Clinical Decision Making

Ad Hoc Percutaneous Coronary Intervention: A Consensus Statement From the Society for Cardiovascular Angiography and Interventions

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Percutaneous coronary interventions (PCI) may be performed during the same session as diagnostic catheterization (ad hoc PCI) or at a later session (delayed PCI). Randomized trials comparing these strategies have not been performed; cohort studies have not identified consistent differences in safety or efficacy between the two strategies. Ad hoc PCI has increased in prevalence over the past decade and is the default strategy for treating acute coronary syndromes. However, questions about its appropriateness for some patients with stable symptoms have been raised by the results of recent large trials comparing PCI to medical therapy or bypass surgery. Ad hoc PCI for stable ischemic heart disease requires preprocedural planning, and reassessment after diagnostic angiography must be performed to ensure its appropriateness. Patients may prefer ad hoc PCI because it is convenient. Payers may prefer ad hoc PCI because it is cost-efficient. The majority of data confirm equivalent outcomes in ad hoc versus delayed PCI. However, there are some situations in which delayed PCI may be safer or yield better outcomes. This document reviews patient subsets and clinical situations in which one strategy is preferable over the other.

Key words: stenting; percutaneous coronary intervention; angina

INTRODUCTION

Percutaneous coronary intervention (PCI) has evolved since its inception 35 years ago. Initially, PCI required cardiac surgery and anesthesiology standby, and emergency coronary artery bypass surgery (CABG) was performed in ≥5% of PCI patients. As PCI became safer and more predictable, it was more often performed during the same session as diagnostic catheterization (termed “ad hoc” PCI). More recently, it has been suggested that ad hoc PCI may be performed too frequently in situations in which it would be preferable to pause for additional informed consent or consideration of alternatives.1 Guidelines and appropriate use criteria for PCI are frequently being revised, adding to the factors an interventional cardiologist must consider before performing ad hoc PCI.2,3 Recommendations for the appropriate performance of ad hoc PCI were published 8 years ago by the Society for Cardiovascular Angiography and Interventions (SCAI).4 The purpose of this paper is to update those recommendations in light of recent trial results and practice trends.

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DEFINITIONS OF AD HOC AND DELAYED PCI

Coronary angiography followed by PCI is performed in various scenarios, including the following.

Angiography and PCI in the Same Session (Ad Hoc PCI)

Diagnostic catheterization is followed in the same session, or same sitting, by PCI.

Angiography and PCI on Separate Days (Delayed PCI)

After diagnostic catheterization, the patient is taken off the catheterization laboratory table; PCI is performed on a separate day.

Angiography and PCI on the Same Day but Separate Sessions (same-Day PCI)

After diagnostic catheterization, the patient is taken off the catheterization laboratory table and returned later in the same day for PCI. This strategy combines some of the efficiencies of ad hoc PCI while allowing for a “pause” for additional evaluation or treatment, discussion with the patient after sedation has resolved, or expert consultation. Databases usually do not distinguish between ad hoc and same-day PCI, and there are no reliable data on its prevalence or clinical impact.

EVOLUTION OF AD HOC PCI

All trials of ad hoc PCI discussed below used registry data; randomized trials of ad hoc PCI have not been conducted.

Ad Hoc PCI in the Prestent Era

Ten studies5–14 have reported the results of ad hoc PTCA. Of these, seven compared ad hoc with delayed PTCA, and all found similar overall angiographic success and acute complication rates for ad hoc and delayed PTCA (Table I). Kimmel et al.12 reported that ad hoc angioplasty was associated with an increased risk of acute complications in patients with unstable angina, multivessel coronary artery disease (CAD), advanced age, and multilesion angioplasty. Overall, these studies provided evidence that ad hoc angioplasty, compared to delayed angioplasty, was safe in selected patients.

Ad Hoc PCI in the Stent Era

Shubrooks et al.15 reported the outcome of 4,136 PCIs performed in seven New England centers in 1997. Ad hoc PCI was performed in 42% of PCIs with similar clinical success and ischemic complication rates compared to delayed PCI. Vascular complication rates were lower in patients undergoing ad hoc PCI (0.6% vs. 1.6%, \( P = 0.006 \)).

