Ischemia-Driven Revascularization
Demonstrating and Delivering a Mature Procedure in a Mature Way

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Since the introduction of percutaneous coronary intervention (PCI), the goal of the procedure has been to reduce patient symptoms, improve quality of life, and potentially affect clinical outcomes in specific high-risk clinical scenarios, such as acute myocardial infarction. As coronary intervention techniques and technology have matured, leading to near-complete rates of technical success, physicians, patients, and health policymakers are now often faced with questions around which patient subsets gain the most benefit from the procedure. In this context, some have advocated the broad use of noninvasive testing to demonstrate ischemia in patients with symptoms concerning for obstructive coronary disease. In fact, from the earliest descriptions of percutaneous angioplasty, physicians have looked to demonstrate the impact of percutaneous interventions on objectively measured ischemia from noninvasive testing.1

Current guidelines recommend that patients considered symptomatic with possible obstructive coronary disease have their care driven by risk assessment.2 This risk assessment is derived from the patient’s baseline comorbidities and cardiovascular risk factors coupled with their symptom complex. Low-risk patients should receive cardiovascular risk reducing therapy and follow-up, intermediate risk patients should undergo noninvasive testing for further refining risk assessment, and high-risk patients should undergo cardiac catheterization. This care pathway starts with an evaluation of the likelihood of obstructive coronary artery disease, uses a combination of optimal medical therapy and, in high-risk patients, defining the coronary anatomy, and ends with symptom relief and improved outcomes when revascularization is driven by ischemic symptoms.

With this background, Lin et al3 present a provocative analysis of the outcomes of Medicare patients undergoing elective PCI with or without antecedent stress testing. The authors identified a cohort of 23,877 Medicare beneficiaries undergoing elective PCI from 2003 to 2004, excluding patients with acute myocardial infarction, unstable angina, transferred patients, and patients who had a PCI, coronary artery bypass graft surgery, or acute myocardial infarction in the year prior. Using current procedural terminology codes, the authors identified pre-PCI stress testing in the elective PCI cohort. The authors then obtained >3 years of follow-up data for death using the same Medicare claims files. Finally, Cox proportional hazard models were used to determine the relationship between pre-PCI stress testing and mortality. The authors also used hospital referral regions to categorize regions into 4 groups: high stress test rate/high PCI rate, low stress test/low PCI, low stress/high PCI, and high stress/low PCI regions. These analyses found that pre-PCI stress testing was associated with a 13% lower risk of mortality than no pre-PCI stress testing (hazard ratio, 0.87; 95% confidence interval, 0.81–0.92), and low stress test/high PCI regions were associated with a 14% higher risk of mortality than high stress test/high PCI regions (hazard ratio, 1.14; 95% confidence interval, 1.03–1.26). The authors conclude that greater adherence to guidelines with respect to documenting ischemia before elective PCI may result in improved outcomes for patients.

The authors should be congratulated as these data are important and likely will fuel continued national conversation on how best to identify patients who benefit from elective PCI for patients without recent myocardial infarction. However, as with any observational analysis, there are important limitations to the study by Lin et al3 that should be considered before the results are used to inform broad health policy and practice guideline decisions. First, the data set represents a small selected group of Medicare patients (<25,000), compared with the >260,000 patients identified from Medicare undergoing stenting during a similar 2-year time period.4 The data set does not contain detailed or specific patient data on clinical symptoms and relies on claims data for patient comorbidities and risk factors. Symptom burden, and more importantly, exercise tolerance or activity level measured as metabolic equivalents, is essential and used by clinicians to determine the pretest probability of obstructive coronary artery disease and the need for stress testing. Second, the data set does not contain any information on the findings from the stress tests (such as exercise time or reproduction of symptoms), the rates, location and burden of obstructive coronary artery disease, and the rates of cardiac catheterization without PCI. Furthermore, the rates of myocardial infarction (either periprocedure or spontaneous), rates of repeat revascularization or hospitalization, or rates of heart failure are not known, providing no data on the potential mechanism of benefit. Finally, the authors did not have access to medication data, so the rates of cardiovascular therapies proven to reduce morbidity and mortality are not known.

