this increased risk is mainly due to T-wave abnormalities.

■ COMMENTARY

This study demonstrates that more complex epidemiologic data (spatial T waves) can be applied to routine ECG interpretation. The excellent predictive ability of frontal plane T-wave axis can be explained by T-wave abnormalities that can be discerned by inspection. Other studies have shown that T-wave abnormalities are related to structural heart disease and electrical perturbations of ion channels (e.g., hypokalemia). The authors propose that since the frontal plane QRS-T angle is a continuous variable, it may detect abnormalities earlier before there are obvious T-wave abnormalities. This hypothesis is not directly tested in this study. However, the QRS-T angle is readily calculated on most computer-interpreted ECGs by subtracting the T-wave axis from the QRS axis and recording the absolute value. If the QRS-T angle is > 180°, then the following formula is used: QRS-T angle = 360° – absolute value. Once the value is obtained, all that remains is to see whether it is normal, borderline, or abnormal. This study uses definitions from the NHANES literature, which is reported in percentiles, but this paper does not give you the actual QRS-T angle values that correspond to the percentiles. For this, you have to read the NHANES III paper[1] and there you learn that the QRS-T angle varies with sex. Also, the actual cutoff values are not simple round numbers that are easy to remember. In general, men have larger values than women, but rough cutoff numbers for both sexes are < 45° is normal, < 90° is borderline, and > 90° is abnormal. These values should work for most ethnicities; however, the study was underpowered for Asians. ■

REFERENCE

1. Whang W, et al. *Am J Cardiol* 2012;109:981-987.

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CME Questions

1. Use of internal mammary artery graft for CABG surgery is associated with:
   a. lower mortality.
   b. fewer myocardial infarctions.
   c. less repeat revascularization.
   d. All of the above

2. In AF patients on oral anticoagulants, hs-Troponin-T is superior to CHADS2-VASc for predicting:
   a. stroke.
   b. systemic embolism.
   c. cardiac death.
   d. all-cause mortality.

3. Which of the following attenuates the predictive ability of the QRS-T angle measurement?
   a. Using vectorcardiography
   b. Primary T wave abnormalities
   c. Using a multiethnic population
   d. Analyzing only women

4. Changes in the endocarditis prophylactic treatment guidelines in 2007 resulted in:
   a. increased mortality.
   b. increased hospitalizations.
   c. a higher incidence of endocarditis.
   d. None of the above

5. Late gadolinium enhancement by cardiac MRI in AF patients is associated with:
   a. increased mortality.
   b. stroke.
   c. rapid heart rate.
   d. higher ablation success rates.

6. Myocardial infarction in hospitalized patients is associated with:
   a. more comorbidities.
   b. lower diagnosis to balloon inflation times.
   c. lower mortality.
   d. All of the above