



Pre- and Post-Procedure Nursing Care

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6.1 Introduction

The development of new tools and technologies have allowed more complex procedures to be done as minimally invasive procedures in the operating room and interventional radiology [1, 2]. Although these interventions have greatly improved, the psychological preparation (in addition to the physical preparation) for patients remains to be addressed. Patient's coping mechanism and compounding sources of stress contribute to increase anxiety and distress as the patient prepares for surgery or non-invasive procedures. Evidence has shown that the preparation of the patient undergoing a surgery/procedure can significantly be reduced by using an individualized approach in managing patient's coping mechanism and addressing sources of distress [3]. A study has shown that too much or too little information during patient's education in preparation for procedure can increase anxiety. However, comparing pre education and after education has shown decreased anxiety and increased satisfaction. So, needs-based education helps determine the appropriate patient education [4].

Patients are encouraged to implement some basic approaches in overcoming the impact of anxiety on psychological and recovery process such as [1, 5–7]:

1. Read reliable medical sources such as information provided by the provider or by professional societies such as the Association for Radiologic and Imaging Nursing (ARIN), the American College of Radiology (ACR), or the Society of Interventional Radiology (SIR). Some hospitals offer YouTube videos for common procedures.
2. Prepare a list of questions or concerns, such as potential complications or limitations post-procedure.
3. Speak with provider about: medical history, consent and ensure that it is clear and understandable; availability of medical drugs before surgery; type of anesthesia or sedation medications; and share list of all home medications and over the counter medications.
4. Discuss post-procedure pain management after surgery and at home (for outpatient).
5. Submit all required documents requested by the providers' office, hospital, or outpatient facility where procedure will be performed.
6. Practice deep breathing exercises or other relaxation techniques, such as listening to music. Plan for family/friend assistance when going home. Some procedures will necessitate that the patient have someone with them for 12–24 h after discharge.

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6.1.1 Definitions

Key definitions to understand in this chapter include:

Pre-procedure care—the nursing roles in this phase focus on validating existing information, eliciting additional or new information, reinforcing preoperative/procedure teaching, reviewing discharge instructions and providing nursing care to complete preparation for the experience [1].

Post-procedure care—the nursing roles in this phase focus on providing post-anesthesia/procedure nursing in the immediate post-procedure and transitioning the patient's transfer to the inpatient unit or to home. If patient goes home, the necessary preparation for discharge to home needs to be implemented. Constant vigilance is required during this phase [1].

Provider—includes the radiologist, nurse practitioner (NP), clinical nurse specialist (CNS), or radiology physician assistant (RPA).

6.2 Pre-procedure Care (But Not Limited To) [1, 7–9]

Follow all individual institutional policies and procedures in the pre-procedure care of the patient.

6.2.1 Assessment

1. Confirm patient identification with wrist band using two identifiers and allergy and fall precaution bracelets, if applicable.
2. Verify consent is done in advance. If done on the day of the procedure, the nurse may sign the consent as a witness to the patient's signature. Ask the patient to verify the procedure site (right or left) as needed. Encourage patient to ask questions.
3. Review medical notes and history (hypertension, cardiac, respiratory, diabetes, endocrine, renal diseases, blood problems e.g., sickle cell disease, anemia), difficulty of voiding, lung problems (e.g., COPD, asthma, obstructive sleep apnea, or airway problems), neuro assessment, current problems, and any previous procedures and surgery responses to anesthesia or sedation and relevant social history (including substance use). Note height and weight per facility policy. The date of the history and physical is important to note. Regulatory agencies may require a date of less than 30 days with a note on the day of the procedure stating no changes.
4. Review all other required documents such as advance directives, X-ray film/disk with patient and labeled as indicated, electrocardiogram, and laboratory test results (hematology, chemistry, coagulation, pregnancy testing, and others) and note any abnormalities.
5. Note medication reconciliation form and include medication ordered before procedure, home medication list including herbals and over the counter medications (OTCs). Assess last dose of *all* medications including anticoagulant, insulin/oral medication, and pain medication as indicated.
6. Inquire about allergies to medications and any history of reaction to contrast media (and treatment, if known), latex, tape, or other bandage products.
7. Review relevant presurgical/procedure status including:
 - (a) Anesthesia/sedation plan with airway assessment, including American Society of Anesthesiologists (ASA) Physical Status
 - (b) Vital signs, oxygen saturation, airway problems
 - (c) Baseline pain and discomfort
 - (d) Psychological, emotional, and spiritual needs
 - (e) Nothing by mouth (NPO) status per guidelines; some medicines maybe permitted with sips of water
 - (f) Language barriers and need for an interpreter
 - (g) Mobility and need for walker, cane, wheelchair, or any device
8. Review readiness of presurgical /procedure patient's teaching, sedation plan, and discharge planning based on patient's needs.

9. Confirm availability of safe transport if patient will be going home or arrangements for an inpatient hospital bed. If appropriate, inquire about attendance overnight.

6.2.2 Intervention

1. Introduce nurse, providers, and other health care team members interacting with patient and family members.
2. Verify and confirm patient's identification using two identifiers.
3. Assist physician in obtaining consent if not taken before surgery/procedure. Confirm site marking by provider, if appropriate.
4. Facilitate the availability of interpreter or other means to assist patient in communicating and understanding the consent and care.
5. Obtain vital signs and implement any intervention as ordered based on clinical assessment and provide emotional, psychological, and spiritual support. Inform providers if additional information is obtained. Implement clinical monitoring.

Assess peripheral pulses prior to angiogram procedure/mark site and document clearly as this will be used for post-procedure comparisons. Note if pulses are palpable or by Doppler, quality, extremity temperature, and sensation. If a radial access site/other is anticipated, perform the appropriate tests for meeting criteria.

