CHAPTER 7

Roles and Responsibilities of the Cath Lab Team

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LEARNING OBJECTIVES

- Determine the primary team roles of the invasive cardiovascular laboratory (ICVL) team.
- Describe the tasks required to set up a cath lab for a patient's arrival.
- Understand how to prep a patient's access site.
- Appreciate the wide range of tasks that the members of a cath lab team must perform during an endovascular procedure.
- Understand how to care for a patient during a diagnostic or interventional procedure.

Overview

In this chapter, we will outline the general roles of non-physician staff involved in patient care during procedures in an invasive cardiovascular laboratory (ICVL). The ICVL is a fast-paced, continually evolving medical environment composed of a multi-disciplinary team with unique skill sets. The non-physician staffing mix varies between different institutions and areas of the world, but members of the team may include registered nurses, cardiovascular technologists/technicians, radiologic technologists, emergency medical technicians/paramedics, respiratory therapists, nurse practitioners, physician assistants, nurse anesthetists, and others.

Regardless of their clinical training, all ICVL support staff members should be certified in basic life support (BLS), advanced cardiac life support (ACLS), and pediatric advanced life support (PALS), if pediatric cardiac studies are performed. All members of the team (cardiologists, nurses, technologists, and advanced-level practitioners) must understand the roles of the other members of the team.

There are three broad roles undertaken by staff in every ICVL: scrub assistant, circulator, and monitor/recorder. Ideally, all team members should be fully cross-trained to perform the primary functions of each of these three roles. Professional licensure, local laws, and institutional guidelines may restrict the scope of practice or duties that various team members may carry out.

Each team member plays a vital role in the safety and well-being of the patient. Everyone should feel comfortable making suggestions, asking questions, and voicing concerns if they do not agree with, or understand, any aspect of a procedure.

All team members, including physicians, need to be active participants in preprocedure huddles, time-outs, and all phases of the procedure as suggested by the Joint Commission and other accrediting organizations. Ultimately, the responsibility of the procedural outcome lies with the attending physician.

Monitor/Recorder

The monitor documents all pertinent data from the procedure in the cath lab computer database (**Figure 7.1**). This should include, but is not limited to the following:

- Patient demographic information
- Date, time, and type of procedure
- Attending and referring physicians, fellows, recorder, and patient
- All hemodynamic data
- All medications administered (this information must also be documented on the appropriate medication sheets)
- Any changes in patient status
- All catheters and other equipment used
- Angiographic views
- Preliminary impression of the diagnostic procedure
- Complications
- IV infusion volume
- Contrast dose administered to the patient
- Fluoroscopy time/cumulative patient exposure (if available) for the procedure
- Disposition of the patient

Figure 7.1 ICVL team member working in the monitor role.

Courtesy of Jay Ryan Opalia.

All events that occur during a catheterization procedure are documented in the procedure log. The recorder, whether a nurse or technologist, is responsible for accurate, comprehensive documentation of the proceedings; handwritten logs must be legible. Any event that may directly affect the present or future care of the patient must be documented. Examples include bleeding or hematoma at the access site, changes in heart rhythm or rate, hemodynamic instability, and medication reactions. All interventions undertaken due to such events should also be documented in the progress section of the patient's medical record.

The relevant hemodynamic values, procedural vital signs, oxygen saturation and Fick measurements, findings and outcomes of all procedures are recorded on a preprinted progress form, structured report, or electronic medical record. This form will be completed by the attending physician or a designee.

The recorder may also be responsible for documenting all billable equipment and procedures. Many labs use an inventory control system, using a scanner with manufacturer barcodes. As the product is scanned, it is added to the patient's bill and simultaneously removed from the cath lab's inventory for easy tracking and reordering.

Close observation of the patient's condition during the procedure is the monitor's primary responsibility. There are key moments in the procedure when close attention must be paid to the patient's vital signs:

- During vascular access the patient may develop a vasovagal reaction due to the needle puncture and manipulation of the vessels. This will manifest as a profound bradycardia and associated hypotension. Atropine IV, elevation of the patient's legs, a rapid saline bolus, and oxygen should be implemented immediately.
- During insertion or exchange of any catheter or guidewire, vessel walls may be traumatized or an atherosclerotic plaque may be disrupted.
- During each contrast injection, it is important to observe the ECG and hemodynamics. Watch especially for bradycardia/dysrhythmias/blocks when contrast medium is injected into the right coronary artery (which feeds the sinoatrial and atrioventricular node branches).
- During high-volume bolus injections, such as for a left ventriculogram, the large volume of contrast medium can trigger arrhythmias.

A tool to help increase awareness of the patient's condition is the audible ECG signal. Generally, this can be set so it will only be heard within the control room because physicians can find the sound distracting. This allows the monitor to notice rate and rhythm changes,

even while typing into the procedure log or tracking the inventory for billing purposes. Although these audible signals are important, the patient is also continuously monitored and assessed by the scout in the lab.

Scrub Assistant

The scrub assistant directly aids the attending physician at the sterile trolley and the procedure table during the procedure (**Figure 7.2**). They must have a thorough understanding of proper sterile surgical technique and the procedures that are being carried out.

