

## Core Curriculum

# Clinical Expert Consensus Statement on Best Practices in the Cardiac Catheterization Laboratory: Society for Cardiovascular Angiography and Interventions

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**Key words:** angiography coronary; diagnostic cardiac catheterization; complications adult cath/intervention; percutaneous coronary intervention

## INTRODUCTION

The cardiac catheterization laboratory (CCL) is a setting in which elective, urgent, and emergent percutaneous procedures are performed. This poses challenges to maintaining and prioritizing high quality care and patient safety. Nonetheless, process expectations of a high-quality CCL include appropriate periprocedural communication, clinical management, documentation, and universal protocol. Regulations primarily targeted at open surgical operating rooms have the potential to negatively impact care because they may mandate focus on performance measures that are not necessarily relevant to the cardiac catheterization laboratory. For example, routine site marking for percutaneous access is irrelevant for most patients since failure to obtain access on one side (e.g., right femoral artery) simply leads to attempting access on the other side (e.g., left femoral artery). Instead, directives should be tailored to the percutaneous procedure setting to assure quality and optimal patient safety. This document will therefore provide expert consensus opinion on a number of issues pertaining to “best practices” within the CCL, focusing on quality and safety during each step of the process. The writing committee acknowledges a dearth in high-quality published studies in this area, making many of the enclosed recommendations based primarily on expert consensus. Although references are provided when available, further research specifically in catheterization laboratory processes and quality improvement is needed.

The document is divided into “best practices” that should be performed during the preprocedure, intraprocedure, and postprocedure settings for diagnostic car-

diac catheterization and coronary intervention, to be consistent with the typical patient flow into and out of the CCL. Despite the long history of cardiac catheterization that dates back several decades, a document describing these “best practices” has not yet been written. The purpose of this document is not to represent all acceptable practices, but to provide consensus opinion on what would currently be considered “best practices” as future goals for catheterization laboratories.

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Conflict of interest: Nothing to report.

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Received 28 November 2011; Revision accepted 24 December 2011

DOI 10.1002/ccd.24311

Published online 00 Month 2012 in Wiley Online Library (wileyonlinelibrary.com)

## Provider Qualifications and Optimal Cardiac Catheterization Team

**Provider competence and documentation.** All physicians should maintain appropriate credentialing and privileging by their institution [1]. In addition, each cardiac catheterization laboratory should have a procedure for recertification of privileges. Case numbers need to be tracked by the CCL director and documented on an annual basis, and all physician staff should comply with the continuing medical education requirements of the state(s) in which they practice. In addition, procedural outcomes, including success rates and observed complications in hospital, should be documented and recorded. Currently, there is also a trend towards tracking 30-day outcomes as a quality measure. A variety of risk adjustment models are available to put these observed outcomes in perspective, and their use is recommended [2,3]. Participation in national or regional quality improvement registries, such as the National Cardiovascular Data Registry's CathPCI registry, is also recommended [4]. In addition, physicians should participate in regularly scheduled quality improvement and/or peer review meetings to maintain privileges, and participate in procedural appropriateness evaluations. Technicians should obtain RCIS certification, and nursing staff should have a minimum of 1 year critical care experience. In addition, nursing and physician assistant staff should comply with the continuing medical education unit requirements for the state(s) in which they practice.

**Optimal catheterization laboratory team.** To ensure optimal safety and efficacy of cardiac catheterization, a multidisciplinary approach is needed. Performing cardiologists must be adequately trained and credentialed, as mentioned above. They are usually assisted by a physician trainee, certified technologist, physician assistant, or nurse. Typically two individuals are tableside, with an additional two individuals serving in "circulating" and "monitoring" roles. Tableside assistants must be trained in the set-up of manifolds, automatic/power injectors, radiation safety, and sterile technique. In cases where there is a risk of developing more than moderate to deep sedation, a CRNA or staff anesthesiologist should be considered, and policies should be drafted that are consistent with hospital credentialing and state guidelines.