6. Insert intravenous access (IV) line, if ordered for procedure. (20 or 18 gauge maybe preferred.) Some interventional procedures, e.g., thrombolysis case or embolization for gastrointestinal bleeding, may require more than one IV access.
7. Administer premedication, e.g., antibiotic, and document last dose of anticoagulant as indicated.
8. Insert urinary drainage catheter as ordered.
9. Implement additional laboratory testing as ordered, e.g., international normalized ratio (INR), partial thromboplastin time (PTT)/prothrombin time (PT), platelets, creatinine, type, and screen.

10. Validate patient's understanding of preoperative/procedure teaching including sedation and discharge planning. Include family members in the patient teaching if available.
11. Implement sedation as ordered or assist anesthesia provider as needed.
12. Implement radiation safety procedures.
13. Prepare special equipment appropriate for the procedure.
14. Take patient belonging inventory and store patient's belongings and valuables in a secure area. Jewelry, eyeglasses (contact lenses), hair pins, dentures, hearing aids, etc. should be removed per facility policy.
15. Instruct and educate family members where to wait, any patient tracking system or communication update system.
16. Complete checklist for procedure room readiness and document on record. Inform the patient about the "Time-Out" procedure that will be done in the procedure room.

6.2.3 Outcome

1. Patient meets all the requirements to undergo procedure with anesthesia, sedation, or local anesthesia as indicated.
2. Patient validates understanding of consent procedure, expectations, and patient's teaching including discharge planning.

6.3 Post-procedure Care (But Not Limited To) [1, 7–9]

Follow all individual institutional policies and procedures in the post-procedure care of the patient.

6.3.1 Assessment

1. Determine patient destination post-procedure (radiology recovery area, post-anesthesia care unit (PACU), home after recovery, or transfer to an inpatient area).

2. Confirm patient identification using two identifiers.
3. Review data received from transfer of care.
4. Review presurgical/procedure assessment and interventions.
 - (a) Obtain vital signs, oxygen saturation, breathing, airway, circulation, consciousness/sedation level, peripheral pulses where appropriate, and pain level. Assess distal pulses every 15 min \times 4, every 30 min \times 4, then every 60 min until discharge/transfer or per physician's orders.
 - (b) Notify physician for the following conditions:
 - Decrease or change in strength of pulses in affected extremities
 - Extremity is cold or cool to touch or color change
 - Pain or nausea
 - Inability to move extremity/sensory, temperature, or color change
 - Change in vital signs, including level of consciousness (LOC)
 - Bleeding or hematoma at the puncture site or dressing site
 - Procedure-specific change in condition (e.g., increased hematuria after tube placement, short of breath after lung biopsy).
5. Assist with hemostasis if surgical suture or plug is not used for hemostasis.
 - (a) Maintain bed rest for a period of time as prescribed by the physician.
 - (b) May logroll patient 10–15° from side to side. Head of bed may be elevated no greater than 30° during bed rest if manual hemostasis for femoral access (see Chap. 9).
6. Assess pain and discomfort, nausea and vomiting, dressing, bleeding, or any complications.
7. Note presence of drainage tubes, patency, characteristics of drainage as indicated and drainage output.
8. Note estimated fluid deficit or blood lost where appropriate.
9. Assess patient's emotional and psychological status.

6.3.2 Intervention

1. Verify patient's identification using two identifiers.
2. Connect patient to monitoring device(s).
3. Obtain hand off report from providers/procedure staff.
4. Obtain vital signs and oxygen saturation.
5. Provide emotional and psychological support.
6. Educate patient including care plan, expectations, and discharge planning. Include family member or significant other if available.
7. Provide written discharge instructions and obtain signature of patient after teaching, verification of understanding, and respond to patient's questions. Instructions should include what to do in the case of questions, concerns, or in an emergency, whom and how to contact provider. Also included will be information about any follow-up appointments needed status post-procedure (e.g., routine tube exchange appointment).
8. Implement post-procedure orders.
9. Provide safe transport of patient to receiving unit or to the car if ambulatory.
10. Arrange safe transportation to home.

6.3.3 Outcome

1. Patient meets discharge criteria for transfer to the receiving unit or home.
2. Patient is safely transported to the receiving unit or home.

6.4 Discharge Criteria

The post-procedure nurse follows standardized minimum criteria in collaboration with the proceduralist and/or anesthesia provider. The expected outcomes before patient is transferred or discharged are:

1. The established criteria must be met or assessment is comparable to pre-procedure status to safely transfer care to an inpatient unit or discharge the patient to home.

2. The anesthesia provider or proceduralist (for non-anesthesia patients) need to order patient's discharge per criteria.

Nursing responsibilities include cultural, developmental, and age-specific assessment, diagnosis, intervention, and evaluation of individuals who have received sedation/analgesia and/or anesthesia for surgical, diagnostic, or therapeutic procedures. In the absence of the physician responsible for discharge, post-anesthesia care unit (PACU) nurses shall determine that the patient meets discharge criteria based on established criteria.

The provider (physician) is responsible for general medical supervision and coordination of patient care in the recovery area (PACU or radiology recovery area), management of complications and resuscitation, and discharge of patients from these areas. In collaboration with PACU RNs, the providers develop discharge criteria that are approved by the department of anesthesiology and medical staff to safely discharge patients from the post-anesthesia/procedure area.