Goldstein et al.16 reported outcomes of 62,873 PCIs performed in 33 centers from 1995 to 1998, using data from the Catheterization and Cardiovascular Interventions DOI 10.1002/ccd. Published on behalf of The Society for Cardiovascular Angiography and Interventions (SCAI).
Ad Hoc PCI in the Current Era

The prevalence of ad hoc PCI has increased over the past decade.15–20 This increase is in part due to the proven efficacy of PCI (usually performed ad hoc) for acute coronary syndromes (ACS)21 and to studies suggesting that ad hoc PCI is safe and effective compared to delayed PCI.15,17,19,20

The appropriateness of ad hoc PCI has been challenged recently, particularly for patients at either end of the spectrum of CAD—those with mild CAD in whom medical therapy might be sufficient and those with extensive and complex CAD for whom the relative benefit of PCI versus CABG has been questioned.22,23 For example, it has been suggested that, for patients with stable ischemic heart disease (SIHD), delay or deferral to discuss treatment options and to intensify medical therapy may be appropriate.22,24,25 For patients with extensive (i.e., complex multivessel, or unprotected left main) CAD, it has been suggested that a “heart team” approach allowing input from both an interventional cardiologist and a cardiac surgeon may be preferable.2,23

GUIDELINES AND APPROPRIATE USE CRITERIA RELEVANT TO AD HOC PCI

PCI Guidelines

The first PCI guidelines,26 published in 1988, recommended against ad hoc balloon angioplasty. Subsequent PCI guidelines characterized ad hoc PCI as “particularly suitable” for patients with acute MI, medically refractory unstable angina, or symptomatic restenosis but advised against ad hoc PCI when “angiographic findings are unanticipated or the indication, suitability, or preferences for percutaneous revascularization are unclear.”27 The 2011 PCI guidelines2 do not specifically address ad hoc PCI but recommend for ACS patients and early invasive strategy that in most cases would include ad hoc PCI, particularly for patients with ongoing ischemia (Table II) (Fig. 1).

Appropriate Use Criteria

The 2012 Appropriate Use Criteria (AUC)3 classified PCI as appropriate, inappropriate, or of uncertain appropriateness in a wide range of clinical scenarios based on four variables: clinical presentation [ST-segment elevation MI (STEMI), non-ST elevation ACS (NSTEMI or NSTEMI-ACS), or SIHD], extent and degree of ischemia suggested by Catheterization and Cardiovascular Interventions DOI 10.1002/ccd. Published on behalf of The Society for Cardiovascular Angiography and Interventions (SCAI).
4  Blankenship et al.

TABLE II. Clinical Scenarios Favoring Delayed Percutaneous Coronary Intervention

1. High-risk/complex anatomic stable coronary disease (e.g., unprotected left main, complex multivessel coronary artery disease, chronic total occlusion).
2. Excessive contrast or radiation during diagnostic procedure or anticipated during percutaneous coronary intervention.
3. Site of service (e.g., facility without onsite surgery in which the patient risk or lesion risk is high or facility lacking necessary interventional equipment).
4. Inadequate informed consent (e.g., diagnostic catheterization identifies anatomy for which the risk of PCI is significantly higher than was discussed before percutaneous coronary intervention).
6. Lack of evidence of ischemia and unavailability of fractional flow reserve or intravascular ultrasound.
7. Complication during diagnostic catheterization (e.g., stroke and access site bleeding).
8. Operator or patient fatigue after diagnostic catheterization.
9. Scheduling problems (e.g., if a new patient presents with ST-elevation as ad hoc PCI is being considered for a patient with stable ischemic heart disease).
10. Inadequate pretreatment (e.g., no aspirin before diagnostic catheterization, inadequate trial of antianginal therapy, and inadequate hydration).

noninvasive testing before coronary angiography, adequacy of medical therapy, and extent of anatomic CAD. The document makes no explicit statement about ad hoc PCI but implies several principles. The AUC imply that ad hoc PCI is appropriate for many patients with ACS, particularly those with ongoing ischemia. The AUC also suggest that patients with stable moderate/severe angina who are optimally treated medically and have moderate/high-risk findings on ischemic testing are generally suitable candidates for PCI, although they do not specify timing. In contrast, the AUC suggest that, for patients without severe symptoms, prior functional testing confirming ischemia, and/or an attempt to provide optimal medical therapy, PCI is generally inappropriate. The AUC note that fractional flow reserve (FFR) or intravascular ultrasound (IVUS) are acceptable substitutes for noninvasive testing before angiography to confirm that a target lesion is sufficiently severe to warrant PCI if a functional test was not performed before angiography.2,28,29 The 2011 PCI guidelines rate PCI of nonculprit lesions at the time of primary PCI as a class III recommendation due to evidence that the strategy increases adverse events.30

