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**REVIEW**

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## The Appropriate Use of Percutaneous Coronary Intervention in Contemporary Clinical Practice

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### ABSTRACT

Percutaneous coronary intervention (PCI) is common and generally low risk. Although shown to be of significant benefit in certain clinical situations, especially in the context of acute coronary syndromes, there exist clinical scenarios where PCI has not been shown to be helpful. In these cases, the risk of periprocedural complications as well as longer term issues such as bleeding or stent thrombosis mean that PCI may potentially be harmful. To inform best clinical practice, we now have published recommendations with regards to the Appropriate Use Criteria (AUC) for coronary revascularisation. The goal of the AUC is to guide physician decision-making and future research as well as to label coronary revascularisation more clearly for patients and payors in regards to its expected benefits in certain situations. In this review, we summarise and discuss the more clinically relevant of these AUC, either because they are contentious or of particular relevance to the local context or practice. We conclude that there continue to be situations whereby inappropriate PCIs are performed, and these represent opportunities for quality improvement.

**Keywords:** Appropriate use criteria, Percutaneous coronary intervention, Stenting, Coronary bypass graft surgery, Revascularisation

### INTRODUCTION

Percutaneous coronary intervention (PCI) is the most common invasive cardiology treatment performed worldwide. In the United States, there were close to half a million individual patients undergoing PCI in 2010, and there is little evidence to suggest that this number is declining<sup>1</sup>. The number of procedures reflects the prevalence of coronary artery disease (CAD), especially with an ageing population, and also the relatively low risks associated with the procedure.

Nevertheless, patients who undergo PCI are still exposed to the risks of peri-procedural complications and longer-term issues such as stent thrombosis and bleeding<sup>2</sup>. This, coupled with the costs of PCI to both the individual as well as the healthcare system, prompted six professional organisations from the United States to jointly develop appropriate use criteria (AUC) for coronary revascularisation to support the

rational and judicious use of PCI<sup>3,4</sup>. The goal of the appropriateness criteria is to guide physician decision-making and future research as well as to label coronary revascularisation more clearly for patients and payors in regards to its expected benefits in certain situations.

The guidelines propose that there are five important variables to consider before deciding if PCI is appropriate. Based on these variables, an expert panel examined different clinical scenarios, and then gave a rating that suggested PCI is appropriate (score 7 to 9), uncertain (4 to 6) or inappropriate (1 to 3). These five variables are the following:

1. Clinical presentation — acute coronary syndrome or stable angina?
2. Severity of angina — asymptomatic, Canadian Cardiovascular Society Class I to IV for angina?