The scrub assistant dons a lead apron, surgical gown, and gloves in the same manner as the physician, following institutional guidelines. Following proper aseptic/sterile technique, the scrub assistant will do the following:

- Preps the patient's access site(s) with an antiseptic solution
- Drapes the patient appropriately for the planned procedure
- Sets up the contrast medium and saline delivery lines (manifold or automated system)
- Sets up and organizes the sterile instrumentation table
- Prepares the diagnostic catheters, guidewires, interventional devices, and other invasive equipment that may be used during the procedure according to manufacturer and hospital protocols
- Assists the physician with catheter and wire exchanges, and placement of interventional devices

Figure 7.2 A scrub assistant at work.

Courtesy of Jay Ryan Opalia.

Local laws, regulations, and policies may restrict or limit the scrub assistant's duties. Depending on the institution, the scrub assistant may be allowed to do the following:

- Give local anesthetic
- Obtain vascular access
- Manipulate the fluoroscopic gantry and "pan" the procedure table
- Select the most appropriate imaging program to define the patient's anatomy
- Initiate X-ray
- Obtain blood samples
- Initiate cardiac output or hemodynamic measurements
- Inject contrast medium (manually or with an automatic injector)
- Inject nitroglycerin, heparin, and other medications through the catheters and introducer sheaths

The scrub assistant should also be responsible for the following:

- Properly identify all medications on the table, preferably with a sterile label. When in doubt regarding the identification of a medication, dispose of it.
- Never force equipment into the patient. There should be little resistance, if any. If resistance is ever met, stop; evaluate the situation and assess the patient. Careful progress is paramount.
- Always preflush catheters and store them lengthwise on the table. The manufacturers have gone to considerable trouble and expense to package and deliver the catheter in a straight fashion. Coiling the catheter for an extended period will alter the shape of the shaft, making it more difficult to manipulate.
- Read manufacturer inserts and ensure that you are properly trained (by physician, preceptor, or company representative) with all products used in the cath lab.
- Never thread a needle over a guidewire because this may "shave" the outer layer off the guidewire.
- Always prep the manifold or power injector tubing with the lights on; this allows any trapped bubbles, particularly near the stopcocks and connections, to be more visible.
- While managing catheters within the patient's body, always hold syringes with the tip pointed down. Aspirate a small amount of blood immediately prior to flushing with saline or injecting contrast medium or medication. Lightly tap the

syringe so that any bubbles rise, reducing the chance of injecting air emboli.
- Flush catheters between each contrast medium injection. Flush indwelling arterial lines every 3 minutes unless the line is attached to a pressurized drip.
- Make sure each device is compatible with the size of the access sheath.
- Carefully inspect equipment for damage before handing it to the physician or inserting it into the patient. Quality control by the manufacturers may be excellent; however, one last check is important because the equipment may have been damaged during shipping or unpacking.
- Save or retrieve the original packaging if there is equipment failure or if the equipment is defective in some way. This will allow the manufacturer to track down the source of the problem. If the defective device causes any harm to the patient, the device and packaging should be saved for hospital risk management.
- Make sure that the wire is longer than the catheter. Use exchange-length (260 centimeters or greater) wires when the patient has peripheral vessel disease or torturous vessels.
- Sheaths, catheters, guidewires, and interventional devices may sometimes become damaged within the body, leaving fragments that may cause an infarction, stroke, or pulmonary embolism. Inspect equipment for damage after it has been removed from the patient's body.
- When inserting a Swan-Ganz catheter that will be left in the patient after the procedure, make sure that a sterile sleeve is in place over the exposed section of the catheter to allow for manipulation when the patient is in the unit.
- Be familiar with the procedure and anticipate the physician's and patient's needs.
- Always maintain aseptic technique.
- Pay attention to your instincts.

Circulator

The circulator assists the flow of the procedure from outside the sterile field, wearing a lead apron and additional personal protective equipment as stipulated by their institution (**Figure 7.3**). They are responsible for the direct assessment of the patient, the administration of procedural sedation and other medications, and the opening of sterile equipment for the scrub staff as required.

The circulator is responsible for preparing the procedure room before the arrival of the patient. Once the patient arrives, the circulator does the following:

Figure 7.3 A circulator opening a sterile packet for the scrub assistant.

Courtesy of Jay Ryan Opalia.

- Assists other team members to transfer the patient to the procedure table
- Attaches the ECG electrodes
- Attaches a noninvasive blood pressure measurement cuff
- Inserts a peripheral IV line, if the patient has not yet been cannulated

Interprocedurally, the circulator's responsibilities include the following:

- Assists the scrub team by retrieving, opening, and handing off additional sterile supplies as needed.
- Receives blood samples for point of care tests (activated clotting times, whole blood oximetry, etc.)
- Receives fluid and tissue samples that must be properly labeled, identified, and sent to the appropriate hospital laboratory.
- Handles all nonsterile equipment such as power contrast medium injectors, intravascular and intracardiac imaging consoles, 3D mapping systems, interventional device consoles, cardiac pacing systems, cardioversion and defibrillation, and cardiac assist devices.
- Verifies any devices requested by showing them to the operator before opening.
- Administers medication as required.
- Maintains direct observation of the patient. When procedural/conscious/moderate sedation is administered, some institutions require an independent sedation nurse, whose only responsible is to administer medication and document the patient's response.
- Talks to the patient periodically, offering reassurance and answering questions when appropriate.
- Asks the patient about any discomfort or pain. If the patient is in pain, the circulator should ask the

patient to rank it on a scale of 0 to 10 (0 being no pain, 10 being intense pain).
- Continually monitors the patient's oxygen saturation via pulse oximetry and/or capnography so that appropriate oxygen therapy can be administered as needed.

