Among patients with coronary artery disease (CAD), there are widely divergent clinical practice styles in the use of myocardial revascularization, medical therapy, and the assessment of symptomatic or functional status after the initiation of treatment. Frequently, patients who have undergone initial successful revascularization, principally with percutaneous coronary intervention (PCI), are re-evaluated with diagnostic testing (both noninvasive and invasive) within the first year of follow-up, presumably to document objectively the absence of recurrent ischemia, despite the fact that current clinical practice guidelines proscribe such routine testing in otherwise asymptomatic individuals. Clearly, all clinicians seek to achieve optimal care for their patients, but both external pressures from payers and the need to conform to established treatment guidelines often create conflict and uncertainty in physician decision-making regarding what is right.

There should be general agreement that the best outcomes in patients with CAD are observed when comprehensive risk factor modification, intensive medical therapy, and appropriate use of revascularization are used in the setting of judicious clinical decision-making that is evidence based. Optimal medical therapy can be defined as that which uses guideline-directed, disease-modifying interventions (eg, aspirin with or without thienopyridines, statins, and inhibitors of the renin-angiotensin system) as well as therapeutic agents directed toward angina relief and control of ischemia (eg, β-blockers, calcium channel blockers, nitrates, or ranolazine—used alone or in combination). For patients with CAD who are symptomatic, antianginal therapy is not considered to be optimal unless at least 2 antianginal agents have been prescribed, and, generally, a desired, favorable treatment effect is achieved in sufficient doses. Similarly, stress testing in the patient with CAD may be performed for evaluation of ischemic symptoms, to assess prognostic risk or, when there is concern that a revascularization procedure has been incomplete, to assess the functional significance of residual obstructive coronary disease in a patient who has developed recurrent angina symptoms. An invasive evaluation is generally recommended only when the noninvasive evaluation demonstrates objective high-risk findings, such as significant ischemia at a low workload, evidence for left ventricular systolic dysfunction, or heart failure. After such an invasive evaluation, PCI with stenting is considered appropriate in patients on optimal medical therapy who have either uncontrolled anginal symptoms or an inadequate therapeutic response (both of which would be categorized as failed medical therapy) or in those patients with CAD who have significant, residual flow-limiting coronary stenoses.

All of the above recommendations can be found in the American College of Cardiology/American Heart Association clinical practice guidelines and are largely considered evidence based. However, in the context of the above clinical setting of a patient with CAD who has undergone a presumably successful PCI for an ischemia-producing stenotic coronary artery, the important corollary question is, do cardiologists practice evidence-based medicine in the subsequent evaluation and care of the revascularized patient? In this issue of Circulation: Cardiovascular Imaging, Mudrick et al\(^1\) report on the “Patterns of Stress Testing and Diagnostic Catheterization After Coronary Stenting in 250 350 Medicare Beneficiaries,” and the authors’ findings would suggest, in fact, that the American Cardiology community does not, as a group, follow these guidelines. In their elegant analysis, which includes National Cardiovascular Data Registry (NCDR) CathPCI Registry data linked to longitudinal Medicare administrative claims data from 2005 to 2007, Mudrick et al found that ≈50% of this large cohort of post PCI patients (122 894/250 350) underwent routine stress testing and an additional 10% (25 512/250 350) had coronary angiograms performed within 60 to 365 days of the index procedure regardless of symptoms. Perhaps not surprisingly, stress testing led to repeat invasive evaluations in ≈20% of cases (18 472/122 894) and additional revascularization procedures in another 10% of patients (8 831/122 894). Even more revealing was the observation that when coronary angiography was performed as the first post PCI diagnostic test, more than half of the patients (53%, 13 316/25 512) underwent subsequent revascularization. One might infer from these observations that, when an invasive evaluation is initially performed in these patients, PCI begets more PCIs. Of note, during the same time interval, the observed rate of overall cardiac mortality was 6%, an appreciable rate that is perhaps not surprising in an older CAD cohort aged >65 years. Importantly, however, repeat stress testing was associated with a 19% (17%–21%; \(P<0.0001\))
decreased likelihood of death or myocardial infarction. By contrast, repeat invasive evaluations in this study population were associated with a 27% (23%–32%; P<0.0001) higher likelihood of death or myocardial infarction. It was also remarkable to observe from these data that, paradoxically, the very patients who might likely have derived a proportionately greater clinical benefit from additional testing, and possibly clinically-indicated revascularizations, because of higher clinical risk (eg, older patients, males, smokers, patients with diabetes mellitus, and those with heart failure), were actually less likely to undergo additional testing. It is also of interest to note that more invasive testing and more revascularization procedures were performed at high-volume nonacademic centers than at academic centers, which could suggest the potential for procedural overuse (both diagnostic and therapeutic) in these post PCI patients.

What can we learn from these provocative data? Several points merit emphasis. First, the reported rates of invasive and noninvasive testing after an index PCI greatly exceeded the previously documented 1-year recurrent angina rates of 15% to 30% after revascularization procedures.6–11 It is tempting to hypothesize that this likely reflects an overuse of routine diagnostic post PCI testing. However, proving that this apparent, excessive testing pattern did not conform to existing appropriate use criteria is inherently problematic, given the lack of detailed individual clinical chart documentation, reviews of testing indications and the absence of patient interviews and examinations that are indigenous to administrative claims database analyses. On the other hand, one might argue that the routine post PCI testing rates were justified given the appreciable 6% 1-year mortality, which suggests a high-cardiovascular risk in the studied population of Medicare beneficiaries aged ≥65 years.

