PANEL DISCUSSION

Optimizing PCI Workflows: Imaging, Physiology, and Therapy Selection

The growing role of intravascular imaging, physiology, AI, and personalized treatment strategies in contemporary PCI decision-making.

With Rhian E. Davies, DO, MS, FACC, FSCAI; Alexander Fanaroff, MD, MHS; and Jennifer Rymer, MD, MBA, MHS

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At what stage(s) do you see the greatest variation in real-world percutaneous coronary intervention (PCI) workflows? Do you think more standardization is required here, or should PCI remain largely operator and case specific?

Dr. Davies: The greatest variation in PCI workflows is typically seen during lesion assessment, procedural planning, use of intravascular imaging (IVI), and management of complex lesions (eg, bifurcations, calcified vessels, chronic total occlusions [CTOs]).

There is also considerable variation in antithrombotic strategies and postprocedure optimization practices. Some standardization is beneficial for patient selection, physiologic assessment, imaging-guided stent optimization, complication management, and quality reporting.

These areas are supported by evidence and can help improve consistency and outcomes across operators and institutions. However, the technical execution of PCI often needs to remain flexible because coronary anatomy and patient factors vary widely. Overall, PCI should follow standardized decision-making frameworks while allowing operators to tailor procedural techniques to the individual case.

Dr. Fanaroff: There are really so many answers to this question. The low-hanging fruit is IVI use. Although IVI now has a class I guideline recommendation per

2025 multisociety guidelines,[1] it is only used in 20% of PCIs nationwide. In contemporary cath labs, IVI can be performed safely in only a few minutes, and it has a substantial effect on cardiovascular events (as big as switching from moderate- to high-intensity statin, for example) and especially stent-related events, which we all try to avoid.

The harder question is whether it's right to make decisions about lesion severity using angiography alone. We have known since the 1970s that there is tremendous operator variability in assessment of lesion severity, and it affects management decisions related to revascularization. Yet, most contemporary decisions regarding whether to perform PCI are made based on visual assessment. Using physiology to guide PCI decisions is not as simple as using IVI; wire-based tools add time and risk to angiography, and there's a steep learning curve to angiography-based fractional flow reserve (FFR). I am hopeful that the angiography-based FFR systems will catch on and add some rigor to this decision-making.

Regardless, I think we owe it to our patients to standardize stent optimization with IVI and utilize physiology in the decision to pursue PCI or other revascularization.

Dr. Rymer: Variation exists at multiple levels. At the point of patient selection and case preparation, some operators have moved to coronary CTA (CCTA) to help guide and prepare for potential PCIs. CCTA gives valuable information about lesion physiology, and if the anatomy suggests likely treatment with PCI, CCTA can help the operator prepare guide selection, calcium modification technique, and stent techniques for bifurcation lesions. In the case of a CTO, CCTA can be invaluable before planned PCI. However, despite the availability of CCTA, its use in PCI planning is still low.

IVI utilization during PCI remains low as well and is used variably in practice. IVI is integral to determining the mode of previous stent failure and ensuring that additional stent implantations are well-apposed and appropriately sized to avoid future stent failure. Particularly for higher-risk lesions such as left main lesions, bifurcations, heavily calcified lesions, and graft lesions, IVI should be used the majority of the time; unfortunately, its use in practice remains inconsistent.

Post-PCI, the interventional community has the opportunity to optimize guideline-based medical therapy and assess for important markers of residual risk. However, this important "touchpoint" is often underutilized, and opportunities to decrease future cardiovascular risks and prevent repeat visits are frequently missed.

A major question in contemporary PCI is how treatment decisions should be guided: anatomy/imaging, physiology, or a hybrid approach. In which clinical scenarios do you use each, and how does IVI factor into those decisions, including intravascular ultrasound (IVUS) versus optical coherence tomography (OCT) selection?

Dr. Rymer: There are many cases where a combination of imaging and physiology might be most useful. In the case of a discrete lesion, physiology may help to guide the operator to medical treatment if the lesion is not found to be flow-limiting on physiologic assessment but may be borderline on an imaging assessment. It's critical that we use all information to ensure that we are not intervening when not necessary. When I am trying to assess the left main, I will usually always incorporate imaging data to determine stenosis, calcification, and disease in the ostia of the left anterior descending (LAD) and left circumflex arteries. Most importantly though, it is critical to use both modalities if one has borderline findings to direct your interventional plan.