Team

In some ICVLs, each job (scrub, circulator, monitor) is quite distinct and is carried out by specific team members. In other labs, the roles overlap, and staff carry out tasks from several roles. It has been shown that the best patient care is given when staff members cross-train; they are trained and competent to work comfortably in each job area in the lab. In addition to better patient care, when staff have cross-trained within the limits of their specific licensure or registry, they can fill in wherever they are needed in a busy cath lab. Cumulative or overuse injuries caused by repeatedly using the same group of muscles for the same job are diminished when the roles are rotated during the day. For example, if scrub staff switch positions with the monitoring staff during the day, both parties benefit. Getting away from the computer allows monitors to rest their tired eyes; scrub assistants can use different muscles and relax from standing in the same position in a lead apron for hours.

Procedure Preparation

Equipment must be prepared before the first procedure of the day can begin. This varies between labs, but in general, the first steps of the day in an ICVL are as follows:

Imaging and recording systems are switched on and warmed up. Supporting computer systems have to be logged on. If not completely digital, printer paper supply should be checked. Quality assurance procedures for imaging and all necessary equipment should be performed by appropriate personnel prior to the first patient arriving in procedure room.

Prior to the first scheduled case, a thorough review of **stock levels** should be conducted and deficiencies restocked. These supplies should be constantly checked throughout the day and restocked by the circulator or ICVL staff as time allows, or by a materials management assistant, if there is one on the team.

The **procedure schedule** for the day should be reviewed by the team. The physicians should be questioned about the procedures they are anticipating. This can be done at the start of any list with a group huddle or safety check. Patients at high risk should be identified to facilitate a higher level of care if necessary. Patients who have a known or suspected contrast medium allergy or renal insufficiency should receive preprocedural medication or hydration on the ward as set out in the institution's protocol. The ward staff responsible for patient care should be informed of these patients' likely procedure times to ensure adequate patient preparation prior to their arrival at the lab.

The **procedure table** on which the patient lies during the procedure should be cleaned and prepared as dictated in the institution's protocol. The instrument table used for the sterile procedural equipment is cleaned with disinfectant at the start of the day and between each procedure.

Mechanical or power **contrast injector** must be turned on and loaded.

The **defibrillator** should be tested and left on all day while procedures are in progress.

Emergency supplies such as temporary pacemaker generators and catheters, pericardiocentesis trays, and cardiac support devices should be ready for use. Emergency medications, airway, and intubation supplies must be checked and available .

Before entering the procedure room, scrub assistants should wash their hands for 3–5 minutes, covering fingers, hands, and arms (up to the elbow) in approved **surgical scrub** solution as set out in the institution's infection control guidelines. As much water as possible should be allowed to drain from the arms into the sink before entering the procedure room. The less water dripped, the lower the likelihood of a fall occurring. Waterless surgical scrub solutions, generally chlorhexidine or alcohol based, require less time and are easier to use. However, manufacturers often recommend a traditional soap and water surgical scrub for the first case of the day.

Depending on the institution, gowns can be disposable or cloth. **Gowns** should be donned using standard sterile technique; the outside of the gown should never be touched.

The gown should be picked up by the inside of its collar, and each arm is slipped into a sleeve. This can be done one arm at a time or both arms at the same time. With a disposable gown, scrub assistants hand off the tie holder to the circulator and turn around, remove the tie from the holder, then tie themselves up. With a cloth gown, assistants should let someone hold the tie with a sterile clamp as they turn around. Assistants then take the tie back and secures their gown.

Where the **sterile gloves** are placed and opened varies between institutions. In some, the gloves are opened on a separate table away from the main sterile field, whereas in other institutions the gloves are opened on top of the sterile field. Scrub assistants keep their hands within the gown's sterile cuffs to don their sterile gloves. Once gowned and gloved, scrub assistants' hands should never go below their waist or outside the sterile field.

The **procedural tray** usually comes as a fully disposable, all-in-one, sterile package. Reusable, resterilized packs, or combinations of reusable and disposable components are not uncommon, particularly in electrophysiology and hybrid procedure rooms. The scrub assistant opens the table set and lays out the contents. This usually includes the following: This usually includes the following:

- Two basins, one containing 500 milliliters of saline solution to which heparin is commonly added
- A bowl or cup for local anesthetic
- Surgical skin prep applicator(s)
- Various syringes and needles
- Sterile drapes to cover the patient to maintain a sterile area
- A #11- or #15-scalpel blade
- A percutaneous access needle for cannulating the artery
- A manifold setup with attached lines for pressure, waste, contrast medium, or mechanical contrast medium management system disposables
- Sheaths and catheters (these will vary and can be added to the table by the circulator once the patient is on the table and draped)

Circulators should fill the set's basins as required, and then open the procedural catheters and wires. It is not uncommon to have the puncture needle, sheath, exchange wire, and diagnostic catheters packaged together. Each piece is flushed, removed from the package, wiped, and placed on the table.