Cardiogenic Shock

Revascularization decreases the mortality of STEMI patients with cardiogenic shock complicating ACS.31 Ad hoc PCI of the infarct artery is appropriate. Ad hoc PCI of more than one lesion may be appropriate if the culprit cannot be identified with certainty. Among patients with hemodynamic stabilization after PCI of the infarct artery, ad hoc PCI of noninfarct artery stenoses correlates with poorer outcomes.32 If shock persists despite PCI of the culprit lesion, ad hoc PCI of nonculprit lesions may be helpful if they are flow limiting at rest and supply a large risk region.33

NSTE-ACS

The 2011 PCI guidelines give a class I recommendation for an early invasive strategy defined as diagnostic angiography with the intention to perform PCI for patients with NSTE-ACS who are at increased risk for clinical events or who have refractory angina, hemodynamic compromise, or electrical instability.2 While these guidelines do not specifically advocate ad hoc PCI in these situations, it is commonly used to provide the revascularization as recommended in these guidelines. Plaque rupture apparent on angiography or IVUS may occur in multiple sites,34 warranting PCI of multiple lesions if the culprit cannot be identified or if more than one is suspected to be a culprit. Routine ad hoc PCI of nonculprit arteries in ACS may be of benefit.35–37 In a survey of 411 interventional cardiologists regarding PCI of nonculprit lesions in patients with ACS, 42% recommended ad hoc PCI, 37% recommended delayed PCI, and 14% recommended PCI of nonculprit lesions only if the patient experienced recurrent ischemia after PCI of the culprit lesion.38

Stable Ischemic Heart Disease

The 2011 PCI guidelines and 2012 AUC provide guidance for PCI in SIHD.2,3 In general, either ad hoc or delayed PCI is appropriate for symptom relief when patients are on optimal medical therapy, have symptoms limiting their quality of life, have evidence of ischemia in the target artery by stress testing or FFR, and have undergone informed consent. Among patients with SIHD, the AUC give the highest ratings of appropriateness (8 or 9 on a scale of 1 to 9) to those with the most severe symptoms and largest areas of myocardium at risk. These patients are the most likely to benefit from PCI,25 and indications to perform ad hoc PCI

AD HOC PCI FOR SPECIFIC PATIENT SUBSETS

ST-Segment Elevation Myocardial Infarction

Ad hoc PCI of the infarct-related artery within 12 hr in symptomatic patients with STEMI has a class I indication in the 2011 PCI guidelines.2 The 2011 PCI guidelines give a class I recommendation for the early invasive strategy defined as PCI at time of primary PCI for patients with STEMI.2 The 2011 PCI guidelines and 2012 AUC provide guidance for PCI in SIHD.2,3 In general, either ad hoc or delayed PCI is appropriate for symptom relief when patients are on optimal medical therapy, have symptoms limiting their quality of life, have evidence of ischemia in the target artery by stress testing or FFR, and have undergone informed consent. Among patients with SIHD, the AUC give the highest ratings of appropriateness (8 or 9 on a scale of 1 to 9) to those with the most severe symptoms and largest areas of myocardium at risk. These patients are the most likely to benefit from PCI,25 and indications to perform ad hoc PCI
are clearer than in patients with less severe symptoms or ischemia. Ad hoc PCI may be inappropriate if complications have occurred during the diagnostic catheterization, excessive radiation or contrast were used, the significance of a lesion cannot be determined, or a heart team approach is indicated to identify the best strategy for treatment of complex coronary disease.

FFR performed immediately after diagnostic angiography can help distinguish lesions that are hemodynamically significant and, therefore, appropriate for ad hoc PCI. IVUS may be useful in assessing the severity of coronary lesions, but it is not able to assess functional or hemodynamic significance, and there is no consensus on the criteria that define a hemodynamically significant lesion.