Dr. Fanaroff: When making the decision to proceed with PCI, I use a combination of physiology and angiography. In cases involving an unquestionably severe lesion (> 80%) with clear symptoms, that's enough for me to perform PCI. In cases where the lesion is intermediate, I reach for physiologic testing. I am especially likely to use physiology when making the decision to send a patient for coronary artery bypass grafting. If there is three-vessel disease including an intermediate LAD lesion, for example, I think it's important to confirm its severity before the patient goes for bypass; otherwise, they've gone for a high-risk surgery for no reason. I use wire-based instantaneous wave-free ratio (iFR) and FFR for physiologic testing because our lab does not have angiography-based FFR yet. I use IVI for PCI planning (vessel size, calcium modification), not to make decisions about whether to perform PCI or not.

Dr. Davies: I generally favor a hybrid approach that integrates anatomy, physiology, and IVI rather than relying on a single modality. Physiology, such as FFR or iFR, is most useful for intermediate lesions where the hemodynamic significance is uncertain, and it can help avoid unnecessary PCI. Anatomy and angiography tend to drive decisions in clearly severe lesions, acute coronary syndrome (ACS), left main disease, or situations where physiology may be less reliable. IVI is particularly valuable for lesion characterization, stent sizing, optimization, and identifying mechanisms of stent failure.

I typically favor high-definition IVUS for PCI, particularly for large vessels, left main interventions, and heavily calcified lesions because of its deeper tissue penetration, whereas OCT is especially helpful when high-resolution assessment of plaque morphology, stent expansion, or edge dissections are needed. Ultimately, the most comprehensive approach often involves physiology to determine whether to treat and imaging to determine how best to treat.

What role is artificial intelligence (AI) currently playing in PCI planning and procedural decision-making? Where do you see it becoming meaningfully integrated into PCI workflows?

Dr. Rymer: AI is already playing a major role in the increasingly sophisticated output provided by modern IVI systems. While the systems don't make recommendations for lesion preparation techniques, calcium modification strategies, or stent size—which may have medical-legal ramifications—they do have much of the information needed to support these decisions. Through AI, current OCT and IVUS systems can measure lesion length, detect plaque burden, identify detection (including arc, thickness, and length), lumen and vessel segmentation, and detect the external elastic lamina.

AI supports physiology testing via both CCTA and angiography-derived physiology, where various physiologic indices can be calculated from angiographic segments. AI capabilities will continue to evolve to allow for more precise PCI.

AI will increasingly be used to calculate residual risk of the post-PCI patient, allowing the operator to precisely target areas for intervention (both medical and procedural) throughout the entire body, not just the coronary tree.

Dr. Davies: AI is currently a decision-support tool, mainly for imaging interpretation and lesion characterization. It improves efficiency and standardization but does not replace clinical judgment. Future roles include automated lesion assessment, planning, and procedural optimization. However, given the complexity and variability of coronary anatomy and patient presentations, AI will likely serve as a decision-support tool that augments operator judgment rather than replaces it.

Dr. Fanaroff: In our lab, AI currently plays no real role in PCI planning and procedural decision-making, but I think its role will expand in the future. AI is particularly good at pattern recognition, and most of what we do in PCI planning and procedural decision-making is based on pattern recognition (eg, choosing a guide/wire/balloon/stent, calcium modification). The big barrier is ensuring the technology is usable with minimal human input but still legible to humans who are using it to support their decision-making.

How has the increasing availability of angiography-derived physiology (eg, FFRangio [Cathworks], quantitative flow ratio [QFR]) changed your cath lab workflow or decision-making?

Dr. Fanaroff: As of yet, it has not. We don't have FFRangio available, and we don't really use QFR. We do have a CT coronary angiography-based tool for PCI planning, but so few patients at our center undergo CT coronary angiography prior to catheterization that it has not changed decision-making.

Dr. Davies: It has helped streamline assessment of intermediate coronary lesions by providing physiologic information without the need for a pressure wire or hyperemic agents. In practice, these tools can improve efficiency, reduce procedure time and costs, and increase the use of physiology-guided decision-making in cases where traditional FFR or iFR might not otherwise be performed. They are particularly useful when lesion significance is uncertain and can help identify patients who may safely avoid PCI. However, I still view invasive wire-based physiology as the reference standard when results are borderline, image quality is suboptimal, or clinical and angiographic findings are discordant. These technologies have generally increased confidence in deferring nonsignificant lesions while supporting more evidence-based revascularization decisions. As validation data continue to grow, angiography-derived physiology is likely to become an increasingly routine component of PCI workflow.