## Preprocedure Best Practices

**Documentation of procedure indications and the history and physical (H&P) examination.** All patients that undergo cardiac catheterization must have a history and physical (H&P) examination prior to the procedure, performed by either a physician or mid-level

provider (e.g., physician assistant or nurse practitioner). If the procedure is emergent, then a targeted history and limited physical examination is reasonable. For patients undergoing an outpatient procedure, a timed and dated H&P performed within 30 days is acceptable, with a focused update documented by the attending physician within 24 hr prior to the procedure. This update should reflect any changes in medical status (e.g., change in renal function) or medications that have occurred since the original H&P. For inpatients, an H&P should be performed within 24 hr of admission or registration, but prior to procedures requiring anesthesia services. At a minimum, the H&P should describe the history of present illness, comorbidities, indications for the procedure and a review of systems focusing on the common issues encountered during cardiac catheterization relating to cardiovascular, renal, gastrointestinal, peripheral vascular, and pulmonary systems. In addition, any history of contrast reaction should be documented, including the specific clinical reaction. The H&P should also outline barriers to the patient's ability to tolerate and adhere to long-term dual antiplatelet therapy (DAPT), such as upcoming surgeries and procedures that might necessitate the cessation of DAPT, requirement for long-term oral anticoagulation (e.g., mechanical heart valve or atrial fibrillation) and the patient's history of adherence to medications. The physical examination should be focused on the heart and vascular system, including an assessment and documentation of peripheral lower extremity pulses, with findings documented that are relevant to the underlying condition for which the cardiac catheterization is being considered. An assessment of the clinical condition and a therapeutic plan that details how the results of cardiac catheterization would assist in overall clinical care should also be considered. Risk scores for periprocedural complications, such as bleeding and renal failure, have been published, and should be considered for documentation in the medical record [5,6].

**Informed consent process and documentation.** Informed consent is necessary before every cardiac catheterization procedure and is consistent with the ethical principles of patient autonomy [7]. The hospital must have a written policy on informed consent that describes the process used to obtain informed consent, including documentation and surrogate-decision maker issues, as well as circumstances that would allow for exceptions to obtaining informed consent. Ideally, the informed consent process must be performed in a neutral environment by the operator, an informed physician or a mid-level provider who is a member of the cardiac catheterization team and can serve as the physician's designee. The informed consent should be in the

patient's native language using terms that allow a lay person to understand what the procedure entails, the risks, benefits and alternatives to the procedure proposed, including no treatment, and potential outcomes and complications that may occur during and after the procedure [8,9]. Although not required, best practice would be for the informed consent process to be witnessed by a third party, preferably by the patient's family or a staff member independent of the CCL. The document is subsequently entered into the medical record. The consent must be obtained within 30 days, and should be confirmed as complete and present in the chart on the day of the procedure. Specific mention should be made of DNR status and whether it has been revoked for the duration of the procedure. Potential treatments that may result from the findings of a diagnostic procedure and their attendant risks should be reviewed, as well as recommendations for percutaneous coronary intervention (PCI), issues surrounding DAPT and restenosis. Recently, tools to enhance the informed consent process with the use of electronic decision-making aids have been described [9,10], but are not currently in wide use.

#### **Sedation, anesthesia, and analgesia evaluation.**

Cardiac catheterization procedures are performed with conscious sedation [11]. Therefore, all CCL physicians should demonstrate proficiency in sedation pharmacology, patient monitoring, and airway management, and accordingly be credentialed by their hospital for providing moderate sedation. There are established guidelines for training and credentialing physicians and CCL personnel in the appropriate management of patients requiring moderate sedation that must be followed [12]. Nurses, nurse practitioners, and physician assistants are able to administer sedation medications and assist in monitoring patients during sedation, but must be directly supervised by the physician performing the procedure. In addition, such allied health care team members must also demonstrate proficiency in sedation management and recovery in accordance with local institutional guidelines. In all cases, an ASA and Mallampati classification designation should be established by physicians or their designees as part of pre-sedation assessment and updated within 24 hr of the procedure.

