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Core Curriculum

Infection Control Guidelines for the Cardiac Catheterization Laboratory: Society Guidelines Revisited

Writing Committee Members: Charles E. Chambers,*† MD, FSCAI, Michael D. Eisenhauer,† MD, FSCAI, Lynn B. McNicol, BSN, MPH, Peter C. Block,† MD, FSCAI, William J. Phillips, MD, FSCAI, Gregory J. Dehmer, MD, FSCAI, Frederick A. Heupler,† MD, James C. Blankenship,† MD, FSCAI, and the Members of the Catheterization Lab Performance Standards Committee for the Society for Cardiovascular Angiography and Interventions

In the early years of diagnostic cardiac catheterization, strict sterile precautions were required for cutdown procedures. Thirteen years ago, when the original guidelines were written, the brachial arteriotomy was still frequently utilized, femoral closure devices were uncommon, "implantables," such as intracoronary stents and PFO/ASD closure devices, were in their infancy, and percutaneous valve replacement was not a consideration. In 2005, the cardiac catheterization laboratory is a complex interventional suite with percutaneous access routine and device implantation standard. Despite frequent device implantation, strict sterile precautions are often not observed. Reasons for this include a decline in brachial artery cutdown, limited postprocedure follow-up with few reported infections, limited use of hats and masks in televised cases, and lack of current guidelines. Proper sterile technique has the potential to decrease the patient infection rate. Hand washing remains the most important procedure for preventing infections. Caps, masks, gowns, and gloves help to protect the patient by maintaining a sterile field. Protection of personnel may be accomplished by proper gowning, gloving, and eye wear, disposal of contaminated equipment, and prevention and care of puncture wounds and lacerations. With the potential for acquired disease from blood-borne pathogens, the need for protective measures is as essential in the cardiac catheterization laboratory as is the standard Universal Precautions, which are applied throughout the hospital. All personnel should strongly consider vaccination for hepatitis B. Maintenance of the cardiac catheterization laboratory environment includes appropriate cleaning, limitation of traffic, and adequate ventilation. In an SCAI survey, members recommended an update on guidelines for infection control in the cardiac catheterization laboratory. The following revision of the original 1992 guidelines is written specifically to address the increased utilization of the catheterization laboratory as an interventional suite with device implantation. In this update, infection protection is divided into sections on the patient, the laboratory personnel, and the

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*Correspondence to: Dr. Charles E. Chambers, Hershey Medical Center, 500 University Drive H047, Division of Cardiology Hershey, PA 17033. E-mail: cchambers@psu.edu

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laboratory environment. Additionally, specific CDC recommendation sections highlight recommendations from other published guidelines.

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INTRODUCTION

In the evolving environment of the cardiac catheterization laboratory, the sterile techniques of the 1970s, typical of those in an operating suite, became less prevalent in the 1990s. Rigorous postprocedure follow-up to track infectious complications is now uncommon and only catastrophic events are noted. Brachial artery cutdown is rarely performed, disposable one-time use equipment is standard, and major symposia often broadcast physicians as moderators on camera rather than surgeons operating in a sterile field. However, as advances in technology are made, there are reasons to believe more rigorous sterile techniques are necessary. Implantable devices such as percutaneous heart valves, septal closure devices, femoral access closure devices, and vascular stent grafts are making it difficult to distinguish a cardiac catheterization suite and a surgical suite. With these advances, a reevaluation of infection control guidelines in the cardiac catheterization laboratory is appropriate.

The Laboratory Performance Standards Committee of the Society for Cardiovascular Angiography and Interventions (SCAI) published the first guidelines for infection control in the cardiac catheterization laboratory in 1992 [1]. To reassess the need for updated guidelines, SCAI conducted a survey of its membership regarding infection control issues in the cardiac catheterization laboratory. Approximately 20% of the membership responded, with the majority being directors of catheterization laboratories (Table I). Significant infections requiring extended admission, readmission, surgical procedure, or death were reported by 36% of the respondents. Only 60% had written infection control policies in place, and nearly 80% of responders requested publication of revised infection control guidelines for the cardiac catheterization laboratory infection control.

When the last guidelines were published, there were limited data describing the frequency, prevention, and outcome of nosocomial infections in the cardiac catheterization laboratory. The reported incidence of all catheter-related infections was $< 1\%$, but this assessment was based only on retrospective studies [2]. A major problem with tracking the incidence of such events is the 5- to 10-day delay between the procedure and the development of common signs or symptoms of infection. Therefore, such retrospective studies may, and likely do, underestimate the incidence of infectious complications.