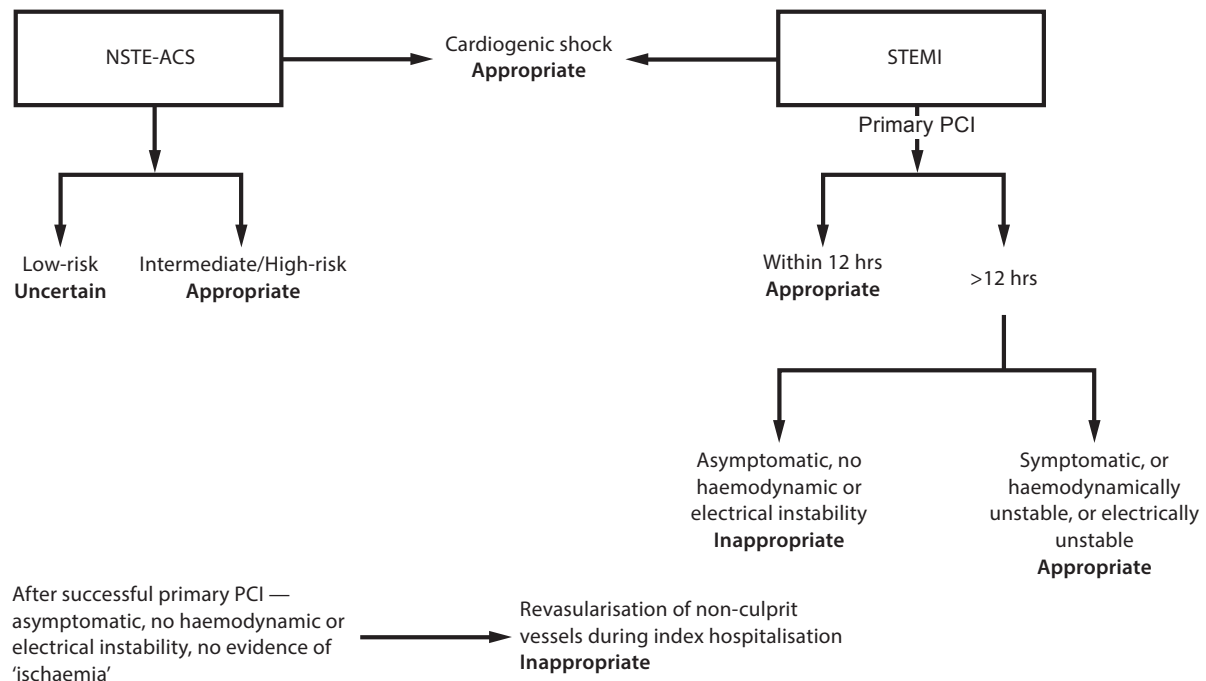


Fig. 1. Appropriate use criteria for revascularisation in acute coronary syndromes.

3. Extent of ischaemia on noninvasive testing and the presence of other prognostic factors — heart failure, diabetes or depressed left ventricular function?
4. Extent of medical therapy — whether or not a patient is on maximal medical treatment, defined as being on at least two classes of anti-anginal agents.
5. Extent of anatomic disease — single, double or triple vessel coronary artery disease, presence of proximal left anterior descending artery or left main coronary disease?

In total, 171 different clinical scenarios and their appropriateness scores were updated in the most recent iteration of the AUC for coronary revascularisation<sup>4</sup>. In this review, we plan to summarise and discuss the more clinically relevant of these AUC, either because they are contentious or of particular relevance to the local context or practice.

### ACUTE CORONARY SYNDROMES

Consistent with the published guideline recommendations from the major professional societies, PCI for the culprit lesion in acute coronary syndromes (ACS) is generally deemed appropriate, especially when the overall clinical risk is considered to be high<sup>5–8</sup>. In the AUC for

coronary revascularisation, the two exceptions to this general rule are as follows. First, among patients presenting with ST-segment elevation myocardial infarction (STEMI) greater than 12 hours from symptom onset and who are asymptomatic with no evidence of haemodynamic or electrical instability, immediate revascularisation is deemed inappropriate. Second, after successful treatment of the culprit artery in STEMI, in stable patients with no evidence of recurrent or provokable ischaemia, and with a normal LVEF, revascularisation of remaining non-culprit arteries before hospital discharge is deemed inappropriate. This, however, may potentially be revised in light of recent studies reporting improved outcomes for patients who also have non-culprit vessel PCI performed at the time of primary PCI<sup>9</sup>.

For non-ST-segment elevation myocardial infarction (NSTEMI) or unstable angina patients with low clinical risk scores, revascularisation was graded as uncertain, suggesting that despite the limited data on clinical benefit, it may be reasonable to consider revascularisation.

The AUC for coronary revascularisation in ACS patients is broadly consistent with local practice even before their introduction, and has therefore not significantly affected current clinical management (Fig. 1).

Table 1. Appropriate use criteria for percutaneous coronary intervention in multivessel coronary artery disease.

Clinical scenario	Level of Appropriateness
Three vessel CAD with low CAD burden (e.g. low SYNTAX score)	Appropriate
Three vessel CAD with intermediate to high CAD burden (e.g. diffuse lesions, chronic total occlusions, high SYNTAX score)	Uncertain
Two vessel CAD with involvement of proximal left anterior descending artery	Appropriate
Isolated left main stenosis	Uncertain
Left main stenosis with low CAD burden (one or two vessel CAD with low SYNTAX score)	Uncertain
Left main stenosis with intermediate to high CAD burden (three vessel CAD, or chronic total occlusions, or high SYNTAX score)	Inappropriate

CAD=coronary artery disease; SYNTAX=Synergy between PCI with TAXUS and Cardiac Surgery

### STABLE CORONARY ARTERY DISEASE

As an initial management strategy in patients with stable CAD, the COURAGE trial demonstrated that PCI did not reduce the risk of death, myocardial infarction, or other major cardiovascular events when added to optimal medical therapy<sup>10</sup>. Nevertheless, there was more symptomatic relief in the PCI group, and further analyses suggested that there might be subgroups of patients who would have improved outcomes after PCI<sup>11</sup>. Because of data such as this, the rationale for PCI in patients with stable CAD has always been somewhat contentious<sup>12,13</sup>.