To ensure an uncluttered working space, it is best to loop all wires three or four times. A wet sterile gauze or lint-free wipe can be placed on each to ensure that it stays in place until it is used.

Patient Preparation

The first exchange between the patient and the caregiver should involve a **greeting and an introduction**. Patients should be properly identified by checking their wristbands with their documents and the name in the procedure room computer system(s). During the identification process, patients may be asked their name, date of birth, and the reason that they have come to the hospital. Patients should be able to describe what procedure will be performed in their own language. If necessary, a translator should be present from the very beginning of the procedure.

The staff member should ask patients how they slept, when they last ate, and whether they took any medication that morning. The best time to ask patients if they need to **urinate** is immediately before they enter the laboratory.

If the **consent form** has not yet been signed, it must be done before the patient enters the IVCL and prior to any sedation being given.

While the circulator and scrub are preparing the patient and the lab for the procedure, the monitor reads through the patient's notes, paying close attention to **lab results**. Any abnormal values or findings should be discussed with the attending physician and other team members before the procedure begins.

As patients are helped onto the procedure table, a **quick description** of the X-ray system, the monitors, the equipment, and the upcoming procedure can help reduce the anxiety some patients may feel. The procedure room contains many unfamiliar pieces of equipment, and the experience can be quite overwhelming for first-time patient.

By this stage, the circulator will have developed a fairly good **assessment of the patient's state of mind**. For example, a nervous patient is often very talkative, and the circulator should listen as much as time allows. They should also steer the conversation back to the matter at hand and try to learn if the patient has any issues that need to be resolved before the procedure begins.

A very **anxious patient** tends not to talk very much and may give only the shortest possible answer to any question. It is important that patients receive adequate reassurance from the team, both in manner

and words. The staff should make sure that anxious patients are informed about their procedure and the reasons for it, even if they have heard the explanation before. The team's behavior should portray both competence and confidence, that the procedure is routine, and that all possible care will be taken. Very nervous or anxious patients may require additional sedation.

One of the best elixirs for patient confidence is maintaining a friendly, positive atmosphere in the lab. This demonstrates that the personnel are competent and that they enjoy taking care of patients, encouraging them to relax and place themselves in the hands of the team for the duration of the procedure.

Staff should always try to see the procedure from the patients' perspective. To anxious patients, they have just entered a room that looks like something out of a science fiction movie. Someone is about to remove their last article of clothing, shave and disinfect parts of their body, and start playing around with the inside of their heart. It is natural that patients will be apprehensive. It is important to reassure patients in a professional manner. If the procedure is performed with moderate or conscious sedation, music of the patient's choice playing quietly in the background will also help put most patients at ease and give them something to listen to during a long procedure.

Generally, the circulator is responsible for **positioning the patient on the table**. Each table and X-ray setup has a different optimal position for each patient. Since most tables can be freely moved by the operator, the important thing to check is that the patient is centered and close enough to the cranial end of the table to allow filming of the groin and lower extremities should problems arise during sheath insertion. Newer X-ray gantries are designed to move in several planes and can effectively image the patient from head to toe.

The concepts of neutral body alignment and positioning are helpful in decreasing patients' discomfort from lying on a cold, hard table for an extended period of time. Start at the patient's head. Support the back of the neck with a pillow, and perhaps place a towel at the nape to support the head, neck, and shoulders. This will decrease the incidence of shoulder spasms. Then look at the spaces behind their knees. If the knee is allowed to hyperflex, the stress of this unsupported position will lead to strain on the hamstrings, then to the gluteal muscles, then to the lower back. This back pain can be decreased with the simple addition of a soft towel or blanket placed under the back of the knees, separating the patient's feet a few inches apart. As the patients' body is aligned in a neutral pose, the overall result is a more relaxed body to work with, a decrease in the patient's anxiety level, and reduced need for additional sedation or pain medication. Remember that patients must lie relatively still on a hard table for an extended period of time; an extra bit of comfort can make a big difference in how they experience the procedure. For patients undergoing prolonged procedures with deep or general anesthesia, pressure points should be cushioned with foam or gel pads to prevent pressure ulcers. For patients who walk with a limp or if their notes state that they have orthopedic problems, some form of special support may be necessary.

The circulator should check that patients have a **working IV line**. If there is no line because the patient has been rushed in as an emergency, the circulator or other qualified team member should insert one. See Chapter 8, *Nursing Care of the Cardiovascular Procedure Patient*, for more information on intravenous line placement. If peripheral access is a problem, the physician may elect to insert a venous sheath in the groin for IV access. IV fluids are usually set at a slow drip to maintain the patient's hydration unless contraindicated.

