benzodiazepine antagonist, can be given 0.2 mg IV every 2–5 minutes to a maximum of 1 mg. All drugs must be recorded in a procedure log or electronic record and signed by the attending physician, and such records should be easily accessible, particularly when the patient leaves the CCL.

Infection Control in the Catheterization Laboratory

Infectious complications resulting from cardiac catheterization are exceedingly rare; however, best practices for sterile technique are essential. Electric clippers should be used to prepare the femoral access site. A variety of antimicrobial agents are available, and chlorhexidine-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. Physicians may use Chlorhexidine/ethyl alcohol solutions, such as 3M Avagard, an FDA-approved surgical hand antiseptic, which can be used for the first scrub of the day and all subsequent scrubs. However, a traditional surgical scrub with water and soap is an alternative. Although their efficacy remains unproven, it is reasonable but not mandatory for hats and masks to be worn for every procedure. Antibiotic prophylaxis is not indicated for routine coronary procedures, but is often used before permanent implantations other than coronary stents and, at some institutions, before vascular closure device (VCD) placement in high-risk subsets, such as diabetics or immunocompromised persons (38).

Radiation Exposure

All CCL procedures should be performed with the goal of keeping radiation doses as low as reasonably achievable (ALARA) [39,40]. All personnel in the room should wear personal protective equipment, including lead aprons and thyroid shields as well as radiation badges. For team members closest to the radiation source, leaded glasses should be used. Radiation exposure to the staff should be carefully monitored and posted in a central area. Reducing imaging frame rates (15 fps or 7.5 fps), using "fluoro store" when possible, masking, and keeping the flat panel detector close to the patient are recognized methods, among others, of reducing radiation exposure. Using multiple angles for imaging reduces the radiation exposure to any one site on the patient's body, and keeping the radiation source farther away from the operator can minimize physician exposure. A complete description of strategies to reduce radiation exposure to patients and operators is beyond the scope of this article [39].

CCLs should record total radiation doses in Grays (Gy) in real time, and inform the operator and referring physician when thresholds indicative of potential radiation damage are reached [39]. For exposures greater than 5 Gy, patients should be educated regarding potential skin changes (e.g., erythema). For >10 Gy exposure, a qualified medical physicist should promptly calculate peak skin dose with skin examined at 2–4 weeks. TJC considers exposures over 15 Gy a sentinel event for which hospital risk management and regulatory agencies should be contacted within 24 hr. Suspected tissue injury should be referred to a specialist, with a biopsy performed if required.

Angiographic Contrast Administration

Nonionic, low-osmolar contrast (e.g., iohexol, iopamidol, ioversol) should be utilized for the majority of cases. While iso-osmolar contrast agents (e.g., iodixanol) could be considered for patients with chronic kidney disease, recent data suggest this approach may have no benefit. Total contrast administered to the patient must be monitored in real time and limited as clinically possible. A maximum contrast volume of 3.7 x eGFR can be used as an upper limit of acceptable contrast dose during a single procedure to help limit the risk of CIN [32]. CCL staff should inform physicians when these limits have been reached.

Universal Protocol and "Time out" Procedure

All team members should understand the intended procedure and the sequence of that procedure. This should be performed during a dedicated "Time Out" protocol, performed before vascular access or moderate sedation is initiated, when all members of the team are present. Patient identification should be confirmed with unanimous agreement on the procedure to be performed. Since the goal 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 [41,42]. Table II provides a sample "Time Out" checklist. If team members rotate out, then it is their responsibility to brief their replacement, who must introduce themselves to the team and announce their role, whereupon a repeat "Time Out" should be completed.

Universal infection precaution protocols for the staff should be followed in each case rather than on a case-by-case basis. All solutions on the table must be labeled in real-time (not prelabeled), including syringes specifically used for lidocaine and other agents (e.g., iodinated contrast). Preprinted labels of common medications should be incorporated into drape kits, and sheets of