Since the publication of the last guidelines, several studies have addressed the occurrence of infection in the cardiac catheterization laboratory. In a series of over 22,000 patients undergoing invasive, nonsurgical, coronary procedures from 1991 to 1998, bacterial infections occurred in 0.11% at a median of 1.7 days after the procedure [3]. In over 4,000 patients undergoing coronary intervention, bacterial infections occurred in 0.64% and septic complications occurred in 0.24% [4]. Ramsdale et al. [5] obtained blood cultures in 147 consecutive patients undergoing complex PCI. Positive blood cultures were found in 18% immediately after the procedure and in 12% at 12 hr after the procedure, but no clinical sequela was seen. Case reports have described both intracoronary stent and vascular closure device infection, with both significant morbidity and mortality reported [6,7].

Despite these reports, recommendations for specific sterile techniques in the cardiac catheterization laboratory are still hampered by the lack of supporting prospective trials. With the potential for acquired diseases such as HIV and hepatitis, the use of protective measures by all cardiac catheterization laboratory personnel is required by the standard Universal Precautions applied throughout the hospital [8]. Additionally, standard precautions applicable for infection prevention in surgical wounds may logically be applied to wounds produced in the cardiac catheterization laboratory. Among the types of procedures currently performed in the cardiac catheterization laboratory, most can be classified somewhere between the initial insertion of a central line and an actual surgical incision with primary closure.

The limited published literature as well as the other credible sources utilized in revising these recommendations will be referenced when appropriate. Specifically, several articles deserve notation for their specific value. In 2003, the AHA published a scientific statement regarding nonvalvular cardiovascular device-related infection [2]. In 2002, the Centers for Disease Control (CDC) published guidelines for prevention of intravascular catheter-related infections, which are now considered the best clinical practice guidelines [9]. Other recent guidelines, including those on the prevention of surgical site infection [10], hand hygiene in healthcare settings [11], and environmental infection control in healthcare facilities [12], contain recommendations relevant to the cardiac catheterization laboratory.

Throughout this document, applicable statements from these guidelines are listed separately under the heading ''CDC recommendations.''

Though not differentiated here, the CDC recommendations in their publications are classified as either ''strongly recommended for implementation or strongly supported

TABLE I. SCAI Member Survey: Infection Control in the Cardiac Catheterization Laboratory

Members Responded (337/1768)	Number of Responses	Response Rate
1. IN WHAT COUNTRY DO YOU PRACTICE MEDICINE?		
United States	259	76.85%
2. For the catheterization laboratory, are you in a position to establish policy (e.g., director or other policymaker role)?		
Yes	240	71%
No	98	29%
3. Is there a standard written practice regarding infection control in your lab?		
Yes	201	59%
No	88	26%
DK	54	16%
4. During all invasive procedures in the lab, do you routinely wear:		
a cap or head covering?	269	80%
a facemask?	276	82%
eye protection?	274	81%
5. Are your lab table setups required to be completed by staff wearing cap, mask, gown, and gloves and practicing sterile techniques?		
Yes	250	74%
No	84	25%
DK	5	1%
6. Is air exchange rate in your cath lab satisfactory?		
Yes	207	61%
No	34	10%
DK	98	29%
7. Have you seen or heard of any serious documented infectious complications following a procedure in your lab, i.e. requiring extended admission, readmission, surgical procedure, or death?		
Yes	114	34%
No	224	66%
8. In the current era of implantable devices, do you think strict (O.R. style) sterile technique is an important issue in the catheterization/ interventional lab?		
Yes	226	67%
No	45	13%
Maybe	67	20%
9. Do you think that SCAI and ACC should have a specific policy regarding infection control that is communicated via educational conferences or videotaped procedures?		
Yes	265	79%
No	19	6%
Maybe	53	16%

by well-designed experimental, clinical, or epidemiologic studies'' or ''strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies, and a strong theoretical rationale.'' Further information regarding the CDC guidelines can be found at http://www. cdc.gov/ncidod/hip.

These SCAI guidelines are presented as recommendations to assist cardiac catheterization laboratory directors and managers in establishing laboratory policy. The society recognizes the importance of local expertise from individual laboratory supervisory personnel in establishing specific policies for any individual cardiac catheterization laboratory.