6.4.1 Criteria (But Not Limited To)

1. Activity: Able to ambulate and move all extremities at preoperative level or as expected.
2. Oxygen saturation: Oxygen saturation by pulse oximeter upon discharge to home or nasal cannula for transfer to inpatient unit is at patient's preoperative/procedure baseline.
3. Respirations: Able to cough and deep breathe freely or within 20% of preoperative/procedure rate.
4. Pulse: Within 20% of preoperative /procedure rate.
5. Blood pressure: Within 20% of preoperative/procedure baseline with two consecutive blood pressures 15 min apart.
6. Temperature: Equal to or greater than 36.0 °C/96.8 F.
7. Consciousness/mental status: Level of consciousness and orientation has returned to preoperative/procedure baseline.
8. Pain: Tolerable with basic function or at a reasonable level for the patient, and it has been at least 30 min since the last dose of intravenous narcotics/sedatives were administered.
9. Nausea: Nausea/vomiting is absent or minimized with no active vomiting.
10. Surgical bleeding: Consistent with procedure, bleeding, drainage, swelling, or inflammation is minimal.
11. Reversal agents: Reversal agents have not been administered within 120 min of discharge.

6.4.2 Considerations

All criteria must be met with "Yes" or comparable to pre-procedure condition. If any assessment of the above criteria has "No" answer, the nurse may not discharge the patient from the post-procedure area without consultation from the anesthesia provider or designee. Discharge criteria should be developed in consultation with the anesthesia department using the above assessment parameters but not limited to. Discharge criteria must be approved by the department of anesthesiology and the medical staff.

6.5 Common Procedures/Special Care/Complications

6.5.1 Arteriogram [10]

An **arteriogram** (angiogram or arteriography) is performed to evaluate various vascular conditions, such as an aneurysm, stenosis, or blockages.

Arteriograms can be used in many areas of the body. Some of the more common types are: **aortic angiography**, **cerebral angiography**, **coronary angiography**, **extremity arteriography**, **fluorescein angiography**, **pulmonary angiography**, and **renal arteriography**.

Special Care

Assess the arterial puncture site frequently or per physician's orders. At each interval assess the patient for:

1. Bleeding—Check dressing for any oozing or bleeding from the puncture site and mark the size/diameter of any hematoma with a surgical marking pen. Always check for bleeding after the patient coughs or vomits. In the case of a femoral approach a hematoma around the puncture site can also be indicative of internal bleeding into the thigh, pelvis, or retroperitoneal space. If bleeding does occur, place pressure directly over the site manually until hemostasis occurs and report to practitioner.
2. Circulation—Monitor pulses in the extremity used for access for presence and quality. Compare to baseline.
3. Position—On average the patient will remain on bed rest for 2 h following radial catheterization until hemostasis wristband is deflated and removed. If procedure is done through the femoral artery bed rest is usually 4 h post-diagnostic catheterization and at least 6 h post-interventional catheterization with head of bed at 30°. If a surgical closure device or plug is used, follow the manufacturer's instructions for care.
4. Cardiovascular status—Monitor closely for any arrhythmias, chest pain, or signs of stroke.
5. Medications—After the arteriogram patients may resume most medications. The providers should note when to resume anticoagulants or medications with those properties.
6. Other—Drink plenty of fluids; resume a regular diet; not perform any strenuous activity or lifting for 2 days; and not take a hot bath for 12 h. Additional care for the procedure site, for 1 or 2 days, includes keeping a bandage/dressing over the spot where the catheter was inserted; put ice or a cold pack on the area for 10–20 min at a time to help with soreness or swelling; and may shower 24–48 h after the procedure, or as ordered by the physician. Patients should have a responsible adult drive them home and stay with them for the first 24 h.

Complications

General risks of an arteriogram include pain, bleeding, infection at the place where the catheter was inserted, blood clots, hematoma, and damage to blood vessels. Other risks include distal embolization, loss of peripheral pulse, retroperitoneal hemorrhage, pseudo aneurysm, allergic reaction, or renal injury due to the contrast media used. Specific types of arteriograms may carry additional risks.

6.5.2 Cardiac Catheterization [8, 9, 11]

A diagnostic cardiac catheterization (often referred to as a cath) uses either a radial or femoral artery approach to study coronary vessels and left ventricle of the heart. Contrast is injected under fluoroscopy to examine the vessels for blockage and evaluate the contractility of the left ventricle. Additionally, the femoral or brachial vein can be accessed using a Swan-Ganz catheter to evaluate the right side of the heart. Samples of blood can be taken to evaluate the oxygen content of the heart. An interventional cardiac cath encompasses aspects of the diagnostic cath with the addition of an intervention such as angioplasty and stenting to open blocked arteries and restore blood flow to the area of the heart that the vessel feeds.

Special Care

Assess the arterial puncture site frequently or per post-cath physician orders.

1. Monitor closely for any cardiac arrhythmias, chest pain, or signs of stroke.
2. Monitor as for any arterial angiography as described in general angiography.

Complications

Although rare, a coronary arteriography might lead to low blood pressure, a [stroke](#), or a [heart attack](#). However, serious complication rates are very low.

6.5.3 Percutaneous Drainage Procedures [11–17]

Percutaneous drainage is sometimes recommended to treat fluid or air collections which produce symptoms. Recurrent fluid collections (e.g., seroma) maybe treated by medication installation. Drainage catheters are a minimally invasive method of draining abscesses. Drains are commonly made of latex, polyvinyl chloride, or silicone and placed within either wounds or body cavities. Drains may also be used postoperatively to form hollow connections from internal organs to the outside to drain a body fluid, such as the T-tube for bile drainage, nephrostomy, gastrostomy, jejunostomy, and cecostomy tubes. Drains within wounds are removed when the amount of drainage decreases over a period of days or, rarely, weeks. Body fluid drains are often left in for longer periods of time.

Drains and catheters are procedure specific but all require maintenance and due diligence. Proper catheter/drain management post-procedure is an extremely important part of the patient's plan of care (POC). The nurse will be responsible to teach the patient and caregivers home care and assess their ability to properly manage the catheter/drain, and possibly record drainage amounts while at home.