Decisions about ad hoc PCI for multivessel CAD are complex since angiography may overestimate and stress imaging may underestimate the number of significant lesions. FFR-guided PCI produces better outcomes than angiographically guided PCI for multivessel CAD. A strategy of partial revascularization with ad hoc PCI followed by a repeat procedure targeting...
other lesions if clinically indicated is reasonable for some patients.42

**Patients Requiring Complex PCI Techniques**

PCI involving complex techniques (e.g., requiring left ventricular support devices or involving unprotected left main lesions) is relatively uncommon (i.e., <5% of cases) in most interventional practices. It is appropriate only if the patient has undergone informed consent specifically addressing the increased risks usually associated with these procedures. For anatomically complex PCI [e.g., moderate-high SYNTAX score patients, chronic total occlusions, or complex bifurcation stenting (e.g., Medina class 1,1,1 lesions)], ad hoc PCI is less likely to be appropriate than for simpler lesions.43 Ad hoc PCI should not be performed if there is a reasonable likelihood of needing adjunctive therapy not available onsite (e.g., rotational atherectomy, percutaneous left ventricular support device, or CABG).

**Contrast and Radiation Dose**

Contrast-induced nephropathy correlates with contrast dose, may be predicted,44 and should be considered before proceeding with ad hoc PCI. It is prudent to limit total contrast dose to less than 3.7 times the estimated glomerular filtration rate.45 Excessive radiation may cause injuries46 and should be avoided.47 Total radiation dose for 1 day should not exceed 4–6 grays, particularly in patients at high risk of radiation injury. If ad hoc PCI is likely to exceed these limits of contrast or radiation, delayed PCI may be preferable.

**REQUIREMENTS FOR AD HOC PCI**

Ad hoc PCI should be performed only as part of a comprehensive, multidisciplinary institutional program that ensures (1) an informed consent process that involves the patient in shared decision making; (2) availability of data to determine the appropriateness of PCI; (3) tools for the assessment of periprocedural patient risk; (4) capability of administering appropriate adjunctive pharmacotherapy; and (5) flexibility in scheduling of patients and the physician operator.

**Patient Consent**

Informed consent for ad hoc PCI must be obtained before conscious sedation for cardiac catheterization. It should include discussions with the patient about advance directives and the goals, risks, alternatives, and risks of the alternatives to PCI. The discussion as well as the patient’s wishes regarding ad hoc PCI should be documented. Patients tend to overestimate the benefits of procedures and underestimate the success of medical therapy.48 It is the operator’s responsibility to ensure that the patient has an accurate understanding of the benefits of alternative therapies. Operators who perform ad hoc PCI for multivessel CAD, high-risk anatomy, or high-risk clinical situations must include the increased risk of these situations in the informed consent discussion. However, since patients cannot give informed consent on the table under sedation, any circumstances not anticipated in preprocedural informed consent discussions should lead to termination of the diagnostic procedure without proceeding to ad hoc PCI.

The ideal informed consent process should (1) precede the procedure by enough time for the patient to ask questions and consult with family and caregivers and should be confirmed immediately before the procedure; (2) be patient centered, using a shared decision-making model involving a two-way exchange of all relevant medical and personal information between the physician and patient (and potentially others) in a collaborative approach; and (3) be patient specific, with estimates of risk and benefit based on the patient’s unique characteristics.25,49 Validated prediction models have been developed to assist clinicians in estimating procedural risk and PCI outcome before PCI.50 Tools are available to help evaluate the appropriateness of PCI prior to diagnostic catheterization so that when the anatomy becomes known, the appropriateness of PCI can easily be ascertained.49

**Data Needed to Determine Appropriateness of PCI**

Programs performing ad hoc PCI should ensure that information critical for determining the appropriateness of PCI is available, including (1) clinical presentation and severity of angina or angina equivalent symptoms; (2) extent and severity of myocardial ischemia assessed by noninvasive testing or FFR; (3) extent of antianginal medical therapy; (4) coronary anatomy; and (5) knowledge of the patient’s wishes obtained during the informed consent discussion.