During the preprocedural evaluation, **diabetic patients** should have their blood glucose level measured. If the blood glucose readings are over 200 mg/dL, short-acting insulin should be given as set out in the institution's protocol. If hypoglycemia is evident, an IV infusion of 5% dextrose in water (D_5W) may be warranted. If the patient's consciousness changes suddenly, 50% dextrose in water (D_{50}) should be administered immediately. If the schedule delays a diabetic patient's procedure, their blood glucose level should be repeated shortly before the procedure begins, following the institution's guidelines and the physician's instructions.

The patient's **medication**, and when it was last taken, should be reviewed with the patient. If the patient has regularly taken anticoagulation or antihypertensive medication, this should be discussed with the physician prior to the procedure. Depending on the medication and the last dose taken, the procedure may need to be delayed or rescheduled.

Patients should also be asked if they have ever had **allergic reactions** to anything, particularly contrast media. Allergies should always be reviewed with patients, even if it is written in their notes that they have no allergies.

Moderate/conscious sedation requires **pulse oximetry and noninvasive blood pressure**

monitoring during the procedure. However, a decrease in oxygen saturation is not the earliest sign of respiratory issues, and many institutions now require the monitoring of **end-tidal CO_2 with capnography** for all moderate/conscious sedation procedures.

ICVLs are cold to prevent the X-ray equipment from overheating. Patients, who are almost naked on the table, feel this more than the staff. The circulator should have a warming cupboard filled with blankets to **keep patients comfortable** during the procedure if the patient wishes. For prolonged deep sedation or general anesthesia procedures, warming blankets are used to help regulate the patient's temperature.

During the preparation time, the scrub assistant and circulator work together to get patients to the point at which the procedure can begin. It is a good time to explain to patients what will be expected of them during the procedure. They should be told that during most of the procedure they will have to **keep their hands behind their head**. The circulator should find out if this is problematic for any reason and provide support for a patient's arms if required.

During the procedure, and particularly during angiography runs, patients should move as little as possible. The physician or the scrub assistant will ask patients to **breathe in deeply** and then hold their breath as an angiography run is filmed. Patient should be told that they can breathe normally again when the angiography run has finished.

In a busy ICVL during a normal shift, staff may prepare many patients. Even for the most eager professional, it may be difficult to approach each patient with the same enthusiasm, explaining everything as if it were for the first time. Few things, however, are worse than subjecting a patient to a boring, robotic drone of information that has obviously been churned out the same way for years. That is where rotation of the jobs within the laboratory is important. The empathy and compassion that are so useful on the ward are also the foundations of effective communication in the ICVL. Treat patients as you would like to be treated yourself.

ECG electrodes are attached to the patient. Although some labs place a full set of 12 ECG leads on every patient, this is unnecessary for the majority of interventions. Unless the electrodes are radiolucent or (better yet) radiotransparent, they often get in the way of a clear X-ray picture. Four limb leads and at least one chest lead should be placed on a relatively hairless (for better contact and for painless removal) and muscular (for optimal signal transmission) part of the body. In some cases, this area will have to be shaved, and in others, it will have to be cleaned to remove dirt or oils to ensure effective electrode adhesion. The electrodes can be safely placed on the calf or thigh muscles, and on the shoulders or upper arms.

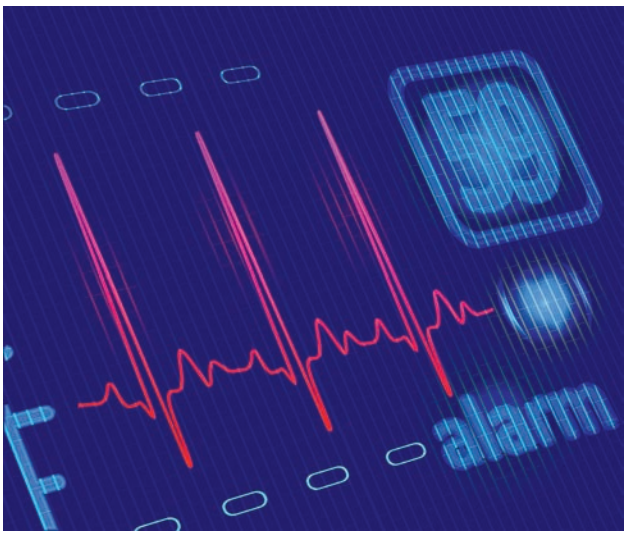

Figure 7.4 ECG monitor

Once the ECG is connected and running **Figure 7.4** the circulator should check it before leaving the patient's side and consider the following questions:

- Are the connections good and free of artifact?
- What is the rhythm and the heart rate?
- Does the patient need comforting or additional medication?

At this point, a baseline recording of the ECG should be made.

The area around the **puncture site** is to be shaved, disinfected, and anesthetized prior to catheter access as set out in the institution's protocol. The circulator and/or scrub assistant should explain these steps to the patient before beginning the procedure.

