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Interventional radiology (IR) is appealing to many caregivers because of the technical challenge, creative problem-solving opportunities, and the immediate gratification associated with a wide array of minimally invasive procedures. In addition to possessing excellent technical skills, interventional radiologists must also be able to provide comprehensive periprocedural care.

Comprehensive care involves providing education to patients and their families, developing excellent working relationships with referring physicians and practices, and directing holistic patient management, both during a procedure and throughout the post-procedure and follow-up periods. For patients that remain in the hospital following a procedure, interventional radiologists must be comfortable functioning as the primary team or as a highly engaged consultant. Inpatients requiring interventional procedures are often complicated, debilitated persons; it is incumbent on the interventionist to be comfortable working with various hospital teams and confident in their own medical management to ensure maximum procedure safety [1].

Consults

Assisting other services in the care of inpatients is the bedrock of IR. Our specialty is often best known for performing drainage of obstructed biliary systems, management of thromboembolic disease, recanalization of arterial occlusions, embolization of gastrointestinal hemorrhage, and

other procedures that can dramatically change the course of a hospitalized patient. An IR consult service must rapidly respond to the primary team to help them plan and implement care for their patient. This straightforward concept means that the IR consultant must not only be familiar with the indications and risks of common IR procedures but must also be familiar with the pathophysiology and surgical or medical treatment options of disorders often seen by an IR consultant.

Performing an IR consult includes reviewing available imaging, obtaining a focused medical history, reviewing laboratory and other noninvasive testing, performing a focused physical examination, making recommendations for additional tests, and, finally, making a recommendation on whether or not an IR procedure is technically feasible and clinically appropriate [2]. Most consultations serve to provide referring teams reassurance that all options have been evaluated, whether they lead to an IR procedure or not [3]. When IR is consulted, whether or not a procedure is actually performed, a consult note should be written to provide a record of our assessment. Many IR consults are informal, with review of a CT and a brief medical history, but writing a consult note ensures that the Interventional radiologist will be an accountable member of the healthcare team [4]. Sometimes the most challenging part of an IR consult is stating that an IR procedure is not indicated. These consult patients must remain on the rounding list in case conditions change and a procedure becomes necessary.

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Key Point

Patients often ask what time they are scheduled for their procedure. Do *not* commit to a specific time unless the patient is tentatively the first case. The schedule may change for a variety of reasons and patients may become very upset if their procedure is delayed.

The How To

- The services IR provides are highly technical and outside of the training and experience of many referring physicians. As the IR consultant, you are the voice of your entire IR team. Our educational role should not be ignored and our attitude never demanding or condescending. This role involves multitasking, triaging each consultation in terms of urgency, while providing each referring physician with timely feedback. The consultant is often also the gatekeeper for IR procedure slots, balancing limited procedure resources with the needs of multiple patients with varying acuity.
- Review the electronic medical record (EMR) and imaging.
- Have a check list of common evaluation points related to the clinical situation or disease state you are evaluating [5].
- Obtain consent from the patient or appropriate surrogate.
- Write a note after every consultation.
- Current Anesthesia Society of America (ASA) requirements for fasting prior to moderate sedation are 6 h for solids and 2 h for clear liquids for adults [7, 12].
- Ensure that the patient will be able to lie in the appropriate position for the length of time necessary to safely perform the procedure.
- Check eGFR prior to administering contrast. Check for contrast allergies and premedicate as necessary [8].
- Determine whether the patient is currently or has recently been on anticoagulation.
- Communicate verbally with the primary team, nursing staff, and appropriate members of the IR team regarding the planned procedure, its urgency, and any extenuating circumstances.

Pre-procedure Evaluation

A history and physical must have been performed within 30 days of a procedure. This history may have been documented during a previous clinic visit or hospital admission. Patients are also reevaluated immediately prior to a procedure. Essential elements of a pre-procedure note are current history and physical; assessment of prior sedation and outcomes; assessment of airway, heart, and lungs; procedural plan, including side or site delineation as indicated, and plan for sedation, including drugs to be used; and level of sedation intended for

the procedure [9–12]. It is important to include the patient's previous response to sedation medications. Most often, you will be evaluating the patient's ability to receive moderate sedation, which means your team will titrate medications to control pain and anxiety but at the same time insure the patient retains their protective reflexes and response to physical stimulation or verbal commands [13, 15]. These elements must be evaluated and documented immediately prior to a procedure.