**Preprocedure checklist.** A preprocedure checklist is recommended, an example of which is provided in Table I. In addition to procedural indications, H&P, informed consent, sedation and analgesia, precatheterization assessment should include a review of patient medications. In particular, antiplatelet therapies, metformin, and other medications that could affect renal function should be reviewed. Any upcoming potential or required surgeries should be reviewed. Risk of bleeding should be assessed. Any history of intolerance

to specific antiplatelet therapies or antithrombotic agents is relevant, especially when a PCI is under consideration.

The use of ancillary laboratory studies varies among institutions, but at a minimum all patients scheduled for outpatient cardiac catheterization should have a complete blood count (CBC), serum electrolyte panel, and assessment of renal function within 30 days. For inpatients, CBC and metabolic profile are recommended within 24–48 hr. Significant anemia should be addressed prior to the procedure, especially when PCI and associated antiplatelet therapy are being considered. Given the relative lack of evidence surrounding the utility of measuring PT/INR prior to vascular procedures, the routine measurement of PT/INR should be determined by the clinical scenario and ultimately left to the discretion of the performing physician [13]. For patients on chronic warfarin therapy, however, PT/INR should be obtained within 24 hr of the procedure. In general, an INR >1.8 should prompt the operator to consider cancellation of a femoral arterial access procedure, unless the procedure is emergent or the INR is unlikely to normalize [11]. In the latter instances, transfusion of fresh frozen plasma and other precautions to limit blood loss, such as use of the transradial approach and bivalirudin (for PCI), may be considered. Alternative strategies for patients with elevated INR have been described; however, there are limited data on their safety and efficacy [14].

For patients with baseline renal insufficiency (creatinine clearance <60 ml min<sup>-1</sup>), providing saline or sodium bicarbonate hydration should be strongly considered unless contraindicated by congestive heart failure [15]. Recent data suggest that *N*-acetyl cysteine may not offer significant benefit, and is therefore no longer routinely recommended for patients with baseline renal insufficiency [15,16].

A baseline EKG is essential as it serves as a basis for comparing changes that occur during or after the procedure. A chest X-ray is not required unless congestion or other pulmonary pathology is evident on physical examination. Women of childbearing age should have beta-HCG levels checked within 2 weeks of the procedure [17]. For patients who have had prior catheterization or coronary/peripheral bypass surgery, every effort should be made to review procedural reports to help guide the operator during the procedure. The documentation of allergies should focus on the most common allergy-related problems encountered in the CCL, in addition to medication allergies. Specific allergies, including contrast and latex allergies and allergies to medications used during the procedure (heparin, aspirin, etc.) need to be documented along with the patient's history of multiple allergies. It is important