The size of the area to be prepped should have a radius of at least 5 centimeters from the intended point of insertion to ensure antisepsis. A much larger area is required if the sheath will be covered by a dressing immediately after the procedure for later removal. This will prevent the painful tearing out of hair when the dressing is removed. In some labs, the entire genital area is shaved, from the umbilicus to the knees, for femoral access. In most facilities, however, this is usually restricted to high-risk patients who may need advanced support devices because it adds otherwise unnecessary discomfort for the patient.

Puncture site disinfection is most often performed with a chlorhexidine prep, beginning where the intended puncture will be and moving outwards. If a Betadine solution is used, prepping is also performed in a circular fashion, moving outward from the intended access site, but with three preps. The skin should be completely dry prior to placing the sterile drapes on the patient to ensure good contact.

When the puncture site has been prepared, the scrub assistant takes the **sterile drape** from the table and places it over the patient, with the opening in the center of the prepped area. With one hand holding the drape in place, the other hand spreads out the rest of the drape with circulator's help.

The table controls and the lead shield should be covered with sterile plastic covers. In some labs, the X-ray tubes are also covered.

If a **blood pressure manifold** is used, it is then plugged in, flushed, and zero calibrated. Manifolds come in different configurations, most commonly with three ports. These have one port for pressure measurement, one for contrast medium, and one for heparinized saline. This setup makes it easy to flush the manifold. Care must be taken that all the air bubbles are purged from the lines with saline at the beginning of the procedure and kept that way. If using a mechanical contrast injection system, the same care must be taken to prime the system and place a sterile cover over the console controls.

As the draping continues, the **X-ray gantry** will be brought into position. This can be quite intimidating from the patient perspective, so taking a moment to explain the need for "close-up" pictures can help to decrease any anxiety patients may feel from having such a big piece of machinery hanging above their body.

Procedure

When physicians arrive, they are assisted into their gown and gloves. They make the arterial or venous puncture and insert the sheath(s).

When a physician removes a wire from the patient, it is passed to the scrub assistant, who wipes it with saline and loops it together. The scrub assistant uses a wet gauze or lint-free wipe in the nondominant hand, squeezing it around the wire to ensure a good wire wipe. Pulling the wire out at a steady pace using the dominant hand, the scrub assistant then wraps it around on itself three or four times. This should be done carefully and slowly to minimize the potential for spattering blood. Most splashes are caused by something that could have been prevented (distractions, hurrying, etc.). Scrub assistants should always be aware of what they are doing, be methodical, and wear appropriate personal protection.

Most guidewires come packaged in a sterile plastic loop. The wire can be threaded back intro this and flushed when appropriate, ready for reuse later in the case.

Extra care is taken with guiding catheters not to kink or bend them. Be aware of blood squirting out of a catheter's side holes when it is being inserted into the sheath. It is good practice to aim the side holes away or cover them with something until they are inside the sheath.

The following must be monitored continuously during the procedure:

- Blood pressure (noninvasive and invasive hemodynamics)
- ECG (rate, rhythm, ST segment changes)
- Oxygen saturation
- Contrast medium volume
- Heparinized saline volume
- Patient status

Although the responsibility for the procedure and patient ultimately lies with the physician, all these observations are the combined responsibility of all members of the ICVL staff. While most procedures are routine, there are still risks involved, and unexpected complications are always a possibility. A good team will work as a cohesive unit, anticipating changes to the patient's condition before they occur.

Blood Pressure

With a left heart procedure, as soon as the diagnostic catheter has been placed in the aorta and the proximal end connected to the manifold, a pressure tracing and digitized values of the aortic systolic, diastolic, and mean pressures will appear on the monitor. This value should immediately be checked and treated as one would treat any blood pressure measurement.

If it is too low, it may indicate a vasovagal reaction or a technical problem such as a loose connection. Once possible technical sources of the problem have been ruled out, the staff should ask if the patient is feeling faint or nauseated. An injection of atropine, administration of IV fluids, or both may be warranted. A low pressure may also be due to the patient being dehydrated. A patient who has been fasting since the previous evening and does not come onto the table until the afternoon will most probably be dehydrated, especially if it is a warm day. This can be corrected promptly with a rapid saline or glucose and saline infusion.

If an unusually high blood pressure is seen, ask patients what their blood pressure normally is and whether they have taken their medication that morning. Administration of a medication such as nifedipine or nitroglycerine may be necessary to bring the blood pressure within the normal range. Hypertension may also indicate that the patient is anxious or nervous. If so, soothing talk may be enough to bring the pressure down. As time is usually of the essence once the patient's artery has been punctured, some form of sedative may be administered for a quicker and more certain result.

High blood pressure can also be an indicator of pain. If the patient has pain in their groin, more local anesthetic can be injected. For lower back pain, the patient's position and supports can be adjusted. If the pain has a cardiac source, it can be dealt with pharmacologically.

Another cause of a high or low blood pressure reading is a full bladder. Contrast medium is usually metabolized efficiently and an IV infusion is running, so a patient's bladder can fill up quite quickly. A bedpan or bottle can usually be put in place without much difficulty, and the procedure can continue. If this fails to work, and the procedure still has quite some time to run, a transuretheral (foley) catheter may have to be inserted.