SECTION I: PATIENT PREPARATION AND PROTECTION

A. Hair Removal

Consideration should be made to avoid hair removal unless it directly interferes with the procedure. If it is necessary to remove hair at the access site, use a clipper or depilatory on the day of the procedure, and not before. Shaving with a razor should be avoided because it can injure the skin and increase the risk of infection [13,14]. Literature in this area is limited to hair removal before surgical procedures. Lazenby et al. [15] reviewed 1,980 consecutive adults undergoing open heart surgery and found an increased incidence of suppurative mediastinitis manually shaving compared to electric shaving.

Clipping the day before the procedure should be avoided, because it can be associated with dermal abrasions that could be a nidus for local infection [16]. Depilatories sometimes will produce hypersensitivity reactions, so the cardiac catheterization laboratory staff should be observant for these types of complications.

CDC recommendations. Do not remove hair preoperatively unless the hair at or around the incision site will interfere with the operation [10].

If hair is removed at an access site immediately before a procedure, it is preferable to use electric clippers or a depilatory cream [10].

B. Skin Cleaning

The skin at the cutdown or puncture site should be thoroughly cleaned. Immediately before the procedure, a broad-spectrum antimicrobial agent should be generously applied, in accordance with manufacturer's recommendations [17].

CDC recommendations. A 2% chlorhexidine-based preparation (e.g., Chloraprep) for skin antisepsis is preferred during central line insertion, but tincture of iodine (an iodophor) or 70% alcohol may be substituted [9].

Allow the antiseptic to remain on the insertion site (do not swab excess) and air-dry before catheter insertion when possible. Povidine iodine is most effective when allowed to remain on the skin for at least 2 min or longer if it is not yet dry [9].

For patient skin preparation in the operating room, iodophors, alcohol-containing products, and chlorhexidine gluconate (CHG) are most commonly used. CHG achieved both a greater reduction in skin microflora and had a greater residual activity after a single application when compared with providine-iodine. Further, CHG is not inactivated by blood or serum protein, whereas iodophors may be [10]. CHG is bacteriostatic and effective as long as it is present on the skin.

C. Drapes

Nonporous drapes should be used to cover the area surrounding the wound [14]. Maximum sterile barrier precautions should be utilized during catheter insertion. The sterile sheet should be large enough to cover the entire patient and any other hardware attached to the table that could come in contact with long catheter or wires. Any adhesive material attached to the skin around the wound and to the drapes should isolate the wound site from the surrounding unprepared skin.

CDC recommendations. Use surgical drapes that remain effective barriers when wet (i.e., materials that resist liquid penetration) [10].

Use aseptic technique, including the use of a cap, mask, sterile gown, sterile gloves, and a large sterile sheet, for the insertion of central venous catheters (including peripherally inserted central catheter (PICCs)) or guidewire exchange [9].

D. Antibiotics

Antimicrobial drug prophylaxis is not routinely recommended for procedures performed in the cardiac catheterization laboratory. In fact, prophylaxis is generally not indicated for ''clean'' surgery unless it involves implantation of certain prosthetic material [18]. Antibiotic prophylaxis should be considered for the immunocompromised patients and for any patient with probable or definite wound contamination during the procedure [19].

If an antibiotic is used prophylactically, the activity should be against common skin organisms. A cephalosporin with a moderately long serum half-life, such as cefazolin, is a common drug of choice before the catheterization procedure [18]. A single dose of parenteral antimicrobial given within 30 min of device insertion usually provides adequate tissue concentration for several hours. This is common practice for device insertions, such as in patent foramen ovale closures.

A patient with an active bacterial infection at a site remote from a surgical wound has a greater risk of wound infection than an uninfected patient. This risk may be reduced by treating the remote infection before an invasive procedure is performed [14]. While this applies to bacterial infections, the approach for local fungal infections is less well defined. In these instances, avoidance of the infected site when possible or aggressive local skin cleaning is standard practice.

CDC recommendations. Antibiotic prophylaxis is not routinely indicated for a sterile procedure, such as cardiac catheterization. In the rare circumstance when it is indicated, selection of the antibiotic agent should be based on its efficacy against most common skin pathogens [10].

In most instances, when a prophylactic antibiotic is used, it should be given 30–60 min before the procedure [10].

Whenever possible, identify and treat all infections remote to the surgical site before an elective operation; postpone elective procedures until the infection has resolved [10]. If a fluroquinolone or vancomycin is chosen, it should be given 120 minutes before the procedure [10a].