All complications are procedure specific however in general; drainage interventions may include pain, bleeding or hematoma formation, local arterial thrombus, sepsis, perforation and failure of procedure to provide relief of symptoms or improve outcomes. Accidental early removal may result in caustic drainage leaking within the tissues. The risk is reduced within 7–10 days when a wall of fibrous tissue has been formed. If a drainage catheter is accidentally dislodged, the patient should know that if the catheter is still needed, it should be replaced as soon as possible so the track does not close and to ensure the easiest replacement.

6.5.3.1 Nephrostomy Tube Placement [14, 18–20]

Percutaneous nephrostomy (PCN) is an image-guided placement of a catheter into the renal collecting system to provide permanent or temporary urinary drainage or to relieve ureteric obstruction. Indications for nephrostomy tubes are to remove renal calculi, to decompress an obstructed system, and to maintain or improve renal function following ureteric obstruction caused by malignant tumor. PCN is used to access the renal pelvis for radiological procedures such as an insertion of an antegrade stent.

Special Care

All percutaneous interventions are considered clean-contaminated procedures but are most often contaminated when an obstruction is present. Follow the antibiotic prophylaxis guidelines recommended by the Society of Interventional Radiology (SIR). The nurse should pay special attention during the “allergy” review in anticipation of pre-procedure administration of antibiotics. Pertinent lab results would be anticoagulation studies, complete blood count with platelets, urine culture, electrolyte assessment, and creatinine per protocols. Ask the patient if they are taking any anticoagulants and the last dose; check the medication administration record for all inpatients. Contraindications to the procedure are bleeding diathesis such as hemophilia or thrombocytopenia, uncontrolled hypertension, and/or anticoagulant use such as warfarin. A urine specimen may be taken during the procedure for culture and sensitivity. Post-procedure, most patients have bloody urine for several hours. Normally this bleeding will resolve spontaneously. The nurse should report any clots noted. As stated above the most important role of the nurse pre- and post-procedure is that of an educator, instructing the patient and the family on the management, care, and flushing of the nephrostomy tube. Patient (and caregiver) education should emphasize the following points:

1. The patient (or caregiver) can demonstrate how to connect and disconnect tube from drainage bag.
2. The drainage bag should be kept lower than the insertion site and drainage catheter to enable gravity drainage.
3. The nephrostomy tube can be held in place with a special catheter-holding device, and then secured to clothing using a safety pin. The catheter can be secured to the leg using a leg bag with straps. There should be a little slack in the tubing to allow for different positioning.
4. Nephrostomy tubes may require flushing to maintain patency. Usually 10 mL of sterile saline is *forward flushed* gently. Specific flushing instructions will be provided per the provider. Aspiration *should not* be attempted without explicit instruction from the provider. The patient will need a prescription for the necessary supplies for flushing.
5. Dressing care and skin care at the insertion site should be given per the provider's preference and instructions. Wet or soiled dressings should be replaced.
6. Instructions will need to include information on activities of daily living and taking care not to dislodge the catheter. If the catheter is accidentally dislodged it should be immediately reported. The longer the catheter is out, the more difficult it can become to reinsert as the established tract will close.
7. Drainage bags should not be overfilled; therefore they may need frequent emptying. The nephrostomy tube leg bags can be connected to larger bags for overnight drainage.
8. Patient should know the signs of a blocked drainage catheter and to report any signs of infection such as fever, purulent discharge, skin breakdown, or leaking around the catheter at the insertion site.
9. Patients should also be aware that there will be routine scheduled tube changes every 4–6 weeks or as needed if the nephrostomy has to remain in place for a long period of time. Patients should be encouraged to schedule appointments in advance and adjust if needed.

Complications

Bleeding and sepsis are the two most serious complications of percutaneous nephrostomy which will be the same for any intervention that requires a drain/catheter placement. All general complications listed for any drains/catheter also pertain.

6.5.3.2 Biliary Tube Placement [13, 16, 17, 21, 22]

Bile is produced by the liver and aids in the breakdown of food and flows from the liver, through the bile ducts, and into the intestines. When the bile ducts become blocked due to inflammation, tumors, or infection, bile backs up into the liver. This build-up can cause sepsis, nausea and vomiting, anorexia, and fever. It causes jaundice, pruritus, and dark urine. Biliary drainage requires the insertion of a catheter into the bile duct and a drainage tube into one of the bile ducts in the liver to allow bile out. A biliary drain allows bile to flow from the liver into either a bag or the intestines depending on the procedure. Percutaneous transhepatic biliary drainage (PTBD) is often related to ongoing care of the oncology patient but plays an essential part in the treatment of biliary obstruction whatever the cause.

Special Care

Prior to the procedure the patient's international normalized ratio (INR) and platelet count should be reviewed. At many institutions 1.5 is the maximum INR and the minimum platelet count is 50 per microliter for the initial placement. Institutions may vary on these parameters. Any percutaneous procedure involving infected drainage and the passage of a tube through highly vascularized organs has an increased risk of sepsis. Prevention is the best treatment for sepsis. The standard of care is the administration of pre-procedure broad spectrum antibiotics to all patients unless contraindications prohibit it.

Proper catheter/drain management is an extremely important part of the patient's plan of care (POC). The nurse will be responsible to teach the patient and any caregivers present pertinent after care and assess their ability to properly manage the drain at home. Education should include the following:

1. Check dressing and catheter daily. Change dressing if it is loose, soiled, or saturated. Inspect the insertion site while dressing is off. There should not be redness, swelling, or leaking fluids.
2. Flush catheter daily with 10 mL sterile saline using sterile technique. *Flush forward only.* Stop if there is resistance, pain, or leaking around the insertion site and notify the provider. Provide a prescription for all necessary supplies for flushing.
3. Manage drainage. Empty and measure the drainage as necessary. Record the amount of drainage. If more than 500 mL in a 24 h period notify provider.
4. Report fever/chills or sudden lack of drainage.
5. Follow-up care includes routine drain changes in IR, usually 8–12 weeks or as needed. Patients should be encouraged to schedule appointment in advance and adjust if needed.