A break in the pressure signal usually means that the doctor or assistant has disengaged the system, probably to inject contrast. It is also possible that a connection in the system has become loose. It is important for the staff to be familiar with the system, from catheter to the computer monitor, to isolate and correct any connection problems that arise.

ECG

The ECG should be monitored continuously during the procedure for changes in rate, rhythm, and ST segments. Extra systolic beats can be expected when a catheter makes contact with the heart muscle, especially when entering the ventricle. Extra systoles occurring without manual stimulation should be recorded when possible and brought to the attention of the physician.

If the ECG suddenly goes flat, there are two possible explanations. First, assess the patient, who may be in asystole. The hemodynamic pressure display should be checked immediately. If the pressure reading is continuing normally and the patient is responsive, then you can assume that the problem lies within the ECG system. In most cases, it will be due to one or more of the ECG electrodes or leads becoming disengaged. Each one should be checked and replaced as necessary.

Faulty connections or old cables can also be responsible for a break in the ECG signal. The staff should be familiar with troubleshooting the ECG, from the electrodes to the computer monitor, and spare leads and connectors should always be on hand. Invasive cardiovascular procedures cannot be safely carried out without a reliable, continuously monitored ECG. If a fault cannot be remedied with the staff and equipment at hand, another ECG monitor, even that in the defibrillator, can be used until that procedure is finished and a technician can repair it.

A noisy/artifact ECG can be due to the patient shivering. If the patient is cold, the circulator can place a warmed blanket over the undraped parts of the patient. The electrodes can also be placed over muscles less susceptible to shivering if it becomes an issue.

Contrast Medium

There are two main methods of using the contrast medium: the *open system* and the *closed system*. With the open system, the contrast medium is poured into a bowl on the sterile table. The scrub assistant fills a syringe with this liquid and then connects it to the catheter, either directly or through a stopcock. The open system is rarely used in adult coronary angiography.

With the closed system, the bottle of contrast is connected to the manifold by an infusion line, and the scrub assistant fills the syringe by turning the manifold stopcock. The closed system cuts down on the risk of air bubbles and makes it easier to estimate the amount of contrast medium used during a procedure. It is important, though, that the contrast medium bottle is changed before it is empty; otherwise, air will be drawn into the line and may cause air emboli if injected into the patient. If air is present in the line, disconnect the line from the patient and immediately purge it of air.

It is becoming more common for angiography contrast medium injections to be performed using a mechanical delivery system. This system ensures that the amount of contrast medium given is of a constant pressure and volume. Every injection is automatically recorded, and the total contrast volume calculated.

To inject larger volumes of contrast medium during ventriculography and aortography, a mechanical delivery system or power injector is commonly used. The scout prepares the power injector and ensures that the syringe and line are completely free of air. A tap with the knuckles or an instrument on the connection and syringe cylinder while it is held vertically, syringe end upwards, should be enough to reveal and dislodge any bubbles. The line should be purged and

connected to the patient. A small amount of the contrast medium should be released while the line is being connected to the catheter, creating a wet-to-wet connection to minimize the risk of air bubbles forming.

The circulator should ask the doctor before each injection to verify the contrast medium volume, injection rate, and maximum injection pressure.

The scrub assistant should make sure the tubing is properly connected to the catheter before angiography is performed. Potentially contaminated contrast medium can shower the team and cover a great deal of the lab in a very few seconds if the connection is not tight.

Prior to performing ventriculography or aortography, the patient should be told that they will be experiencing warmth all over their body. The warm, flush sensation causes some patients to feel as if they are urinating. Assure the patient that this sensation is normal and will pass quickly.

During injection, the head of the power injector syringe is positioned downward so that any small bubbles that may be present in the syringe will not be injected. The contrast medium injection should begin shortly after filming has begun. If the filming stops suddenly due to some technical problem, stop the injection immediately.

Cath lab staff should be familiar with the power injector settings and operation to make problem solving more efficient if the injector does not work properly.

Heparinized Saline

This solution is used throughout the procedure for many purposes. The catheters and the rest of the system must be periodically flushed with it, gloves and the working area should be periodically cleaned with it, and the contrast medium must be mixed with it in the inflator to inflate the balloon. It is a simple task to ensure that enough heparinized saline is always available to those working at the table.

In instances where the patient has, or is suspected of having, heparin-induced thrombocytopenia (HIT), "clean" normal saline can be safely used. The ICVL team members must be keenly aware of this, and due diligence must be taken to ensure that catheters and wires are regularly wiped and flushed. Extra caution must also be taken to ensure that contrast medium and blood do not remain inside catheters.

The Patient

The circulator should talk to the patient during the procedure as appropriate for ongoing assessment. Patients should be asked if they have any discomfort or feel anything unusual. They should also be asked general comfort questions such as if they are too hot or cold. In addition to benefiting patients by relieving any discomfort they may have, this also helps to relax them and distract them from the procedure for a few minutes. Talking occasionally to the patient during the procedure has the added benefit of reminding the physician that the patient is actually present and taking an active part in the procedure.

If the patient preparation has been thorough, there should be little that has to be done for them during a procedure of normal duration. If the procedure goes longer than expected, the staff will have to check the patient's well-being more frequently.