E. Catheterization Technique

Prolonged procedures and lapses in aseptic technique are important causes of wound infections [14]. Care should be taken to prevent large hematomas, which serve as a nidus for infection [14]. Although no data exist on the performance of cardiac catheterizations or coronary interventions in a febrile patient, those with ongoing infections should be appropriately treated before an elective cardiac catheterization. Fever is a relative contraindication for an elective cardiac catheterization. The risks versus benefits of performing urgent invasive procedures on a febrile patient must be weighed individually.

The choice of the access site is an issue if a second percutaneous procedure is performed shortly after the first. Local infection at the puncture site is more likely to occur after early repuncture of the ipsilateral femoral artery [20]. If a PCI procedure is performed after a 6-hr delay following a diagnostic catheterization, the operator should consider contralateral access for the PCI.

With advances in femoral and radial percutaneous access, brachial artery cutdown is now an infrequent method for artery access in patients undergoing cardiac catheterization. One study demonstrated a 10-fold increase in infectious complication with this approach [2]. If used, infection control precautions for cutdown procedures should be more rigorous than percutaneous procedures and should be similar to those used for any minor surgical procedure.

F. Sheath Removal and Vascular Closure Devices

Vascular access sheaths are routinely removed following diagnostic procedures but not infrequently left in place following femoral interventional procedures. When this is necessary, a standard wound-dressing protocol should be followed, similar to that for other indwelling vascular catheters. For in-dwelling venous catheters, the duration of the catheter placement is the most important predictor for an infection [21]. Therefore, it is prudent to remove any in-dwelling sheath or catheter as early as clinically appropriate. When clinically indicated, a catheter and rarely even a sheath may be maintained for a period of days following the

procedure. In this circumstance, appropriate wound dressings and daily wound inspections are critical.

Multiple vascular closure devices (VCDs) are available for establishing hemostasis following femoral artery access. While these devices are designed to eliminate the need for manual compression and allow for earlier ambulation postprocedure, they have not been shown to decrease vascular complications [2,6 7,22]. Vascular closure devices are used in many diagnostic catheterization laboratories and in approximately 40% of patients undergoing PCI in the National Cardiovascular Data Registry (NCDR) data registry. Occasionally, the complication with VCD is more severe than with manual compression [23]. One of the most significant of these is infection of the suture or collagen anchor leading to arteritis [24]. These complications occur in 0.5% of VCD procedures and can be limb- and life-threatening [2].

Special precautions may be warranted in patients receiving a VCD. Antibiotic coverage for common skin flora is recommended for the diabetic patient undergoing VCD placement [2].

These devices should be avoided when arterial puncture is into a preexisting synthetic vascular graft, if local or systemic infection is a possibility, or if the sheath has been in-dwelling for an extended period of time [7]. Following prolonged procedures, consideration should be given to site recleaning as well as new sterile gloves for the operator before VCD placement. The presence of a hematoma before placement of a VCD may increase the incidence of infection [22]. When sutures are involved, these should be cut so the ends retract well below the skin and a topical triple antibiotic cream applied to the puncture site. The patient should be instructed to avoid tub baths until the skin puncture site is healed and to report early any groin complications or signs of infection. A pseudoaneurysm following a closure device should be considered a possible early sign of infection and thus treatment by local injection of prothrombotic agents used with caution [22].

G. Wound Dressings

Although more applicable for prolonged use, occlusive nonpermeable plastic dressings should be avoided because they increase the infection risk two- to fourfold compared with traditional gauze dressings [25].

CDC recommendations. Use either a sterile gauze or sterile and transparent semipermeable dressing to cover the catheter site. Do not use nonpermeable (plastic) dressings [9].

If the patient is diaphoretic, or if the site is bleeding or oozing, a gauze dressing is preferable to a transparent semipermeable dressing [9].

Topical antibiotic ointments or creams promote fungal infections and antibiotic resistance. They should therefore be avoided except with dialysis catheters [9].

SECTION II: LABORATORY PERSONNEL—THE PRIMARY OPERATOR AND STAFF

A. Hand Scrub and Gloves

Hand washing is the single most important procedure for preventing nosocomial infections [11]. An operator should start the day in the laboratory with a hand scrub of at least 2 or 3 min, utilizing a sterile surgical scrub brush impregnated with detergents and a topical antiseptic agent that has a persistent chemical effect. For subsequent cases, it is best to avoid repeated scrubbing, which may irritate the skin and increase the likelihood of dermal abrasions. It is preferable to use an antiseptic solution or foam before subsequent procedures. All rings and bracelets should be removed before scrubbing. Ideally, fingernails should not extend past the fingertips and should be kept free of fingernail polish and artificial coverings.