Complications

Minor:

1. Fever, chills, and rigors can be treated with antibiotics, antipyretics, and possibly meperidine to control rigors
2. Bile leakage into the surrounding tissue which can be alleviated with proper flushing technique.
3. Surgical pain at the insertion site which can be anticipated and usually resolves within a 48–72 h period.

Major:

1. Sepsis can be a life-threatening complication if not treated. Administration of prophylactic antibiotics pre-procedure is one of the best ways to prevent infection from turning into a sepsis situation.
2. Bleeding excessively, either venous or arterial, must be promptly recognized and treated. Signs of bleeding are rapid accumulation of blood into the drainage bag, excessive bleeding around the dressing, or spurting blood. The patient may require an embolization (see

embolization) in IR to treat the blood flow or have surgery for correction of the cause. Recognition and proper management of these rare but potential complications are an essential part of the IR nurse's skill set.

6.5.3.3 Abscess Drainage [15–17, 20]

Historically, intra-abdominal abscesses were treated with surgical drainage. This intraoperative method of drainage was associated with substantial morbidity and mortality. Over the last 20 years advances in image-guided percutaneous drainage have provided a more effective and safer choice than surgical debridement, while in fact being classified now as the treatment of choice. Image-guided percutaneous abscess drainage (IGPAD) is minimally invasive and the relatively simple choice to avert development of sepsis, thereby reducing the hospital length of stay (LOS), reducing the cost of treatment, and often able to be done on an outpatient basis. Ultrasound (US) and CT are the most commonly used imaging modalities to guide IGPAD and fluoroscopy is also used to guide serial dilatation and drain placement following successful needle access.

Special Care

Prophylactic antibiotics may be considered prior to drain insertion. Positioning is variable depending on the location of the abscess. Depending on the location and size of the abscess local anesthesia may be sufficient but moderate sedation is often used as the patient is already experiencing pain caused by the abscess. As described above (see nephrostomy tube) catheter/drain management post-procedure is an extremely important part of the patient's plan of care (POC). The nurse will be responsible to teach the patient and caregivers home care and assess their ability to properly manage the catheter/drain at home. Drainage from the catheter should be measured and emptied every 8–12 h. Amount of flush and frequency is decided per provider. Follow up abscessogram, which is an injection of a small amount of contrast media through the drainage catheter followed by digital fluoroscopy or CT. Examination is done at routine intervals (weekly, bi weekly, monthly) to assess the decrease in the abscess

size and characteristics. Often when there are less than 20 mL returned in a 24 h period, the drain can be removed by the provider.

Complications

Patient and caregivers are instructed to notify the provider immediately if:

1. Temperature is greater than 101.5 F, chills, nausea, and or vomiting (sepsis/peritonitis).
2. Swelling, redness, increased warmth, or drainage/leakage at the procedure site (local infection, sepsis, peritonitis).
3. Excessive pain or bleeding at the site or drainage in catheter becomes bloody (hemorrhage).
4. Sudden increase in drainage (>50 mL daily) could indicate the development of a fistula.
5. If sutures break or become loose, drain falls out, drainage stops, or resistance is met when flushing.

6.5.4 Percutaneous Biopsy [12, 14, 17, 23, 24]

Percutaneous biopsy is one of the most common procedures done in interventional radiology. A tissue sample can differentiate a benign or malignant tumor. Common biopsy sites include the thyroid, muscles, lungs, abdominal structures (liver, kidney), pelvic organs, lymph nodes, and bone. The type and location of the target lesion determines what image modality will be used. Ultrasound (US), fluoroscopy, computed tomography (CT), and magnetic resonance imaging (MRI) are all utilized for biopsy procedures. For the most part there are very few contraindications to performing a biopsy under local anesthetic; however, sedation may be necessary for the patient to remain still during the procedure. Patients must understand that test results may not be available on the day of the procedure. If the test results are not available, the patient will be instructed to make an appointment with the referring physician to discuss the results. The patient should be told not to assume everything is normal if they have not been contacted by the physician or the medical facility as test result time varies.

Emphasis should be on the importance of following up on all test results.

6.5.4.1 Liver Biopsy [17, 20, 23, 25]

US- and CT-guided liver biopsies are commonly used for diagnosing and staging many chronic liver diseases. Due to coagulopathies that commonly occur in patients with hepatic disease, bleeding is the most common and potentially critical complication. In some instances the interventionalist will use a transjugular approach. Transjugular liver biopsy (TJLB) is the alternative to a percutaneous approach in hepatic patients with diffuse liver disease, coagulopathy, and ascites. With this approach there is a decrease in the potential for bleeding afterward and pressure measurements may be done during the biopsy that can determine the degree of portal hypertension.

Special Care

1. Perform usual procedural workup with special attention to blood work (complete blood count/platelets, chemistries, and coagulation studies).
2. Anticipate moderate sedation for anxiety and pain relief. It is important to go over everything that will happen in a calm and assuring manner. Many patients actually feel the biopsy being retrieved and it can be frightful. Informing them ahead of time without great detail allows them to be prepared and know that this is normal for the procedure.
3. After the procedure patients will lay on their right side with an ice pack over the biopsy site. Patient remains NPO until cleared by physician in case of any complication.
4. Studies indicate that most complications occur within 2 h post-procedure but can occur up to 24 h later. The recovery time varies from institution to institution. Anywhere from 1 to 5 h could be considered normal.
5. Patients should have a responsible adult drive them home and stay with them for the first 24 h.
6. Instruct the patient not to lift more than five pounds or play contact sports for 2 weeks.
7. Instruct patient not to drive for 24 h.

