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Appropriateness of Percutaneous Coronary Intervention
Are We Acting Appropriately?

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**RESULTS** A total of 2.7 million PCI procedures from 766 hospitals were included. Annual PCI volume of acute indications was consistent over the study period (377,540 in 2010; 374,543 in 2014), but the volume of nonacute PCIs decreased from 89,704 in 2010 to 59,375 in 2014. Among patients undergoing nonacute PCI, there were significant increases in angina severity (Canadian Cardiovascular Society grade III/IV angina, 15.8% in 2010 and 38.4% in 2014), use of antianginal medications prior to PCI (at least 2 antianginal medications, 22.3% in 2010 and 35.1% in 2014), and high-risk findings on noninvasive testing (22.2% in 2010 and 33.2% in 2014) (P < .001 for all), but only modest increases in multivessel coronary artery disease (43.7% in 2010 and 47.5% in 2014, P < .001). The proportion of nonacute PCIs classified as inappropriate decreased from 26.2% (95% CI, 25.8%-26.6%) to 13.3% (95% CI, 13.1%-13.6%), and the absolute number of inappropriate PCIs decreased from 21,781 to 7,921. Hospital-level variation in the proportion of PCIs classified as inappropriate persisted over the study period (median, 12.6% [interquartile range, 5.9%-22.9%] in 2014).

**CONCLUSIONS AND RELEVANCE** Since the publication of the Appropriate Use Criteria for Coronary Revascularization in 2009, there have been significant reductions in the volume of nonacute PCI. The proportion of nonacute PCIs classified as inappropriate has declined, although hospital-level variation in inappropriate PCI persists.

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**Appropriate Use Criteria for Coronary Revascularization and Trends in Utilization, Patient Selection, and Appropriateness of Percutaneous Coronary Intervention**

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**IMPORTANCE** Appropriate Use Criteria for Coronary Revascularization were developed to critically evaluate and improve patient selection for percutaneous coronary intervention (PCI). National trends in the appropriateness of PCI have not been examined.

**OBJECTIVE** To examine trends in PCI utilization, patient selection, and procedural appropriateness following the introduction of Appropriate Use Criteria.

**DESIGN, SETTING, AND PARTICIPANTS** Multicenter, longitudinal, cross-sectional analysis of patients undergoing PCI between July 1, 2009, and December 31, 2014, at hospitals continuously participating in the National Cardiovascular Data Registry CathPCI registry over the study period.

**MAIN OUTCOMES AND MEASURES** Proportion of nonacute PCIs classified as inappropriate at the patient and hospital level using the 2012 Appropriate Use Criteria for Coronary Revascularization.

As modern medicine has grown and evolved, there has been an enormous explosion of information available to clinicians and patients. This ongoing explosion has no end in sight. The amount of available information that must be examined and integrated into patient care is so extensive that it strains the mind to consider it all. This is especially true in the field of cardiology, especially when considering possible coronary revascularization. Despite the potential for information overload, judgements and choices must be made in everyday practice. To help, professional societies, such as the American College of Cardiology, the Society for Cardiovascular Angiography and Interventions, and the American Heart Association, have been publishing clinical practice guidelines for 30 years now.¹ These periodically revised documents are meant to provide evidence-based reviews and recommendations for several clinical conditions, including ratings for many possible diagnostic tests and therapeutic interventions.

Unfortunately, some guidelines were perceived to be less than ideal for certain aspects of cardiology practice a number of years ago. The guidelines for coronary revascularization were judged to be incomplete formulations of common clinical scenarios; the evidence base and interpretations put forward within the guidelines were considered to be insufficient for diagnostic tests and therapeutic interventions that could or might be performed in patients with coronary disease. A newer formulation was sought based on a concept of “appropriateness.”² In other words, for certain common clinical problems that could be expressly delineated, what is and when is it appropriate to perform certain tests or procedures? This question takes on enormous importance when one considers the costs of treatment of coronary artery disease in the United States. The developers of these Appropriate Use Criteria (AUC) stated their goal...
was to outline a schematic for an efficient use of resources when confronted with a variety of clinical problems. The AUC, then, are just one more formulation of evidence designed to help clinicians and patients make informed choices; they are meant to complement, not replace, the guidelines. Both the guidelines and AUC can provide insights but from different perspectives.

How have these AUC been received, and are they being increasingly followed as time goes by? A study published in the November 2015 issue of JAMA by Desai et al analyzed trends in AUC use by measuring percutaneous intervention (PCI) procedures from 2009 to 2014. The authors used the world’s largest PCI registry, the CathPCI database of the National Cardiovascular Data Registry. Their analysis included 2.7 million PCI procedures at 766 hospitals. Several important trends were noted: (1) the volume of nonacute procedures decreased by approximately one-third (from 89,704 in 2010 to 59,375 in 2014), whereas the number of acute procedures remained about the same (377,540 in 2010 and 374,543 in 2014); (2) the proportion of nonacute patients with severe angina using 2 or more antiangial medications increased; (3) the proportion of nonacute patients with high-risk findings on pre-PCI noninvasive testing increased; and (4) the classification of nonacute PCIs as “inappropriate” declined from 26% in 2010 to 13% in 2014.

This decline by half in the inappropriate category suggests that clinicians are responding positively to AUC. One might argue that interventionalists could be playing the system by reclassifying nonacute, elective PCI procedures as “acute” and thus increasing their levels of appropriateness. But that does not seem to be the case; the volume of acute procedures remained constant over the 5 years while the volume of nonacute procedures actually declined. The authors also documented increases in angina symptoms, use of antianginal medications, and high-risk findings on noninvasive tests, as well as increased use of fractional flow reserve measurements in the catheterization laboratories. This suggests that clinicians in general are more careful about selecting nonacute patients for PCI, and this is in part why nonacute volumes declined. Only time and additional studies will tell whether more careful patient selection is truly the explanation.

One additional fascinating observation emerges from this report: hospital-level variation in inappropriate PCIs did not change substantially over the 5 years (interquartile ranges, 16.7%-37.1% in 2009 vs 5.9%-22.9% in 2014; median variation, 12.6%). If interventionalists were moving toward greater adherence to AUC and the inappropriate category declined, hospital-level variation should narrow rather than stay constant. The explanation for this persistent variability is not apparent and must await additional studies. It has been known for more than 20 years that regional variations exist in health care, variations that cannot be explained by patient clinical characteristics, disease states, or hospital characteristics. One might even note here that the AUC developers had internal variations over the ratings of the clinical scenarios for coronary revascularization, perhaps suggesting that there are more widespread and fundamental decision-making forces at work underneath. Perhaps variations like this will always be with us.

We are called on both as individual physicians and as hospital systems to demonstrate that clinical outcomes are being improved while serious adverse events are being minimized and that the bulk of medical care delivered is necessary and appropriate. As new technologies emerge and new procedures are developed, we must show that these permit safer and more successful approaches to existing clinical problems and/or permit more difficult problems to be treated that might have gone untreated before. Additionally, we are called on to demonstrate not only that individual procedures are safe and effective in their immediate outcomes but also that they have value to patients over longer periods compared with alternative treatments. That is what is meant by “appropriate” care. The responsibility for doing it right is ours. The work of Desai et al illustrates one area where we are moving in the right direction and points out where still more work must be done.