Two types of agents are commonly used for hand washing: detergents (plain soap) and antiseptics. The primary action of plain soap and water is to remove viable noncolonizing organisms physically from the skin surface [26]. Antiseptic agents have additional important properties. No definitive clinical trial has yet conclusively demonstrated the effects of hand washing with an antiseptic agent on nosocomial infection rates.

The use of antiseptic hand scrubs is nearly universal in the operating room environment [10,11]. All agents have a bactericidal effect, killing and/or inhibiting growth of both ''normal flora'' of the skin as well as more virulent bacteria. Some antiseptics bind to the skin, resulting in persistent chemical activity that inhibits proliferation of organisms within the moist environment of rubber or plastic gloves [26]. Brushless, waterless scrubs containing alcohol are often preferred because of less hand irritation, increased efficacy, and immediate bactericidal activity.

Gloves should be applied in a sterile manner. They should be changed if a puncture occurs or blood is detected under the gloves during the procedure. As noted previously, surgical hand antisepsis using either an antimicrobial soap or an alcohol-based hand rub, with persistent activity, is recommended before donning sterile gloves.

Damage to physician gloves was evaluated in one study during cardiac catheterization [27]. No punctures were detected in 25 pairs of unused control gloves, but 19% of 200 gloves worn during procedures had small punctures. The thumb and index finger were the sites of 81% of the punctures; this was attributed to glove

trauma from manipulation of stopcocks. Therefore, consideration should be given to the use of double gloves when an operator has hand abrasions.

CDC recommendations. Observe proper hand hygiene procedures either by washing hands with conventional antiseptic-containing soap or with waterless alcohol gels or foams. Observe hand hygiene before and after palpating catheter insertion sites, as well as before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter [9].

When performing surgical hand antisepsis using an antimicrobial soap, scrub hands and forearms for the length of time recommended by the manufacturer, usually [2–5] min. Long scrub times (e.g., 10 min) are not necessary [10,11].

Scrub hands with brushes only once per day; subsequent procedures require only repeated antiseptic foam/gel hand washing [11].

When using an alcohol-based surgical hand scrub product with persistent activity, follow the manufacturer's instructions. Before applying the alcohol solution, prewash hands and forearms with a nonantimicrobial soap and dry completely. After application of the alcohol-based product as recommended, allow hands to dry thoroughly, approximately 15 to 25 seconds, before donning sterile gloves [11].

Remove debris from underneath fingernails using a nail cleaner under running water before scrubbing the hands with either a brush or antiseptic gel or foam [11].

B. Gowns and Shoe Covers

The operator should wear a nonporous gown to prevent the contamination that occurs when porous cloth gowns become wet with blood or other fluids. The operator should wear a scrub suit or other clean hospital uniforms, and not street clothes, in the cardiac catheterization laboratory. There are no scientific data to support the role of shoe covers in preventing surgical wound infections. However, they may provide protection to laboratory personnel and are commonly used to prevent tracking contaminated fluids throughout the facility by soiled footwear.

CDC recommendations. No recommendations exist on how or where to launder scrub suits, restricting the use of scrub suits to the operating suite, or for covering scrubs when out of the operating suite [10].

Change scrub suits that are visibly soiled, contaminated, and/or penetrated by blood or other potentially infectious materials [10].

Shoe covers are not required solely to prevent a surgical site infection, but are required by Occupational Safety and Health Administration (OSHA) if soiling of shoes is likely, in order to reduce contamination of other areas of the healthcare facility (i.e., room-to-room transmission) [8].

C. Caps, Masks, and Eye Protection

Although masks protect the operator's mucous membranes from contamination by a patient's body fluids, the effect of caps and masks on the incidence of infection in the cardiac catheterization laboratory is unclear. Caps and mask are standard attire in a surgical suite, but there are diverse opinions and only limited data regarding their benefit in the cardiac catheterization laboratory. A study by Laslett and Sabin [28] of 504 patients undergoing diagnostic cardiac catheterization or electrophysiology studies found no difference in infection rate, with or without caps and masks. Banai et al. [29] prospectively studied 960 patients undergoing cardiac catheterization using standard patient preparation and operator hand scrub, gloves, and gown but without a cap and mask. The four clinically significant bacteremic episodes documented after the procedure appeared to be related to intravenous lines rather than the cardiac procedure. However, given the small size of these studies and the low overall incidence of infection, these studies are likely underpowered to assess the potential association between procedure-related infections and operator use of caps and masks.