8. Instruct the patient to resume medications per provider's order.
9. Ensure understanding of dressing changes as directed.

Complications

Minor:

1. Localized and temporary discomfort at the site of the biopsy.
2. Pain that requires an analgesic (referred pain to shoulder may occur).
3. Low blood pressure due to a vasovagal response.

Major:

1. Intraabdominal hemorrhage.
2. Intrahepatic or subcapsular hematoma.
3. Biliary peritonitis.

6.5.4.2 Lung Biopsy [12–14, 24]

CT-guided percutaneous lung biopsy is the minimally invasive method to obtain tissue for histopathology and microbiologic analysis from pulmonary lesions suspected to be malignant or infectious in nature. The technique uses a needle passed through an intercostal space to obtain tissue from peripheral pulmonary lesions. There is a great degree of accuracy, sensitivity, and specificity in detecting malignancy, explicitly a primary lung or metastatic disease. An on-site cytology technologist may be desired to assure an adequate tissue sample. A lung biopsy can diagnose bacterial, mycobacterial, viral, or fungal infections that have been intractable to a standard treatment regimen. Lung specimens can be valuable in clarifying the diagnosis and response to treatment in the case of chronic lung disease such as sarcoidosis, pulmonary fibrosis, or rheumatoid lung disease.

Special Care

Pre-procedure planning will include having a recent CT or positron emission tomography (PET) scan of the chest and any available relevant images that the radiologist can use to determine appropriateness of the proposed biopsy and gauge

rate of growth, size, and location of the lesion. These will help determine whether the percutaneous approach is feasible and will be the most effective. At the time of scheduling the patient will be instructed to hold any anticoagulant for 3–5 days prior to the procedure. Relevant labs will be ordered. The provider will determine safe lab levels for proceeding with the procedure. It is imperative that the patient is able to remain still for this procedure, therefore nurse administered sedation or anesthesia is needed. Contraindications for this procedure include an uncooperative patient, patient with altered mental status, intractable cough, patients using positive pressure ventilation, severe respiratory compromise such as patients with prior pneumonectomy, severe interstitial disease, or pulmonary hypertension.

In the pre-procedure area the patient is prepped in the usual fashion. Lab results, history, and physical are checked by the pre-op nurse, provider, and sedation provider/anesthesia. As in all interventional procedures the nurse's ability to educate the patient about what to expect intra-op and post-op is paramount to having a successful outcome. Post-procedure the patient will remain 2–4 h for recovery. The patient will be in a "biopsy" side down position. A chest X-ray is done immediately post-procedure and then 2 h later. If the patient experiences chest pain and or shortness of breath, a comparison between the two will show any pneumothorax progression and whether a chest tube is warranted for re-inflation of the lung.

Complications

Most complications occur immediately or within the first 2 hours but can occur after discharge.

Minor:

1. Pneumothorax: Average of 20% patients develop a pneumothorax of some degree. Most resolve without intervention; however, 5% require chest tube placement and admission for subsequent days. A Heimlich valve with chest tube is used [24].
2. Hemoptysis: Lung tissue becomes irritated with the biopsy and small amounts of blood

are released into the airways. This may cause the patient to cough up small bits of blood; this resolves without intervention in most cases.

3. Localized hemorrhage: Biopsy gun fires and a shock wave is formed distal to the needle. The mild hemorrhage or hematoma resolves on its own.

Major (Rare):

1. Chest wall hematoma: Rare but significant chest wall hematoma and hemothorax may develop if the intercostal or internal mammary arteries are injured during the biopsy. This will most likely require surgical intervention and evacuation.
2. Massive hemorrhage: Very rare but will require immediate resuscitative interventions. Patient will be hypoxic and is at risk for asphyxiation and death.
3. Tumor seeding: Seeding is a risk that tumor will spread along the track of the needle biopsy when a core biopsy is taken. Risk is very rare.
4. Air embolism: This can be fatal. Reported incidences are less than 0.003% [26].

6.6 Embolization [17, 25–28]

Embolization is a minimally invasive treatment that blocks one or more blood vessels or abnormal vascular channels. In a catheter embolization procedure, medications (liquid embolic or sclerosing agents) or synthetic materials called embolic agents (coils, particles, microspheres/beads, plug or absorbable gelatin compressed sponge such as Gelfoam®) are placed through a catheter into a blood vessel to prevent blood flow to the area. Catheter embolization can be applied to almost any part of the body to control or prevent abnormal bleeding. Embolization is commonly the first line of treatment in gastrointestinal bleeding of any cause. Hemorrhage from trauma maybe treated using embolization versus open surgery. Uterine fibroids which can cause

heavy menstrual bleeding and bulk symptoms can be treated by uterine artery embolization (UAE) in some cases. UAE is also utilized for post-partum hemorrhage (see Sect. 6.3.3). Embolization is performed for arteriovenous malformations (in brain, lungs, other). Embolization may be used alone or combined with other treatments such as surgery or radiation.

Embolizations require arterial access either trans-femoral or radial. As such much of the care pre-procedure and post-procedure are the same as routine arteriography care, no matter what type of embolization is being done (see Chap. 9).

Pre-procedure

1. Refer to Sect. 6.6.2. Additional pre-procedure assessment and intervention comments are below.
2. All outpatients will be made aware that they may be admitted post-procedure or, if discharged to home, made aware that a responsible adult should be available to take the patient home and stay overnight with the patient.
3. Radial artery approach:
Assess left radial artery only. Perform a Barbeau test and document the waveform. For a radial approach, the intravenous access site should be on right side if no patient contraindications.