Consent

Most, if not all, of the procedures performed in IR require consent. Most hospital consent forms include the Health and Human Services guidelines for informed consent [6]. Three highlights to remember when obtaining consent:

1. Describe the procedure in “plain English,” using appropriate comparisons to procedures, events, or processes within the patient's realm of understanding.
2. Know the risks, benefits, and alternatives of the procedure and be able to describe the relative and absolute risk. Discuss all risks of the procedure and be patient in waiting for the patient to ask questions. They need to be fully knowledgeable of potential adverse events before being taken for a procedure.
3. The patient should be able to describe the procedure in their own words. If a patient is too confused or obtunded to respond, then they are not capable of signing informed consent.

Assessing patient capacity to give consent is an essential part of the consent process. You should be familiar with your state and hospital policy regarding the process of determining when a patient does not have the capacity to give consent, and how to locate and document lack of capacity in the medical record. Know your hospital and state policy regarding who may give consent, in the event the patient is incapacitated. Consent obtained over the telephone requires a witness.

Key Point

Determine the patient's ability to give informed consent, even if it is not clear that a procedure is indicated. Being “consentable” means that the patient fully understands the benefits and risks of the procedure. Consent should be performed in layman's terms to ensure comprehension. If unable to consent, obtain from the primary team the identity and contact information for the person who has legal capacity to consent for the patient [6].

Key Point

Hierarchy of appropriate decision makers (this varies slightly by US state or country):

- Legal guardian with health-care decision-making authority
- Durable power of attorney for health-care decisions
- Spouse
- Adult children
- Parent
- Adult sibling

If patient lacks capacity and unable to contact appropriate decision-maker, an emergency consent can be performed as needed between two attending physicians.

Key Point

Rule of thumb regarding labs:

- If the procedure affects a particular organ system, draw pertinent labs.
- If the patient has baseline impairment of a system, draw pertinent labs (e.g., glucose for diabetes).

policies may dictate which specific laboratory tests to order and the acceptable interval before a procedure.

Code Status

Moderate sedation, used in many IR procedures, carries a risk of hypoventilation and cardiovascular collapse. Minimally invasive procedures can cause sudden but reversible changes in the cardiopulmonary status (such as vagal reaction during manipulation of the biliary tree). Many IRs will ask patients with a standing do not resuscitate (DNR) order to reverse the order for the duration of the procedure and for a short time following the procedure. However, it is not presumed, or appropriate, for all DNR orders to be reversed for all procedures. Individual situations and procedures must be addressed with the referring team, the patient, and the patient's family. The outcome of that discussion must be entered into the pre-procedure note and communicated with the referring team, prior to placing orders in the EMR.

Laboratory Testing

Practices vary widely on what laboratory screening is recommended prior to a procedure. Administration of intravascular contrast may warrant evaluation of renal function with a basic chemistry panel. Patients at risk for bleeding or undergoing procedures with intrinsic high bleeding risk may have clotting factors evaluated. Pregnancy testing in females of childbearing age is often recommended prior to procedures or exams that would pose a radiation risk to a developing fetus or require sedation. Opinions also vary regarding the safe period of time between obtaining screening laboratory tests and performing a procedure. Hospital guidelines and

Antibiotic Prophylaxis

The Society for Interventional Radiology has developed clinical practice guidelines based on available evidence (Table 5.1) for antibiotic prophylaxis. They have separated procedures performed in IR into two categories: clean (such as diagnostic arteriogram) and dirty (such as abscess drainage or access of an obstructed, infected biliary system). They recommend antibiotics are administered prophylactically 1 h prior to the procedure. In cases where infection is possible due to development of necrosis or needle access of a non-sterile area, IV antibiotics are recommended for 24 h post procedure. In situations where a needle will enter an infected or purulent cavity, they recommend continuing antibiotics for at least 48 h post procedure. Allergies, the site of potential infection, the condition of the patient, and specific antibiotics sensitivities to a known pathogen help define which antibiotics to use.

