

Measuring Diagnostic Health Care Costs in Stable Coronary Artery Disease: Should We Follow the Money?

The field of diagnostic testing in the evaluation of suspected coronary artery disease (CAD) is often criticized for having insufficient comparative clinical and cost-effectiveness evidence to inform health policies for the use of noninvasive tests (1). However, recent trials, including PROMISE (PROspective Multi-center Imaging Study for Evaluation of Chest Pain), have been published that compared strategies of functional stress testing with noninvasive anatomical testing using coronary computed tomography angiography (CTA) (2, 3). PROMISE revealed similar 3.5-year outcomes regardless of whether stress testing or CTA was initially performed. Accordingly, differential patterns of cost or resource consumption gain importance because certain strategies may minimize cost while achieving equivalent outcomes.

In this week's *Annals*, Mark and colleagues present the economic substudy from PROMISE (4). Minimal cost differences were found between patients randomly assigned to strategies involving CTA compared with functional testing: The 90-day mean cost difference between groups was only \$254. Mean cost differences remained small through 3 years of follow-up and were further reduced when noncardiovascular costs were subtracted. Among patients in the functional testing group, 67% underwent stress nuclear testing, 23% had echocardiography, and 10% had electrocardiography; prior evidence reported variable cost patterns for these strategies (5).

In PROMISE, differential utilization patterns were observed in the near term, with the index CTA procedure linked to greater downstream use of invasive coronary angiography and revascularization, which validates prior findings (6). Higher rates of use of post-CTA invasive procedures are contrary to clinical practice guidelines for CAD, which require demonstrable ischemia (7). The economic value of CTA depends on implementation of a strategy of selective use of invasive angiography. In contrast, for the functional testing group, greater use of serial stress testing was observed. Repeated or serial stress testing is common in patients with suspected CAD and likely includes inappropriate testing combined with clinically indicated follow-up procedures. Apportioning each variable cost component is important to define efficient and inefficient post-stress testing strategies.

Within the cardiovascular community, discussions on the varying costs of the index procedure are common, with prior-authorization policies supporting the use of lower-cost procedures. A noteworthy PROMISE finding is that regardless of the index procedure, near-term costs varied little. Thus, the concept of the cost of the index procedure being of primary importance for resource allocation purposes may be misguided. The

PROMISE results reveal the value of characterizing diagnostic evaluation costs by summing the index and linked consequential costs of a given test strategy. In a recent trial, lower-cost exercise electrocardiography was often followed by higher-cost stress nuclear imaging, which resulted in accumulated downstream costs that were several times higher than those for the index procedure (8). Therefore, index procedure costs are an incomplete snapshot of the episodic cost burden, particularly for comparative purposes when utilization management programs seek cost efficiency.

Health care cost comparisons are difficult to interpret without supplemental clinical data. The analysis of cost patterns as they relate to progressive cardiac symptoms or worsening clinical status aids in differentiating inefficient testing patterns (such as routine serial testing without appropriate indications) from evidence-based, symptom-driven use of procedures. Several prior registries and trials showed that downstream use of invasive angiography after the index diagnostic evaluation with stress nuclear testing or CTA was similarly high among patients with moderately or severely abnormal findings (9). However, CTA drove higher rates of follow-up coronary angiography for those with mild coronary artery stenosis, and medical management strategies are supported by CAD clinical practice guidelines for this patient subset (7). Thus, aggregate costs may be misleading without partitioning of inappropriate test use versus patterns of guideline-directed resource consumption (7). In this discussion, we should also include the concept of strategy failure for diagnostic test evaluations, which may define costs related to worsening symptoms that require an acute evaluation in the emergency department or hospitalization. Strategy failures are becoming a vital analysis in diagnostic trials because they identify intermediate outcomes for at-risk patients.

Therapeutic management of suspected CAD includes a focus on symptom control, lifestyle modification, and targeted anti-ischemic and risk factor-modifying treatments. PROMISE lacks details on the costs of medical therapy related to symptom relief during follow-up. Preventive therapies for cardiovascular disease impart a heavy economic burden on the large population of patients with suspected CAD. The absence of treatment costs is disappointing given that a recent post hoc analysis from the SCOT-HEART (Scottish Computed Tomography of the Heart) trial reported that CTA prompted more frequent initiation of preventive therapies and an observed halving of fatal and non-fatal myocardial infarction (10).

It is important to note that PROMISE cannot be expected to fill all evidentiary gaps in the diagnostic evaluation of suspected CAD. The study by Mark and col-

leagues provides us with tremendous insight into the cost implications of diagnostic strategies for suspected CAD (4). Yet, our knowledge remains limited, and future funding is required to prioritize the development of novel, efficient, and effective diagnostic approaches for suspected CAD. Mark and colleagues report relatively low costs of care, especially after noncardiovascular costs were subtracted (4). These findings suggest that current expansive prior-authorization programs to control use of index procedures may be ill-advised. Further evidence is needed for the value of no-testing options; the PROMISE enrollees were largely at low risk and, from a cost perspective, symptom-guided treatment without diagnostic testing may dominate economically because it may eliminate the commonplace finding of “testing begetting more testing.” Treatment strategies for suspected CAD have sought to delay or selectively use coronary angiography leading to revascularization (gatekeeping function), and similar strategies may be valuable in the de novo evaluation of patients with chest pain. This may be our definitive contribution to devising cost efficiency in the treatment of suspected CAD—figuring out who can be managed without diagnostic testing.

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