Because of the risk associated with exposure to blood-borne pathogens, the use of Universal Precautions, as applied throughout the hospital, are relevant to healthcare providers in the cardiac catheterization laboratory [8]. The operator is provided personal protection by following these precautions that include the wearing of a mask, eye protection, gloves, and nonporous gown. Therefore, it is recommended that all personnel exposed to bodily fluids in the cardiac catheterization laboratory use Universal Precautions.

Since the incidence of infections related to procedures in the cardiac catheterization laboratories is low, it is unlikely an adequately powered randomized study of caps and masks will ever be performed. However, the consequences from such infections are significant while the risk of using these precautions is nonexistent [2]. Therefore, it is the recommendation of these guidelines that the use by the operator(s) of a cap, mask, and eye protection be strongly considered, if not mandatory, for all procedures performed in the cardiac catheterization laboratory for the protection of the operator.

If an operator does not use a cap and mask routinely, they should at least be used for procedures in patients who are at increased risk for both an infection as well as for a serious complication, should one develop. Such patients include those with native valve disease or intracardiac prostheses, arterial access performed through a femoral arterial graft, prolonged catheter or procedure times, prolonged use of an in-dwelling sheath following the procedure, intra-aortic balloon pump insertion, per-

cutaneous valvular procedures, and the use of implantable devices such as stents, septal closure devices, and/or VCDs. It may not always be known at the start of the procedure if one of these higher-risk situations will occur. Accordingly, each facility should consider the best policy for their laboratory, with patient safety given the highest priority.

CDC recommendations. Use aseptic technique, including the use of a cap, mask, eye protection, sterile gown, and sterile gloves, for the insertion of catheters or for guidewire exchange. Maximum sterile barrier precaution is required during catheter insertion. The operator should ensure that assistants also use maximal barriers [9].

D. Ancillary Personnel

Technicians, nurses, and any other personnel in the catheterization laboratory should wear scrub suits, cap, mask, and gloves when they assist within the sterile field of the procedure. All should wear eye protection with proper splash protection [8]. Circulators should wear scrub suites and, as all should, observe Universal Precautions. Visitors in the laboratory should wear either a scrub suit or other appropriate available attire over their street clothes and should remain an acceptable distance from the table as to avoid potential contamination of either the patient or the equipment.

E. High-Risk Patients (for Staff Exposure)

As discussed earlier, the potential for acquired diseases from blood-borne pathogens exists for all invasive procedures. Since screening for blood-borne pathogens is not routinely performed before referral to the cardiac catheterization laboratory, it should be assumed that every patient has the potential to transmit an infectious agent. This reinforces the need to apply Universal Precautions, used throughout the hospital, in the cardiac catheterization laboratory [8]. However, some patients referred for cardiac catheterization laboratory will be known to carry HIV or the hepatitis virus. If Universal Precautions are followed, there is no reason such patients should be managed differently.

Since the hands of the operator are most likely to come in contact with blood, some operators choose to wear two pairs of gloves when it is known that a patient has a blood-borne infection. Little is known about the adequacy of available sterile gloves, but some operators claim that 2% of gloves leak even before they are used. More is known regarding the integrity of gloves during surgical procedures. In a study by Gerberding et al. [30], 17.5% of gloves developed a perforation during surgery. Wearing two pairs of gloves reduced the chances of a puncture ho1e in the inner glove by 60%. Though this practice has not been proven to prevent transmission of hepatitis or HIV, it seems prudent to use this technique when the operator is working with high-risk patients.

The active disposal of contaminated fluids into an open container, such as emptying a syringe or flushing a catheter, increases the risk of accidental spilling or splashing. This is prevented by discarding fluid through the manifold via an extra port that contains a one-way valve to a disposal bag. This constitutes a closed system within the manifold.