The AUC for coronary revascularisation guidelines divide stable CAD patients into those that have not previously had coronary artery bypass graft (CABG) surgery, and those who have, and then make recommendations as per the previously defined clinical variables (severity of symptoms, degree of ischaemia demonstrated, intensity of medical treatment, and extent of anatomic disease).

Among patients without CABG, the presence of higher severity of symptoms, the greater the degree of ischaemia on noninvasive testing, or an increasing burden of CAD generally tended to make revascularisation more appropriate. Inappropriate ratings tended to be among the clinical scenarios where patients are receiving no or minimal anti-anginal treatment with low-risk findings on non-invasive testing.

The use of non-invasive functional testing to define the degree of ischaemia in patients with stable CAD is highly recommended in the guidelines, and revascularisation is broadly deemed appropriate if physiological findings are congruent with the findings on angiography. However, for

very symptomatic patients, revascularisation is considered appropriate in these guidelines if there is significant CAD on the angiogram and even if no previous functional testing has been performed. For patients with no previous functional testing and who have 'borderline' or intermediate coronary lesions on angiography, the use of either fractional flow reserve (FFR) or intravascular ultrasound (IVUS) to identify significant stenoses beyond their appearance by angiography is recommended; revascularisation in patients where FFR or IVUS suggest an insignificant lesion is considered inappropriate<sup>14,15</sup>. It should be noted however that, as of now, there are no guideline recommendations with regards to IVUS parameters to guide revascularisation. Among patients with prior CABG, the AUC for revascularisation are broadly similar for patients without prior CABG, in so far that patients with more symptoms, greater degree of ischaemia on functional testing, and increasing burden of disease in either the native coronary or bypass graft vessels should be considered for revascularisation. Nevertheless, there are more uncertain ratings in this group of patients, reflecting the limited data currently available and the greater ambiguity in managing this complex and higher risk population.

### MODE OF REVASCULARISATION IN MULTIVESSEL CAD — CABG VS PCI

The AUC for coronary revascularisation also outline the recommendations of the expert panel with regards to optimal mode of revascularisation among patients who have multivessel CAD, are symptomatic despite medical therapy, and have evidence of at least intermediate risk findings on non-invasive testing. The writing group and technical panel felt some quantification of CAD

burden, either by description or SYNTAX score, could be helpful to clinicians<sup>16</sup>.

Broadly speaking, CABG is recommended in all the clinical scenarios discussed in the guidelines, apart from an uncertain rating for patients with a prior CABG and multiple failed grafts and poor heart function. Conversely, PCI is rated as appropriate only in patients with two-vessel CAD with involvement of the proximal left anterior descending (LAD) artery and in patients with three-vessel disease with a low CAD burden (Table 1). Scenarios rated as uncertain include PCI for three-vessel disease with intermediate to high CAD burden or PCI for isolated left main stenosis, or, is PCI for left main stenosis and additional CAD with low CAD burden. For patients with left main stenosis and additional CAD with intermediate to high CAD burden, PCI is considered inappropriate.

#### **HOW APPLICABLE ARE THE AUC FOR CORONARY REVASCULARISATION RECOMMENDATIONS?**

For the interventional cardiology community, having these AUC to guide practice is useful in so far that it helps to provide the rationale for discussing best practice with patients, and also helps to justify clinical decision making. Nevertheless, it is sobering to note that this does not necessarily translate into contemporary clinical practice. Data from the United States National Cardiovascular Data Registry showed that between mid-2009 (when the first AUC for coronary revascularisation document was published) and mid-2010, more than one in ten PCI procedures performed for stable CAD was deemed inappropriate<sup>17</sup>. Reassuringly, nearly all PCI performed for ACS was deemed appropriate. Nevertheless, this highlights the gap between recommendations and 'real-world' practice.