**TABLE I. Preprocedure Check List for Cardiac Catheterization**

Patient name: _____		MRN: _____		Procedure Date: _____	
<u>Planned procedure:</u>					
Diagnostic cardiac catheterization					
Diagnostic cardiac catheterization with possible PCI					
Percutaneous coronary intervention					
<u>History and physical examination:</u>					
Elective outpatient procedures: H&P documented within 30 days?				Yes	No
Inpatient procedures: H&P documented within 24 hr of admission?				Yes	No
<u>History of prior PCI or CABG:</u>		Yes	No	If yes, were	
reports obtained?		Yes	No		
<u>Candidacy for DES:</u>					
1. Is there significant anemia (i.e., Hct <30)?				Yes	No
2. Any major surgery in the past month or next year?				Yes	No
3. Is there any clinically overt bleeding?				Yes	No
4. Is patient on chronic anticoagulation (e.g., warfarin, dabigatran)?				Yes	No
5. Is there history of medication nonadherence?				Yes	No
<u>Allergies:</u>					
1. Contrast:		Yes	No	If yes, was the patient pretreated?	
				Yes	No
2. Aspirin:		Yes	No	If yes, does the patient need desensitization?	
				Yes	No
3. Heparin (HIT)		Yes	No	If yes, consider alternative antithrombotic agents	
4. Latex		Yes	No	If yes, remove all latex products from procedural use	
5. Multiple allergies		Yes	No	If yes, consider prednisone pretreatment	
<u>Medications:</u>					
1. Did patient take aspirin within the past 24 hr?				Yes	No
2. Did patient take clopidogrel within the past 24 hr?				Yes	No
3. Did patient take metformin within the past 24 hr?				Yes	No
4. Did patient take sildenafil (or equivalent) within the past 24 hr?				Yes	No
5. Did patient receive LMWH within the past 24 hr?				Yes	No
<input type="checkbox"/> If yes for LMWH, time of last dose _____					
<u>Informed consent:</u>					
Was informed consent obtained within 30 days?				Yes	No
<u>Is there a healthcare proxy?</u>				Yes	No
Is the patient DNR or DNI?		Yes	No	Yes, but revoked for procedure	
<u>Sedation, anesthesia, and analgesia:</u>					
Are ASA and Mallampati class documented?				Yes	No
Is there any contraindication to sedation present?				Yes	No
<u>Laboratories and studies:</u>					
CBC and basic electrolytes within 30 days (outpatient) or 24 hr (inpatient)?				Yes	No
Was EKG performed within 24 hr?				Yes	No
PT/INR performed within 24 hr (for patients on warfarin)?				Yes	No
Does the patient require preprocedure hydration?				Yes	No

**TABLE II. Sample Regimen for the Prevention of Contrast Allergy<sup>a</sup>**

Methylprednisolone	60 mg	IV
Diphenhydramine	50 mg	IV
Cimetidine	300 mg	IV

<sup>a</sup>Recommended to be administered before the procedure, however the appropriate timing has not been established.

Common regimen in clinical practice:

1. Prednisone 50–60 mg PO Q6 hr X 4 doses prior to procedure.
2. Prednisone 50–60 mg PO at 13, 7, and 1 hr prior to procedure.

that the history be reviewed for previous heparin-induced thrombocytopenia (HIT). Several regimens have been used to prevent contrast allergy, however none have been subject to randomized controlled trials. Each laboratory should have an established protocol T2 for preventing contrast allergic reactions. Table II lists a sample regimen with several variations on the suggested regimen used in clinical practice. Although one study supports the administration of allergy prophylaxis 13 hr before the procedure [18], the appropriate timing of prophylactic regimens has not been established. Shellfish allergy is no longer considered a predictor of contrast reactions, and therefore does not require pre-treatment. Patients should be kept NPO except medications for at least 3 hr prior to the procedure, and at least 8 hr if conscious sedation is clearly required. Diabetic patients need to have all oral hypoglycemic medications and insulin regimens reviewed and adjusted. Patients should be educated on access site management issues that may occur postprocedure. Finally, for outpatients, the patient should arrange for someone to transport them home postprocedure.

### Intraprocedure Best Practices

**Patient preparation in procedure room.** Upon arrival to the procedure room, a nurse, technician, advanced practitioner, or physician should perform a thorough review of the medical record, including documentation of NPO status and duration, access site concerns, allergies, results of blood tests, recent medications (such as heparin and other anticoagulants), advance directives, informed consent and living wills. If a preprocedure checklist was used then it should be reviewed by the attending physician or designee. All of these items must be documented in the medical record prior to the procedure, as discussed in the preprocedure section and the checklist mentioned above.