F. Skin Puncture or Laceration

Any person who suffers a puncture or laceration with a contaminated needle or blade in the catheterization laboratory should report this incident immediately to their supervisor. Each laboratory should have a protocol for the management of such events, which includes evaluation by a physician, baseline HIV, hepatitis B, and hepatitis C testing of both the patient and the person who received the puncture, along with follow-up HIV and hepatitis testing at regular intervals following the exposure. Tetanus vaccination should be updated if greater than 10 years since the last vaccination. The Centers for Disease Control has published guidelines for the management of occupational exposure to blood-borne pathogens [31]. An overview of these recommendations is provided in Table II.

G. Vaccination

Vaccination for hepatitis B virus should be strongly considered, if not mandatory, for all operators and other personnel who work in the cardiac catheterization laboratory [32].

SECTION III: LABORATORY ENVIRONMENT

A. Cleaning

The laboratory should be completely cleaned once a day and spot-cleaned between each case. The floor should be wet-mopped or wiped if gross spillage is evident. Trash should be removed between each case [10].

CDC recommendations. After the last catheterization procedure of the day or night, wet-vacuum or mop the cardiac laboratory room floors with a single mop and an EPA-registered hospital disinfectant [10].

No conclusive recommendations are available regarding the disinfecting of surfaces or equipment between cases in the absence of visible soiling [10].

B. Air Vents

The air vents should be cleaned at least monthly. The ventilation system should ideally provide at least 15 air exchanges per hour of which at least three should be fresh air [10,12].

TABLE II. Management of Occupational Exposure to HBV, HCV, and HIV

I. Definition: Direct contact with blood or body fluids including percutaneous injury, contact of mucous membranes, or skin contact, especially if abraded.
II. Procedure:
A) Clean site of exposure with soap and copious amounts of water; flush mucous membrane with large quantities of water.
B) Victim should report incident promptly, including patient/source information.
C) Provide wound care and review with victim tetanus and Hepatitis B prophylaxis information.
D) Counsel and obtain consent for HIV testing from both victim and patient/source.
E) Order the following laboratory specimen with appropriate consent obtained.
1) Victim
- Hepatitis C antibody
- Hepatitis B surface antibody
- HIV 1–2
2) Patient/Source
- ETPE Panel (Hepatitis B surface antigen and core antibody, Hepatitis C antibody, ALT, RPR, HTLV 1–2)
F) Review Hepatitis B vaccination and response status of victim and follow post exposure prophylaxis to Hepatitis B protocol.
G) If patient/source is Hepatitis C seropositive or has elevated ALT, follow-up should include:
1) Follow post exposure prophylaxis to Hepatitis B protocol.
2) Follow up for anti-HIV therapy per protocol.
3) Schedule Hepatitis C and HIV testing for 6 weeks, 3 months, 6 months.
H) Proper documentation and appropriate reference to CDC Guidelines recommended.*

*Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Post-exposure Prophylaxis. Center for Disease Control and Prevention; Morbidity and Mortality Weekly Report: June 29, 2001/Vol. 50/No. RR-11, 1-52. (Ref #23).

C. Maintenance of Environment

The doors to the catheterization laboratory should be kept closed, except as necessary for passage of equipment, personnel, and the patient [12]. After a catheterization procedure has started, the number of personnel allowed to leave or enter should be kept to a minimum.

D. Fixed and Disposable Laboratory Equipment

Single-use disposable catheters are the current standard for the majority of equipment utilized in the catheterization laboratory. Standard techniques should be employed to ensure proper sterilization of equipment that is reused. Reuse of equipment should be limited to only that currently permitted by federal regulations [33]. Equipment near the catheter entry site, which has the potential for blood contamination, such as foot switches, should be covered.

Suture material should be fine and monofilament, rather than thick or braided, and a minimal amount of sutures should be used [14]. Multidose vials should be avoided because of the potential for contamination. All containers of contrast material and flush solutions that are used for one procedure should be changed for the following patient, unless an approved device that is protected against backflow is used with an aim toward contrast conservation.

E. Disposal of Waste

Blood-contaminated drapes, gowns, gloves, and sponges should be discarded in special containers and labeled as healthcare waste. Needles and blades should be placed in puncture-proof containers [8].

CONCLUSIONS

In the current cardiac catheterization laboratory environment, procedure-related infections are uncommon and probably underreported. Although multiple guidelines are available for infection control in the healthcare setting, data directly applicable to the cardiac catheterization laboratory are limited. Since the SCAI first published infection control guidelines for the catheterization laboratory in 1992, significant changes, including a marked increase in device implantation, have occurred. The society's updated guidelines provide useful recommendations to assist cardiac catheterization personnel in updating or establishing infection control policies for their own institution.

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