Post-procedure

1. Refer to Sect. 6.6.3 for a femoral approach.
2. For a radial approach and hemostasis refer to Chap. 9

6.6.1 Chemoembolization [29, 30]

Trans-arterial chemoembolization (TACE) is the combination of local delivery of chemotherapy and embolization to treat cancer, most often of the liver. In chemoembolization, anticancer drugs are injected directly into the blood vessel feeding a cancerous tumor. In addition, synthetic material called an embolic agent is placed inside the blood vessels that supply blood to

the tumor, in effect trapping the chemotherapy in the tumor. This method is often used to treat inoperable tumors in the liver. Approach can be trans-femoral or radial artery. Chemo handling and disposal policies and procedures should be followed by the IR team.

Special Care

Often patients have disease-related pain which is difficult to control, chemotherapy-induced nausea, vomiting, fatigue, and anxiety. Systemic chemotherapy agents can affect the immune system increasing chances of bleeding and/or infection. As the IR nurse preparing a patient for TACE (or any interventional oncology procedure), it is important that there is awareness of the implications the patient's systemic disease may have pre- and post-procedure. Laboratory values can be affected by a patient's disease process or systemic treatment which can exacerbate the symptoms of the procedure. Understanding the clinical presentation and communicating it to the interventional radiology team allow for optimal management.

All elements of pre-procedure and post-procedure care for embolization with arterial access are outlined in Sect. 6.6. Attention to the most recent blood work (platelet counts, absolute neutrophil count, liver/renal function and anticoagulation values) is needed. Administration of antiemetics and pain medications is important. Chemotherapy precautions are followed intra-procedure. There is no special precautions post-procedure related to chemotherapy as the drug is not systemic.

Liver-directed therapies such as TACE can levy or exacerbate already present symptoms in many patients such as fatigue, pain, and nausea and vomiting. There are also effects from TACE on liver function or the contrast medium effects on the kidneys. These values can become elevated post-TACE and need close monitoring. Understanding the potential symptoms and risks patients can have allows the IR nurse to adequately assess and manage the patient before, during, and after the procedure with guidance from the interventional radiologist.

Complications

Minor:

1. Most TACE patients experience post-embolization syndrome (PES). It most probably occurs due to the anti-inflammatory responses to tumor ischemia/necrosis and chemotherapy agents. Symptoms of low-grade fever, abdominal pain, and nausea and vomiting can occur within the first 24–72 h after the procedure and last up to a week. Symptom management with antiemetics, narcotics, and fluids are the treatment of choice until the sequelae passes. Acetaminophen is contraindicated for pain due to its hepatic toxicity.

Major:

1. Liver failure.
2. Biloma (an encapsulated bile collection outside the biliary tree due to a bile leak) is a rare but potentially life-threatening complication if it is symptomatic. Timely and appropriate management, including percutaneous drainage, partial hepatectomy, and antibiotic administration, should be performed in the case of any signs of infection [29].
3. Liver Abscess.
4. Nontargeted extra-hepatic embolization can occur when chemotherapeutic or embolic agents are delivered to the gastrointestinal mucosa, gall bladder, diaphragm, or skin.

6.6.2 Radio Embolization

[17, 20, 26, 31]

Yttrium-90 (^{90}Y) microspheres are tiny spheres loaded with ^{90}Y , a radioisotope that emits pure beta radiation. ^{90}Y has a half-life of about 64 h. The radiation from ^{90}Y is largely confined to a tissue depth of 2–3 mm. After injection into the artery supplying blood to the tumors, the spheres are trapped in the tumor's vascular bed, where they destroy the tumor cells by delivering the beta radiation. Normal tissue is not affected.

Most of the radiation emitted from the tumor is contained within the patient's body, and external radiation is so low that it does not present a significant risk to others. Because the spheres may have trace amounts of free ^{90}Y on their surface, only very small amounts of ^{90}Y can be excreted in the urine. This is a palliative and not curative procedure [29].

Special Care

The patient is NPO for the procedure but may take maintenance meds in the morning with a sip of water. IV hydration may be included in the pre-procedure orders; all elements of pre-procedure and post-procedure care for embolization with arterial access are outlined in Sect. 6.6.

Post-procedure, the patient may experience fever, lethargy, fatigue, nausea, and abdominal pain (PES). Despite these potential side effects, typically patients who receive ^{90}Y therapy are discharged the same day. On discharge, prescriptions are given for a proton pump inhibitor, steroids, antiemetic, and pain medications. ^{90}Y microspheres are a source of radioactivity. There is a small amount of radioactivity around the liver. Therefore, if a patient goes to the emergency department within 3 days of ^{90}Y treatment, they should be instructed to identify that they have had a recent radioembolization. All bodily fluids must be properly disposed in the first 24 h. Hands should be washed after using the restroom and any spill should be wiped and flushed. Patients do not need to restrict close contact with household members, unless a caregiver/family member is pregnant or under the age of 10. In those specific instances you must remain at arms-length for 72 h.

Complications

Minor:

1. Post-embolization syndrome (PES) as described in Sect. 6.6.
2. Gastric or duodenal ulceration which can be minor or major depending on the symptomology. Patient can be treated with prophylactic proton pump inhibitors to decrease the likelihood of this.

Major:

1. Radiation pneumonitis (seen 2–3 months after procedure).
2. Radiation hepatitis (seen 2–3 months after procedure).
3. Acute pancreatitis.