**Sedation, anesthesia, and analgesia administration and documentation.** For the vast majority of patients undergoing diagnostic or therapeutic procedures, conscious sedation is ordered by the performing physician, physician assistant or physician trainee, and administered by a nurse. The performing physician manages

the sedation process, including the level of sedation, the medications used, and the personnel involved. Physicians involved in cardiac catheterization must therefore maintain current hospital credentials for conscious sedation and be licensed to prescribe controlled substances. A nurse, or provider with equivalent credentials, should be present during the administration of such medications to monitor for side effects, hemodynamic instability, and change in respiration and/or oxygenation. Misadministration or overadministration can lead to serious respiratory complications. A thorough knowledge of indications, contraindications, and appropriate dose ranges for patients of varying body sizes and ages is therefore required, as is familiarity with dosing and indications for various reversal agents. Drugs administered during the procedure must be recorded in a procedure log or electronic record and signed by the attending physician, either electronically or physically, where they can be easily accessed by other members of the health care team, particularly when the patient leaves the CCL.

**Infection control in the catheterization laboratory.** Infectious complications are rare in the current environment but when they do occur, they have the potential to be significant. Clipping over the access site is routine. A variety of antimicrobial agents are available, and chlorine-based preparations are most commonly used due to their demonstrated efficacy. Patient drapes that adhere to skin around the access site without loosening during the procedure are important. Although practices vary, the consensus of the writing committee is that physicians should perform surgical hand scrubs for the first case of the day and use self-drying solutions before subsequent cases. However, surgical scrubs for every case are reasonable. Similarly, although their efficacy remains unproven, it is reasonable for hats and masks to be worn for every procedure. Hats and masks should be worn for procedures involving insertion of devices, such as prosthetic valves and electrophysiology devices, and to close septal defects and patent foramen ovale. Antibiotic prophylaxis is not indicated for routine catheterization procedures, but is routinely used before implantation of the above devices [19].

**Environmental issues.** Each CCL should be treated as an active patient care area with the special recognition that ionizing radiation is being used [20,21]. All personnel in the room should wear personal protective equipment including lead aprons and thyroid shields. For team members closest to the radiation source, leaded glasses should be considered. Careful attention should be paid to minimizing radiation exposure in general and specifically to any particular entry site. Catheterization laboratories should track and record fluoroscopy times and/or total radiation dose per patient, and inform referring

**TABLE III. Sample “Time Out” Preprocedure Checklist**


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All members of the procedural team must be present for the “Time Out”

The Time Out must take place immediately before vascular access is obtained

The physician taking ultimate responsibility for the procedure should lead the Time Out and ensure each of the following items is announced:

1. Patient’s name and medical record number
2. Procedure to be performed (e.g., left heart catheterization, coronary angiography, right heart catheterization)
3. Route to be used (e.g., right femoral artery)
4. Confirm that the equipment needed is available or alternatives are available including intended stent type for PCI or cath-possible patients
5. Patient’s allergies and premedication if appropriate (e.g., heparin-induced thrombocytopenia, contrast allergy)
6. Special laboratory or medical conditions (e.g., elevated INR, chronic kidney disease)

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physicians when thresholds indicative of potential radiation damage are reached. When doses in excess of six grays are delivered, the patient should be educated about radiation skin burns and followed up in 1–2 months to assess radiation skin effects.

**Universal protocol and “time out” procedure.** All team members should be appropriately briefed as to the intended procedure and the sequence of that procedure. This is most easily performed within the confines of a dedicated “time out” protocol, performed before vascular access is obtained, when all members of the team are present. Patient identification should be checked and confirmed, and there should be unanimous agreement on the procedure to be performed. Because the goal of most procedures in the CCL is to access the heart and its associated vasculature, “wrong site” procedures are generally not a concern (access to the coronary arteries can be gained via radial, brachial, and femoral arteries) and therefore site marking is not indicated [22,23]. Table III provides a sample “time out” checklist. If team members rotate out of the room, then it is their responsibility to brief their replacement who should introduce themselves to the team and announce their role upon entering the procedure area. Universal infection precaution protocols are followed in each case rather than on a case-by-case basis. All solutions on the table must be labeled appropriately in real-time (not pre-labeled). This includes syringes specifically used for lidocaine and other agents (e.g., iodinated contrast). As such, preprinted labels of common medications should be incorporated into drape kits, and sheets of blank labels and felt-tip markers must also be available as part of the sterile field. Finally, appropriate documentation of physician verbal orders needs to be carried out by the recording technician or nurse and these orders confirmed by the performing physician at the close of the case with a signature.