Are you seeing a broader shift toward lesion-specific, individualized PCI rather than a traditional stent-first approach? How has this changed workflows and procedural planning at your institution?

Dr. Fanaroff: The advent of drug-coated balloons (DCBs) has changed workflows and procedural planning, especially for in-stent restenosis (ISR) and bifurcation lesions. Obviously, we can now try to avoid a second (or third) layer of stent in patients with ISR, which simplifies these procedures and hopefully gives us better results. The ability to finish with a DCB in a side branch also makes me more confident in starting with a provisional strategy for bifurcation lesions, because I know I won't necessarily have to use an inferior bifurcation strategy if I need to switch.

Dr. Davies: PCI is moving away from a stent-first approach and toward lesion-specific treatment. Decisions are increasingly based on physiology and plaque morphology. Pre-PCI planning now includes imaging and lesion preparation strategies. The focus is on durable outcomes rather than angiographic stenosis alone.

Dr. Rymer: Increasingly, I am seeing a focus on patient lifespan and how PCI will impact their downstream options. For instance, for patients presenting with ISR, careful consideration is given to avoid multiple layers if possible, potentially treating with DCBs. Additionally, it is important to consider where the lesion is located anatomically. For example, if a lesion is in the distal LAD, one may consider whether a stent should be placed in this location in case future bypass surgery is needed. I think we are moving toward an era where, with additional CT information, we can plan ahead of the PCI; at the same time, we also need to consider the needs and anatomy of the patient and how downstream treatments would be impacted.

What key clinical and procedural criteria do you use to determine whether same-day discharge is appropriate after PCI?

Dr. Rymer: This must be carefully considered and depends on the individual patient. I was an author on the 2021 American College of Cardiology expert consensus decision pathway for same-day discharge in patients undergoing PCI,[2] and I use that decision pathway in my own practice. Characteristics like access site are important to consider; if the patient had successful transradial access, same-day discharge is easier and safer for the patient. In most cases, access-site complications after the procedure should prompt consideration of overnight observation. Additionally, there are anatomic features of the procedure that might prompt the operator to keep the patient overnight for further monitoring due to concern for hemodynamic or volume status (eg, complex left main interventions, last remaining vessel interventions, complex interventions in patients with low ejection fraction). If there were any complications during the procedure that were not completely resolved, these patients may warrant further monitoring. While age, frailty, and comorbidities should be weighed, none of these characteristics necessarily mandate an overnight stay. Logistically, the time of day during which the procedure was performed should also be considered. Complex planned interventions, when possible, should be performed early on in the day. If performed later in the day, there may not be adequate time to monitor the patient and allow same-day discharge.

Perhaps the most important criteria should be patient comfort, and the presence of a family member or friend who can transport the patient home and observe them. Ideally, new antiplatelet prescriptions should be provided to the patient prior to discharge to ensure a safe discharge plan. If the patient lives far from the PCI-performing center, they may prefer not to be transported late in the day but rather be observed. In all cases, if the patient is uncomfortable going home, this should be an important consideration to keeping them overnight.

Dr. Davies: Same-day discharge after PCI is appropriate for carefully selected patients who are clinically stable and have had an uncomplicated procedure. Key considerations include hemodynamic stability, absence of recurrent ischemia, arrhythmias, bleeding, or vascular-access complications, as well as the patient's ability to comply with medications and follow-up. Procedural factors favoring discharge include elective PCI, successful revascularization, and radial access. At our institution, all PCI patients are observed for a minimum of 6 hours before discharge consideration. More complex cases, significant comorbidities, or any procedural complications generally warrant overnight observation. When these criteria are met, same-day discharge can be both safe and effective.

As PCI workflows continue to adapt and become more technology driven, what skills should fellowship programs be emphasizing more heavily?

Dr. Davies: As PCI workflows become increasingly technology-driven, fellowship programs should emphasize proficiency in coronary physiology, IVI, and evidence-based lesion assessment in addition to traditional technical skills. Trainees need to be comfortable integrating angiography, FFR/iFR, IVUS, OCT, and emerging AI-enabled tools into procedural decision-making. Greater focus should also be placed on procedural planning, calcium modification strategies, complex PCI techniques, and management of procedural complications. Equally important is developing the ability to interpret data critically and tailor treatment to the individual patient rather than relying solely on algorithms or technology. Along with knowing how to perform PCI, fellows should also understand when intervention is truly indicated and how to optimize long-term outcomes. Ultimately, the goal is to train interventional cardiologists who can combine technical expertise with thoughtful clinical judgment in an increasingly data-rich environment.