6.6.3 Uterine Artery Embolization [27, 28, 32]

Uterine artery embolization (UAE) is often used to treat pelvic hemorrhage secondary to trauma, malignancy; radiation induced bleeding and postpartum hemorrhage. Early vascular intervention can delay or avoid the need for hysterectomy. Done in this manner the procedure is considered emergent. UAE is performed by accessing the right femoral artery and guiding a catheter under fluoroscopy into position in the distal uterine artery. Embolization is performed using a gelatin sponge material (Gelfoam®) mixed with saline and contrast for opacification. Complete embolization is reached once stasis of blood flow in the uterine artery has been achieved.

Secondly, UAE is done to treat uterine fibroids which cause heavy menstrual bleeding, pain, and pressure on the bladder and bowel. When done to treat fibroids the procedure is also known as a uterine fibroid embolization (UFE). UFE is an elective procedure and as such the patient should have a prior consult with the radiologist. One of the major contraindications to the procedure is the desire to maintain childbearing potential. While not impossible to have successful pregnancy after UAE or UFE, studies show increased risks of spontaneous abortion, abnormal placenta position, and postpartum hemorrhage. The patient and the clinician must do a careful risk/reward analysis prior to the procedure.

Special Care

A pregnancy test should be performed on the day of the procedure; serum pregnancy is more sensitive. The patient is NPO for the procedure but may take maintenance meds in the morn-

ing with a sip of water. Local anesthetic and/or moderate sedation will be used for the procedure. A pain pump may be started during the procedure for pain control. Preparation should be made in advance. All elements of pre-procedure and post-procedure care for embolization with arterial access are outlined in Sect. 6.6. A urinary drainage catheter is usually inserted to keep the bladder deflated during the procedure. It will be removed after the procedure. The patient may stay overnight for symptom control but often is done as an outpatient. In the acute post-procedural period, immediate complications may relate to vascular access, thromboembolic events, infection, and pain management. As with all embolization, post-procedure, the patient may develop post-embolization syndrome (PES), experiencing fever, lethargy, fatigue, nausea, as well as abdominal pain and pelvic cramping. Symptom management with antiemetics, narcotics, and IV fluids are the treatment of choice until the symptoms resolve. There can be a high rate of constipation post-procedure in this group of patients due to fibroids pressing on bowel and opioids for pain management. Over the counter stool softeners and good hydration maybe ordered.

Complications

Awareness of the known complications of UFE may allow more rapid diagnosis and effective therapeutic responses to complications when they occur.

Minor

1. Post-embolization syndrome (PES).
2. Expulsion of fibroid tissue.
3. Altered ovarian and sexual function.
4. Subcutaneous tissue necrosis.
5. Treatment failure.

Major

1. Pulmonary embolus.
2. Uterine ischemia, necrosis.
3. Sepsis.
4. Death.

6.7 Radiofrequency Ablation [33]

Radiofrequency ablation (RFA) maybe indicated for lung, liver, renal, and bone malignancies. Thermal ablation with RFA, cryoablation or microwave ablation (MWA), a newer technique, may be done. Ablation is often a palliative treatment for patients who are poor surgical candidates due to comorbidities. Computed tomography (CT) is the preferred modality. Ultrasound (US) or magnetic resonance imaging (MRI) guidance (for cryoablation) can be done.

Careful team assessment and planning is needed prior to this procedure. Absolute and relative contraindications should be considered. The patient should be screened for metallic implants and pacemakers. It is preferable to have more than one large bore intravenous access. Nursing care will involve care as per procedures that require sedation and analgesia/anesthesia. Antiplatelet and anticoagulation medications are held per physician order. Additional laboratory tests, e.g., serum tumor markers, may be requested. Pre-procedure antibiotics are given. Patient education is an important part of nursing care for patients undergoing ablations.

Special Care

Pain management is an important consideration as the procedure is painful and the patient needs to lie still during the procedure.

Intraprocedural care for thermal ablation involves the use of grounding pads, usually placed horizontally on the patient's thighs. These are used to prevent skin burns. Cool packs may be used on the grounding pads, if needed. Procedures can be lengthy, so careful positioning of the patient for the procedure is needed for comfort and for prevention of skin/nerve injuries.

Patient vital signs should be monitored closely post-procedure for signs of bleeding. Patients often are hospitalized overnight for pain control and observation. Patients should be informed post-ablation syndrome is common after thermal ablation, 1–2 days post-procedure and for 1 week. Symptoms include low-grade temperature, mild myalgia, and fatigue. Treatment is supportive.

Patient discharge instructions should emphasize the importance of follow-up, e.g., by CT or other modality.

Complications

Complications include infection, bleeding, injury to tissue adjacent to the target area, nontarget ablation (e.g., ureteral injury, psoas muscle, bowel injury after renal ablation), post-ablation syndrome (expected), skin burns, or others according to area on which the procedure was done. Hematuria may occur after renal interventions. Pyeloperfusion may be done to prevent thermal injury during some renal ablations. Hydrodissection, by infusing normal saline, to separate target and nontarget tissue may be done.

6.8 Conclusion [25, 34, 35]

As an extension of perioperative services, IR follows the guidelines and care standards of ASPAN and ARIN. Guidelines by the Association of PeriOperative Registered Nurses (AORN) are also useful for perioperative and intraprocedure care of the patient. The role of the IR nurse, with a background in a critical care or perioperative area involves assessment, planning, care, and education of patients who undergo diagnostic, interventional, and therapeutic procedures. Radiology nurses must have high level of technical and clinical skills garnered by a strong grasp of anatomy, physiology, and radiologic science. Critical thinking and planning, along with the ability to balance, organize high workload demands (clinically and operationally), and care for patients with a variety of procedures is a necessity to manage the rapid turnover of a hospital or ambulatory center intertwined with the needs of the most critical of patients.

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