### Postprocedure Best Practices

**Physician to patient communication.** The attending physician should discuss the results of the procedure,

as well as any complications, unexpected findings and events directly with the patient and family. In addition, the management plans for the patient and any further instructions for the patient and family should be discussed, including the need for and duration of dual antiplatelet therapy in those who receive a stent. When possible, this conversation should be in a discreet, private setting to protect patient confidentiality. For cases in which the patient remains sedated or has been treated with amnestic agents, the physician should delay discussion of findings until the patient is alert. In the interim, the results may be communicated to available family members, if prior authorization has been obtained from the patient. The patient and family should have the opportunity to ask questions.

**Access site management.** Manual compression, compression devices and vascular closure devices are used in cases of femoral access. For patients who have received heparin, sheath removal and manual compression can occur when the ACT falls below 175 sec. Checking an ACT is unnecessary when using bivalirudin for PCI, unless the patient has a creatinine clearance  $<30 \text{ cm}^3 \text{ min}^{-1}$ . ACT is generally not clinically useful with low molecular weight heparins. For bivalirudin, sheath removal and manual compression can occur at 2-hr postcessation of infusion in patients with normal renal function. In patients with a creatinine clearance  $<30 \text{ cm}^3 \text{ min}^{-1}$  or those on dialysis, ACT should be checked and sheaths may be removed once the value is  $<180 \text{ sec}$ . Sheaths can be safely removed eight to 12 hr after the last dose of low molecular weight heparin. Following manual compression, ambulation is restricted for 4–8 hr following the procedure, depending on sheath size [24]. If vascular closure devices are utilized, ambulation is restricted for 1–4 hr postprocedure [25,26]. Assessment of adequacy of groin site hemostasis and peripheral pulses is necessary prior to ambulation.

Hemostasis by manual compression for the radial artery access site is usually obtained with wristband compression devices. Sheaths are removed immediately after the procedure regardless of the anticoagulation status. There are no restrictions regarding ambulation

with radial artery access, however it is the opinion of the writing committee that most patients should keep the arm immobile for 2–4 hr after sheath removal.

#### **Appropriate monitoring and length of stay.**

Patients should be monitored on telemetry in a recovery or other unit specializing in the care of patients receiving cardiac procedures. Patients should have vital signs checked every 15 min for the first 2-hr postprocedure by nursing personnel trained in recovery from moderate/conscious sedation, as well as access site assessment. Telemetry is continued throughout the patient's hospital stay, unless specified otherwise by the attending physician. Length of stay for diagnostic catheterization ranges from 2 to 6 hr depending on access site used and the nursing assessment of patient ambulation and well-being. The length of stay for PCI is dependent on access site complications, patient comorbidities and need for further procedures, therapy or testing [27].

#### **Discharge instructions and patient information.**

At the time of discharge, physicians and/or their designees (e.g., nurse, physician trainee or physician assistant) who are taking care of the patient must review the procedure and the discharge instructions. Limitation of physical activity (which may depend on patient age), general physical status, comorbidities and procedure performed are determined at this time, along with instructions for the follow-up appointment with the physician and the need for further laboratory and other assessments (e.g., CBC, creatinine, outpatient testing). In particular, patients at increased risk for contrast nephropathy should have creatinine checked within 5–7 days of discharge. Contact information containing the physician's name and office number, and the phone number of the post-PCI unit, is helpful for patient assistance once discharged. If a patient received a stent, a card with the device information should be provided.