Procedure Completion

The order in which the procedure is concluded depends on which procedures were performed and the state of the patient. The goal is to get patients safely into their bed where the sheath can be pulled or to wait until they are transferred to the ward.

Always follow standard precautions; wear gloves while packing up the table and the room after each patient.

- When the procedure has been completed, all catheters are removed from the patient's body, leaving just the sheath in place.
- The X-ray equipment and monitors are moved away from the patient.
- The contrast medium lines and the pressure monitoring lines are disconnected.
- Depending on the method being used to close the puncture site, the sterile drape is carefully taken off the patient.
- Patients are helped into their gowns, paying careful attention to infusion lines.
- Using a transfer board, or with the patient helping by grasping the overhead handle on the bed, patients are transferred into the bed, making sure that their body and legs remain straight.
- The bed is then taken to the recovery area or to the patient's unit.

As the patient is being wheeled out of the cath lab, the team is preparing it for the next procedure.

- Any needles or blades on the equipment table are carefully transferred to the sharps container.
- All disposable material is wrapped into the sterile drapes and placed in medical trash receptacles. These are emptied before they are full.
- The cath lab is cleaned.

- The material is prepared for the next procedure, as set out at the start of this chapter.
- The next patient is then brought into the lab.

The term *turnover* describes the time between the completion of one procedure and the beginning of the next. This can be defined in various ways; physicians most often prefer "gloves off to gloves on," but it sometimes refers to "wheels out to wheels in." Whatever definition an institution uses, turnover describes the time and process of ending the procedure, breaking down the sterile field and disposable equipment, removing the patient from the room and transporting them to the next area of care, disposing of trash and linen, disinfecting reusable equipment (procedure table, sterile field table, ECG wires, etc.), and receiving the next patient. In many facilities, turnover is a hot button topic related to procedural efficiency. Turnover is also one of the easiest areas to make great improvements. Understanding the three primary roles and responsibilities, team members can standardize and greatly improve turnover times.

Some rules, however, apply in every lab. The scrub assistant or physician should account for all sharps in the sterile field and dispose of them in the designated container. If they tend to leave needles or blades lying around, they should be told of the danger, and the correct form of disposal should be pointed out.

At the end of the procedure, the physician should inform the patient of the results and display them on the monitor if this is warranted. The physician should also explain to the patient what to expect for the next 24 hours or so. The staff can continue to clean up around them while this is going on, but they should do so in a professional manner that shows respect for the discussion.

Depending on institutional protocol, arterial sheath removal can be performed in the recovery area adjacent to the cath lab or on the ward following the procedure. See Chapter 15, *Access Site Hemostasis*, for information on sheath removal.

If the sheath is not to be removed immediately following the procedure, the puncture site area should be cleaned with saline, and then dried. Non-vented sterile caps should be placed on the sheath's sidearm and the area covered with a sterile dressing. Team members should inform the patient when the sheath will be removed and, in the meantime, which body parts can and cannot be moved. Team members must make sure that the patient knows that it is very important to observe these motion restrictions and should explain to the patient what will happen if they are ignored.

The patient can be made responsible for observing signs of bleeding at the puncture site, such as wetness or stickiness, and informing a staff member immediately if this occurs.

Before patients leave the procedure area, they should be told how important it is to rehydrate to help flush the contrast medium out of their body. Patients should drink as much as they can for the rest of the day and should urinate as soon as they experience any pressure on the bladder.

Many ICVLs have a dedicated recovery area, whereas others send patients directly to a coronary care unit or a ward following the procedure. See Chapter 8, *Nursing Care of the Cardiovascular Procedure Patient*, for more information on caring for patients post-procedure.

End of the Day

The end of each day's program should include the following:

- Dispose of all waste.
- Thoroughly clean the cath lab and recovery area.
- Restock the cath lab and recovery area material.
- Restock the emergency trolley.
- Check restricted medication.
- Prepare the cath lab for any emergency procedures that may take place during the night.
- Perform information system backups where required.

WRAP-UP

Summary

The team of non-physician staff that runs a cath lab can be made up of a variety of specialists, each bringing their own expertise to the table. The three main roles that these team members adopt during the cath lab procedures are scrub assistant, circulator, and monitor. Each role encompasses a wide range of knowledge and skills. A cath lab's team members work together to ensure that every patient receives optimal care during their time in the cath lab.

Self-Assessment Questions

1. Describe at least five tasks that are performed by a cath lab's scrub assistant.
2. Describe at least five tasks that are performed by a cath lab's circulator.
3. Describe at least five tasks that are performed by a cath lab's monitor.
4. Outline the process of donning a sterile gown.
5. What is the advantage of using carbon ECG cables?
6. Why is it important to ensure that there are no air bubbles in the lines before injecting a bolus of contrast medium?
7. Give two reasons for a flat ECG signal.
8. Where should a circulator stand while an angiography run is being filmed?
9. How should the puncture site area be treated at the end of the procedure if the sheath is not to be removed immediately?
10. Why are patients requested to drink a lot of fluids following an angiography or angioplasty procedure?