Dr. Rymer: As an interventional program director, I think it is imperative to expose fellows as much as possible to the programs and technologies they will use throughout their career. This includes didactics and multidisciplinary teaching around how CCTA is already changing how we prepare for and plan PCIs.

It's important that interventional fellows have a foundation and education in CCTA prior to graduation. Our program has established multidisciplinary conferences to evaluate and compare CCTA with coronary angiography findings, as well as to discuss the relevant CCTA findings that helped, or could have helped, in PCI planning.

Fellows should leave fellowship with the skills to independently perform and interpret IVUS and OCT images; also important is the ability to understand the information gained from AI-based measurements and how to use that to formulate a PCI plan. IVI will likely always innovate, so it is important to instill in fellows the need for continual learning via conferences, courses, proctored cases, and software education from local device representatives. Fellowship should focus on as many opportunities as possible to interact with the output given on IVI consoles, with supervised decision-making. Most importantly, the concept of lifetime learning must be emphasized. I encourage my fellows to make a plan for how this will occur before graduation so that we can review together.

Dr. Fanaroff: Interventional cardiology has always been a field with rapidly advancing technology; the devices we learn in fellowship are not the devices we use in our careers. The technology we're using and how to interact with it can be taught to anyone, but what distinguishes an excellent operator from an average one is clinical judgment. These skills (Should this patient be on the table? Should I keep going on this difficult case or stop?) will always be the ones we should emphasize. It is seductive to think we can outsource clinical judgment to AI, but I'm doubtful that will ever be the case.

What emerging innovations or trial data are most likely to meaningfully change PCI algorithms over the next 5 years?

Dr. Davies: Over the next 5 years, the biggest shifts in PCI algorithms will likely come from broader use of angiography-derived physiology, routine IVI, and AI-assisted decision support. These tools will make lesion assessment and procedural planning more standardized and data-driven. Advances in calcium modification technologies and stent optimization will also refine how complex lesions are treated. Antiplatelet strategies will continue to evolve toward more individualized risk-based approaches. Overall, PCI is moving toward a more precise, personalized, and technology-integrated workflow.

Dr. Rymer: There are likely many innovations and practice changes coming in the next few years, including ongoing pharmacologic trials that may add new therapies. We may initiate more potent lipid-lowering therapies after PCI and may have novel anti-inflammatory medications to consider after ACS and PCI. There is the possibility that we may use a glycoprotein IIb/IIIa inhibitor upstream of hospital ST-segment myocardial infarction care and primary PCI. The evolution of pharmacologic therapies around ACS is an exciting field right now.

Additionally, we will soon have more data regarding physiology-guided revascularization for complete revascularization in patients with ACS and multivessel disease (COMPLETE-2). There will likely be additional indications for scenarios in which to use DCBs outside of ISR. Within the next few years, we will have more definitive data about the role of microaxial flow pumps in patients undergoing PCI with complex coronary artery disease and low ejection fraction.

Dr. Fanaroff: I think angiography-based physiology measurements will become easier to use for PCI planning and treatment guidance, which will eliminate some of the angiography-based guesswork that we use when making clinical decisions. In the next 5 years, integrated imaging systems will be able to deliver angiography-based FFR measurements and treatment recommendations immediately after angiography, greatly standardizing PCI workflows. ■

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2. Writing Committee; Rao SV, Vidovich MI, Gilchrist IC, et al. 2021 ACC expert consensus decision pathway on same-day discharge after percutaneous coronary intervention: a report of the American College of Cardiology Solution Set Oversight Committee. J Am Coll Cardiol. 2021;77:811-825. doi: 10.1016/j.jacc.2020.11.013

Disclosures
Dr. Davies: Speaking honoraria and/or advisory board for Abiomed, Asahi Intec, Boston Scientific, Cordis, Medtronic, Rampart, Shockwave, Teleflex, and Terumo.
Dr. Fanaroff: Grant funding to institution from Boston Scientific; consulting fees from Boston Scientific; consulting (unpaid) for the Centers for Medicare and Medicaid Services.
Dr. Rymer: Medical advisory board for Boston Scientific; research awards/consulting for Abbott.