**Patient Risk Assessment**

Comprehensive patient risk assessment is a fundamental component of ad hoc PCI programs. The procedural risks (short-term and long-term) must be anticipated while obtaining informed consent and should be discussed with the patient during the shared decision-making process. These risks also must be reassessed when new data emerge (e.g., after diagnostic angiography). Examples of risks that should be considered include major complications of intervention including death, MI, stroke, contrast nephropathy, radiation skin burns, restenosis, stent thrombosis, and early and late bleeding. This assessment should
also include the risks of alternative treatments (medical therapy and CAGB). SCAI supports the use of validated tools for these assessments,23,51 which should be available to patient caregivers.50

Pretreatment

Patients considered for ad hoc PCI should be administered aspirin before diagnostic catheterization. Pretreatment with P2Y12 inhibitors hours to days before PCI is ideal,52 although they can also be administered at the time of PCI, particularly if they are among those that act rapidly.53 Adequate hydration with normal saline should be provided before diagnostic catheterization if ad hoc PCI is to be considered,54 and lack of adequate hydration may be a relative contraindication to ad hoc PCI.

Scheduling

Ad hoc PCI after diagnostic catheterization will prolong the procedure and should be anticipated when the diagnostic procedure is scheduled. This requires flexibility in the catheterization laboratory schedule and operator schedules. If the invasive cardiologist performing diagnostic catheterization is not an interventionist, ad hoc PCI requires the availability of an interventionist. Ad hoc PCI should not be rushed because of scheduling issues.

CODING, COST, AND REIMBURSEMENT FOR AD HOC PCI

Coding

American Medical Association Current Procedural Terminology (CPT) coding guidelines indicate that, when diagnostic angiography is followed on a different day by delayed PCI, diagnostic angiography may not be coded again along with the PCI. Only if the patient’s condition has changed such that repeat diagnostic angiography is necessary (e.g., interim MI), can diagnostic angiography be coded again before the PCI.

Cost and Reimbursement

Two studies have studied cost of ad hoc PCI versus diagnostic angiography with delayed PCI. Panchamukhi and Flaker found that ad hoc PCI reduced total costs by 16% ($P < 0.0001) and Adele et al.55 found that ad hoc PCI with stents reduced cost by 19% ($P < 0.05).

Medicare payment policies reduce payment for diagnostic catheterization by 50% when it is performed on the same day as PCI by the same physician or by a member of the same physician’s group (Table III). Diagnostic catheterization performed on a separate day from PCI is not discounted. Total Medicare reimbursement to hospitals and physicians is greater when PCI is performed on a different day than diagnostic catheterization (Table III). Reimbursement should not influence the timing of PCI. The patient’s interests should drive decisions on whether and when to perform PCI.

RELEVANT ETHICAL PRINCIPLES

The three important principles of medical ethics are beneficence (doing what is best for the patient and avoiding harm), autonomy (respecting and facilitating the patient’s right and ability to make informed decisions about their own care), and justice (considering how the patient’s treatment will affect others in the healthcare system).

TABLE III. Payments to Physicians for Ad Hoc Diagnostic Catheterization/PCI Versus Diagnostic Catheterization and Delayed PCI in 2012

<table>
<thead>
<tr>
<th>Procedure</th>
<th>CPT codes</th>
<th>Physician work RVUs</th>
<th>Total RVUs</th>
<th>Physician medicare payment(^b)</th>
<th>Hospital/facility reimbursement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate-session/separate day diagnostic catheterization and PCI</td>
<td>93458</td>
<td>5.85</td>
<td>9.28</td>
<td>(APC 0080) $2,718.42</td>
<td>DRG 248: $16,553 or DRG 249: $10,210</td>
</tr>
<tr>
<td>Coronary angiography and left heart catheterization</td>
<td>92980</td>
<td>14.82</td>
<td>24.61</td>
<td>(APC 0014) $5,689.41</td>
<td>$8,407.83</td>
</tr>
<tr>
<td>Total</td>
<td>20.67</td>
<td>33.89</td>
<td>$1153.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same-session diagnostic catheterization and PCI (reimbursement for catheterization/arteriography is reduced by 50%)</td>
<td>93458</td>
<td>5.85 @ 50% = 4.63</td>
<td>9.28</td>
<td>(APC 0080) $2,718.42 @ 50% = $1,359.21</td>
<td>DRG 248: $16,553 or DRG 249: $10,210</td>
</tr>
<tr>
<td>Coronary angiography and left heart catheterization</td>
<td>92980</td>
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<td>$7,048.62</td>
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<tr>
<td>Total</td>
<td>20.67</td>
<td>29.24</td>
<td>$995.26</td>
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</table>

New codes for PCI to be implemented January 1, 2013, will render these projections obsolete, but the magnitudes of differences among various scenarios are expected to remain similar. Data are from the 2012 National Physician Fee Schedule Relative Value File (RELEASED 12/21/2011) and Addendum B OPPS Payment by HCPCS Code for CY 2012.