**Medication reconciliation.** Medication reconciliation is performed on multiple levels. Because medications are often changed upon hospitalization, comparison of home medication, and hospital medications is essential. Elements of medication reconciliation include clear statements regarding medications to continue, medications that have been stopped, those that have been added and medications for which a dosage change has been made. Medication reconciliation may be performed by the discharging medical assistant, nurse, attending physician, or trainee. Hospital pharmacists are sometimes involved in medication clarification. Medication reconciliation must be clearly documented on the discharge instructions, which are sent immediately to the primary referring physician. Dual antiplatelet therapy following PCI is generally recommended

for at least 1 year after drug-eluting stents, and 1–12 months after bare metal stents, depending on whether the patient presented with an acute coronary syndrome. Metformin is recommended to be held for 48 hr following contrast injection in those with baseline creatinine  $>1.5 \text{ mg dl}^{-1}$  and those who have received  $>100 \text{ ml}$  of contrast medium [28]. Other diabetic medications are restarted as soon as normal dietary habits resume. Patients previously on warfarin should restart their standard regimen, and arrange for follow-up PT/INR within 1 week of discharge. The role of LMWH as a bridge to therapeutic warfarin remains unclear, and is not routinely recommended (due to the potential for bleeding) except in cases of mechanical prosthetic valves and other causes for extreme risk of thrombosis.

**Appropriate attending to referring physician handoff.** Although an invasive cardiologist performs the procedure, noninvasive cardiologists, internists/hospitalists, and nursing personnel can subsequently assume patient care. These handoffs require appropriate documentation by the invasive cardiologist, including procedure performed, complications, and postprocedural plan for the patient. This is usually provided verbally to the nurse assuming care in the postprocedural unit, but takes the form of a formal procedure note as well as, ideally, verbal communication to the referring physician. Automated electronic systems that send the procedure note to all referring physicians are encouraged.

**Appropriate follow-up evaluation.** The interventional cardiologist, primary care physician, or an appropriate physician extender should see the patient in follow-up at 2–4 weeks following hospital discharge. This visit is to ensure medication compliance, medication reconciliation, lifestyle modification including enrollment in cardiac rehabilitation and to reinforce the plan for long-term follow-up based on procedural results [29]. In addition, an evaluation must be performed of the access site to confirm stability and adequate healing. For patients with baseline renal insufficiency, anemia or other procedural complications, the follow-up visit is usually shortened to 1 week (or sooner), during which a CBC and/or basic chemistry panel should be obtained. For patients with significant cardiac pathology, yearly outpatient appointments are recommended to review symptoms, order appropriate testing, make appropriate changes in medication and reinforce proper lifestyle habits.

**Peer review, quality assurance, and morbidity/mortality conferences.** A detailed discussion of appropriate peer review, quality assurance, and morbidity and mortality conferences is beyond the scope of this document and can be found elsewhere [30,31]. Each cardiac catheterization laboratory should have a method in place for selected and random peer review of procedures. This must be nonbiased and education-based.

This is one element of appropriate quality assurance, which also encompasses best practice standards before and during the procedure. In addition, each program must have a periodic organized review in place for all cases with mortality or significant morbidity (e.g., stroke and emergent surgery). Significant participation (i.e. >75% attendance) should be mandated to all proceduralists and open to any interested cardiologists.

## CONCLUSIONS

From the patient's standpoint, several "best practices" as described herein are required to assure consistent high quality, patient safety, and both patient and referring physician satisfaction as it relates to cardiac catheterization and PCI. Health care systems should provide resources through adequate staffing, which are inclusive of physician extenders where appropriate, to assure the performance of these practices and their ongoing review.

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Published on behalf of The Society for Cardiovascular Angiography and Interventions (SCAI).

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