Second, the so-called treatment-risk paradox is highlighted by the current study findings and is consistent with previous observations12 that sicker patients with acute coronary syndromes were less likely to receive additional invasive management than lower risk patients. This has been a consistently-observed feature of US cardiology practice in that the patients for whom coronary angiography and myocardial revascularization would be most likely to result in improved survival and a reduced rate of recurrent MI are least likely to undergo an invasive approach. Although it is possible that this could have been the result of more complete revascularization during the index acute coronary syndrome event, it may also suggest a bias toward more testing and procedures in lower risk patients who have undergone PCI previously, even though such patients are less likely to benefit from this approach.

Third, in the present study, an invasive evaluation without previous stress testing was more likely to result in repeat PCI. The potential reasons for repeated invasive evaluation without previous risk stratification with stress testing are unclear. Presumably, in this analysis, after the index PCI coronary anatomy was known, flow-limiting coronary stenoses would have been likely addressed. In the absence of recurrent angina or objective evidence of inducible ischemia, it seems difficult to justify PCI on purely anatomic grounds. Given the enormity and consistency of clinical trials data to the contrary that PCI does not reduce the risk of death, myocardial infarction, or other major cardiovascular events when added to optimal medical therapy,5,7,11 it would seem that prophylactic PCI to treat residual coronary stenoses absent an evidence-based indication would be considered inappropriate under current guidelines.5 In similar recent studies, 96% of inappropriate PCIs for nonacute CAD indications were performed in patients receiving suboptimal (≤1 medication) antiangiinal therapy or in those without angina (53.8%), or in patients with low-risk results on noninvasive stress testing (71.6%).14 As such, PCI performed under these circumstances has no favorable mortality benefit15 and, at a minimum, represents a potential overuse of costly resources.

In the management of CAD, sound judgment should include guideline-directed medical therapy in all patients, selective testing according to appropriate use criteria, and the judicious use of revascularization when high-risk anatomy is present or symptoms are poorly controlled despite optimal medical therapy. Although the data reported by Mudrick et al12 was obtained between 2005 and 2007, it remains unclear whether these data are generalizable to contemporary clinical practice. Clearly, since 2007, significant efforts have been made to improve medical care in patients with CAD, and randomized clinical trials in patients with stable CAD have been published.6,10,16 Thus, since the time interval during which the present study and data were collected, management guidelines and appropriate use criteria for stress testing, invasive evaluation, and revascularization have likewise been published and widely disseminated.14 Whether these developments have altered clinical practice in the approach to clinical decision-making post PCI is unclear, though the results from the present study would suggest otherwise.

In summary, we need to redouble our efforts and have both the courage and conviction to apply sound management principles that are evidence based to decision-making at the patient’s bedside. Before patients are referred for invasive evaluation and treatment, we should embrace an optimal medical therapy first approach to management rather than a PCI first approach. Disappointingly, in the post COURAGE era, optimal medical therapy remains woefully underused in as many as 45% of patients with established CAD before undertaking PCI and, perhaps even worse, Borden’s recent analysis of a large NCDR cohort of patients pre- and post COURAGE show that only about two-thirds of patients undergoing PCI are being discharged on appropriate, guideline-driven secondary prevention.17,18 Thus, when optimal medical therapy is applied appropriately and symptoms are controlled, there would be little reason to suspect the presence of residual flow-limiting coronary stenoses, either by noninvasive evaluation or by an invasive evaluation. As a result, additional diagnostic testing would not be considered either warranted or justified in the vast majority of otherwise stable CAD patients. Of considerable interest is the fact that novel laboratory methods, such as peripheral blood gene expression testing (eg, the Corus CAD test for the evaluation of suspected CAD),19 are now commercially available and may provide an alternative to diagnostic imaging or invasive approaches that may pose certain risks caused by increased radiation or contrast media exposure in certain patients with CAD. The Corus CAD test has shown that a gene expression
score has a negative predictive value of 96% when compared with myocardial perfusion imaging in patients with suspected CAD. Although this has not yet been evaluated directly in post PCI patients, such a gene expression test may hold promise as a highly efficient and cost-effective diagnostic tool in evaluating patients with documented CAD.

Finally, as we continue to face escalating costs of health-care delivery in an environment of increasing regulatory oversight and constrained resources, we need to pay particularly close attention to how we make clinical decisions and the degree to which these are evidence based. There are more rigorous pay for performance standards looming on the horizon, and an emerging reality that both physicians and hospitals will need to meet both quality and performance metrics as part of the advancement and implementation of accountable care organizations, or face the rather stark possibility as part of the advancement and implementation of accountable care organizations, or face the rather stark possibility.


Disclosures

None.

References


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Does the Potential Overuse of Routine Post PCI Stress Testing and Revascularization Inspire Courage to Embrace More Evidence-Based Decision Making?
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