\(^a\)Includes physician work relative value units (RVUs), practice expense RVUs, and malpractice insurance RVUs.

\(^b\)National Average Based on 2012 Conversion factor $34.0376.DRG 248, diagnosis-related group for drug eluting stents; DRG 249, diagnosis-related group for bare metal stents; APC, ambulatory payment classifications; PCI, percutaneous coronary intervention.

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Beneficence

Decisions on whether to perform ad hoc versus delayed PCI should be made keeping the patient’s welfare foremost. For example, convenience for the patient may favor the performance of ad hoc PCI when PCI is clearly indicated and can be performed quickly and safely. In contrast, safety may dictate delayed PCI when ad hoc PCI would require dangerous levels of radiation or contrast.44–47 The heart team approach may require delayed revascularization when diagnostic catheterization identifies complex multivessel CAD.2

Autonomy

Decisions for ad hoc versus delayed PCI should involve the patient through the informed consent process described above.49 The principles of autonomy and beneficence may conflict when patients prefer a convenient strategy (e.g., ad hoc PCI) rather than a safer or more effective strategy (e.g., delayed PCI or even CABG for complex multivessel CAD).48 In such cases, the physician should use clinical judgment combined with insightful communication with the patient to reach consensus on a course that is best for the patient.

Justice

Decisions for ad hoc versus delayed PCI should include consideration of how the patient’s treatment might affect others. For example, delaying PCI may be more appropriate than forcing other scheduled patients to wait long periods while ad hoc PCI is performed. Care of acutely ill patients may dictate delays in care for stable patients (e.g., PCI of a STEMI patient taking precedence over an ad hoc PCI).

RECOMMENDATIONS AND CONCLUSIONS

PCI for ACSs

Ad hoc PCI should be the default strategy for patients with STEMI and with NSTE-ACS. Ad hoc PCI of nonculprit lesions should not be performed routinely during primary PCI, may be appropriate in cardiogenic shock if these conditions are contributing to ischemia, and may be appropriate in ACS.

PCI for SIHD

Ad hoc PCI for SIHD should be considered, and has the greatest benefit, when optimal medical therapy for CAD has failed to adequately control patients’ symptoms and large areas of myocardium are potentially ischemic. For patients who have not failed a trial of optimal medical therapy before diagnostic catheterization, the benefits of ad hoc PCI should be compared with the benefits of a trial of optimal medical therapy. It should be recognized that PCI in these patients may be rated as inappropriate by the AUC. Ad hoc PCI is appropriate when indications for PCI are present and other requirements for ad hoc PCI described above are met.

PCI for Multivessel Complex and/or Unprotected Left Main SIHD

Ad hoc PCI for complex multivessel or unprotected left main SIHD should be reserved for unusual circumstances in which surgical consultation has already occurred or is clearly not an appropriate consideration due to comorbidities or other factors, and the patient has been fully informed regarding benefits and above-normal risks.

Informed Consent

Ad hoc PCI should be considered only if informed consent included the risks and benefits of PCI appropriate for the patient and for the extent of CAD identified, as well as the risks and benefits of alternative treatments.

Regulatory and Reimbursement Status

Third-party payers and quality auditors should recognize that ad hoc PCI is appropriate in many situations, and delayed PCI is more appropriate in other situations.

Patient Autonomy

When patient preference (e.g., for ad hoc PCI) conflicts with optimal efficacy/safety (e.g., favoring delayed PCI), the physician should use clinical judgment combined with insightful communication with the patient to reach consensus on a course that is best for the patient.

Future Research

The trends, guidelines, and appropriate use criteria discussed in this article may change the incidence of ad hoc versus delayed PCI and may change the characteristics of patients in these groups. Analyses of large databases should be undertaken in the future to assess changes in practice and outcomes associated with these strategies.

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