Among the PCIs deemed inappropriate in that paper, the majority was performed for patients with no angina, low-risk ischaemia on functional testing, and suboptimal medical therapy. Although this appears self-evident to be inappropriate, this practice may well be also prevalent in our local population. The increasing ubiquity and use of computed tomography (CT) coronary angiography as a 'screening' tool among healthy asymptomatic individuals has created a group of 'patients' who have known CAD, yet have no symptoms and frequently little or mild ischaemia only on functional testing. Similarly, the use of treadmill stress electrocardiograph (ECG)

testing as a screening modality has also identified a set of asymptomatic individuals with CAD with low to intermediate ischaemic burden. The AUC for coronary revascularisation deem performing PCI for these types of patients to be inappropriate, yet it is frequently difficult to convince these patients otherwise once the Pandora's box has been opened. Patients and even some healthcare providers frequently believe instinctively that 'prophylactic' PCI in stable CAD may prevent myocardial infarctions or prolong life, yet this has never been proven convincingly in an asymptomatic or minimally symptomatic population<sup>12</sup>.

The perception that 'prophylactic' PCI may be beneficial, the generally low risk of performing PCI in an otherwise healthy individual, and the relatively high potential earnings for the operator, mean that it is not surprising that procedures for these inappropriate indications will continue to proliferate. However, in part because of guidelines such as the AUC for coronary revascularisation, there is increasingly a drive to audit indications for PCIs and identify practitioners who are not engaged in best practice. In the United States, there have been investigations into 'inappropriate PCIs' performed for financial gain by individual PCI operators that have resulted in ongoing lawsuits.

On the flipside however, are PCIs that would also be deemed inappropriate by the AUC for coronary revascularisation, yet are part of current clinical practice for practical reasons. For instance, in our local population, the cost of functional testing is not inconsiderable and many prefer to proceed directly to coronary angiography and revascularisation. Similarly, the use of FFR or IVUS to routinely evaluate all intermediate coronary lesions will significantly increase the cost to the patient, as well as to the healthcare system on the whole. As such, the current local practice of ad-hoc use of FFR to evaluate the need for revascularisation, and the subsequent utilisation of IVUS to optimise the stenting procedure may be more cost-effective although there is no local data to confirm this yet.

Furthermore, the role of personal and cultural preferences cannot be accounted for in these AUC. Many Asian patients are very resistant to CABG and will only consider PCI as the sole mode of revascularisation, despite advice to the contrary. In these cases, our local practice is to discuss each case thoroughly in a heart team forum before agreeing to

proceed with what would or could be deemed as an inappropriate procedure.

Although the AUC for coronary revascularisation document covers nearly two hundred different clinical scenarios, it is of course not possible to have a recommendation for every single possible situation in daily clinical practice. One such situation that is relevant to the local community is the role of PCI in optimising patients prior to non-cardiac surgery. Intuitively, it appears logical that performing PCI for a patient with known CAD prior to them undergoing the rigors of surgery would reduce the risk of a cardiovascular event in the perioperative period. While the AUC for coronary revascularisation document does not cover this issue specifically, the latest guidelines on perioperative cardiovascular evaluation and management of patients undergoing non-cardiac surgery continues to state clearly that performing PCI in these patients is only indicated if the PCI were to be recommended even if the patients were not about to have non-cardiac surgery<sup>18,19</sup>. Nevertheless, there continue to be reports of surgery being delayed in order to perform PCI for the sole purpose of reducing perioperative risk.

## LIMITATIONS

Our comments and opinions on the local practice patterns with regards to PCI are strictly observational and anecdotal, and not supported by published data as none are available currently.

## SUMMARY

Percutaneous coronary intervention is a low risk and common procedure. There now exist criteria to guide its use in relevant clinical populations so as to inform physician practice and patient education. However, there continue to be situations whereby inappropriate PCIs are performed, and these represent opportunities for quality improvement.

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