Thus, although the authors identify pre-PCI stress testing as a potential marker for high-quality care in patients undergoing elective PCI, further work is needed to understand the...
mechanism of benefit—one related to the test or to the associated care, including medical therapy provided to patients who have stress testing. In fact, to postulate a mortality benefit from stress testing pre-elective PCI, one has to either believe stress testing routinely identifies high-risk patients who gain mortality benefit from PCI or believe that elective PCI in patients without stress testing has significant harm. Some recent data may help inform these hypotheses and provide a path forward for revising practice guidelines and health policy.

With regard to the performance of stress testing, the prevalence of severe ischemia on stress testing has been shown to be decreasing over the past 2 decades. More lower risk patients are undergoing stress testing, and this stress testing less often involves exercise and more often uses pharmacological agents to mimic exercise or induce differential coronary flow. In addition, the rates of nonobstructive disease even in patients with abnormal stress tests have been shown to be high. These data highlight the ongoing need for improved prestress test risk stratification and improved performance of noninvasive testing.

A more patient-specific analysis for elective PCI using the National Cardiovascular Data Registry and the American College of Cardiology/American Heart Association Appropriate Use Criteria, a construct that includes patient symptoms, ischemic burden, medical therapy, and coronary anatomy, has shown that patients undergoing PCIs rated as inappropriate did not have higher in-hospital mortality compared with patients undergoing PCIs rated as appropriate (patients with more ischemia, higher disease, and symptom burden). In fact, in an elegant retrospective study that examined clinical, stress test, and anatomic data mapped to the Appropriate Use Criteria, Ko et al examined patients who had indications for PCI that were deemed appropriate and compared outcomes between those who underwent revascularization and those who were treated medically. They found that patients undergoing coronary revascularization had lower rates of death or acute coronary syndromes at 3 years. It is important to note that, for the most part, the Appropriate Use Criteria and guidelines still require demonstration of ischemia on noninvasive testing or high-risk features and symptom complex.

As an alternative to noninvasive stress testing for ischemia, recent studies have demonstrated that invasive fractional flow reserve (FFR), the ratio of mean coronary artery pressure distal to a coronary lesion relative to the mean aortic pressure during maximal coronary blood flow, represents an important and lesion-specific physiologic measure of ischemia. Coronary stenoses with an FFR ≤0.80 are considered hemodynamically significant. In a randomized study comparing the use of FFR with visual assessment to determine the significance of a coronary stenosis found that FFR-directed revascularization reduced the rate of death, myocardial infarction, and repeat revascularization. When FFR-directed revascularization was studied compared with optimal medical therapy for functionally significant coronary stenoses, the FFR-directed therapy arm reduced the composite of death, myocardial infarction, and rehospitalization requiring urgent revascularization, driven mostly by urgent revascularization.

So how do the practicing community, health policy, guideline, and payer groups move forward using the existing evidence? Although the requirement for pre-PCI stress testing in all patients may seem reasonable, caution is warranted. This approach should be evaluated prospectively because there are several potential unintended consequences that include increased rates of diagnostic catheterization in patients who may not need the procedure (because of false-positive stress tests), adverse events in high-risk patients in whom the process of stress testing alone may induce myocardial ischemia or infarction, and the potential for decreased efficiency and increased cost with redundant testing. Rather, the clinical and research community should increase the focus on decision thresholds: specifically risk stratification methods and pretest risk thresholds for no testing, thresholds for when stress testing should be performed, and thresholds or pretest risk for when direct referral to invasive coronary with FFR should be performed. These thresholds need to be validated and agreed on by the clinical, patient, payer, and legal communities. PCI is a mature procedure that is able to produce life-saving results in acute and emergent applications, improve quality of life, and reduce morbidity in appropriately selected elective applications. The challenge for the clinical community now is determining the gaps in the evidence and treatment processes so that PCI can be applied to the right patient at the right time in the right way.

Disclosures
None.

References


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