Anticoagulation

The Society for Interventional Radiology has developed a guideline for when and how long to hold anticoagulation before or after a procedure. It classifies procedures by bleeding risk, and the recommendations to hold anticoagulation are based on that risk [16]. This guideline is frequently updated and is easily available online at the national guideline clearinghouse maintained by the US Department of Health and Human Services. With the introduction of multiple novel anticoagulant therapies (novel oral anticoagulants or NOAC), decisions regarding what to hold and whether to bridge with shorter-acting anticoagulation have become complex. Reviewing your institution's most updated guidelines is essential to reduce risk of either bleeding or thrombus formation in patients on anticoagulation [17]. Factors to take into account include the reason for anticoagulation (e.g., recent cardiac stent vs. long-standing treatment of atrial fibrillation present differing risks when off anticoagulation), the risk of bleeding associated with the procedure, creatinine

Table 5.1 Society of Interventional Radiology guidelines for antibiotic prophylaxis during procedures. Routine

Procedure	Organism	Prophylaxis	Antibiotic choice	Penicillin allergy
Angiography, angioplasty, thrombolysis, arterial closure device, stent	<i>S. aureus</i> , <i>S. epidermidis</i>	No	Cefazolin if high risk	Vancomycin; clindamycin
Endograft	<i>S. aureus</i> , <i>S. epidermidis</i>	Yes	Cefazolin	Vancomycin; clindamycin
Tunneled central venous catheter	<i>S. aureus</i> <i>S. epidermidis</i>	No consensus	Cefazolin	Vancomycin; clindamycin
Embolization or TACE	<i>S. aureus</i> , <i>S. epidermidis</i> , <i>strep</i> , <i>enteric flora</i> , <i>Corynebacterium</i>	No consensus	Ampicillin/sulbactam; Cefazolin and metronidazole; Ampicillin and gentamycin; Ceftriaxone 1 gm	Vancomycin; Clindamycin and aminoglycoside; without intact sphincter of Oddi, piperacillin/tazobactam
UAE	<i>S. aureus</i> , <i>S. epidermidis</i> , <i>E. coli</i> , <i>Strep</i>	Yes	Cefazolin; clindamycin and gentamycin; ampicillin; ampicillin/sulbactam	Vancomycin; clindamycin
TIPS	<i>S. aureus</i> , <i>S. epidermidis</i> , <i>Corynebacterium</i> , <i>Enterococcus</i> , Biliary pathogens, Anaerobes	Yes	Ceftriaxone; ampicillin/sulbactam	Vancomycin; aminoglycoside
GU procedures	<i>E. coli</i> , <i>Proteus</i> , <i>Klebsiella</i> , <i>Enterococcus</i>	Yes	Cefazolin; ceftriaxone; ampicillin/sulbactam; ampicillin and gentamycin	Vancomycin; clindamycin and aminoglycoside
Liver and biliary interventions	<i>Enterococcus</i> , <i>Strep</i> , gram negative, <i>Clostridium</i> , <i>Candida</i> , anaerobes	Yes	Ceftriaxone; ampicillin/sulbactam; cefotetan and mezlocillin; ampicillin and gentamycin	Vancomycin; clindamycin and aminoglycoside
Gastrostomy or gastrojejunostomy placement	<i>S. aureus</i> , <i>S. epidermidis</i> , <i>Corynebacterium</i>	No consensus	Cefazolin	–
Tumor ablation	<i>S. aureus</i> , <i>S. epidermidis</i> , <i>strep</i> , <i>E. coli</i>	No consensus	Ampicillin/sulbactam; ceftriaxone	Vancomycin; clindamycin and aminoglycoside

Created with data from Venkatesan et al. [14]

Abbreviations: TACE transarterial chemoembolization, UAE uterine artery embolization, TIPS transjugular intrahepatic cholangiogram, GU genitourinary.

clearance (renal function will indicate how quickly the medication clears and may change the length of time medication needs to be held), and the type of anticoagulation.

Antihypertensives

Generally antihypertensives are not held prior to a procedure and are continued on their regular schedule. However, holding loop diuretics may be indicated, especially in patients with reduced creatinine clearance to reduce the risk of contrast nephropathy.

Contrast Allergy Prophylaxis

The American College of Radiology has a consensus document on contrast allergy prophylaxis (Fig. 5.1). It recommends

a combination of 12–18 h of steroids as well as antihistamine prophylaxis:

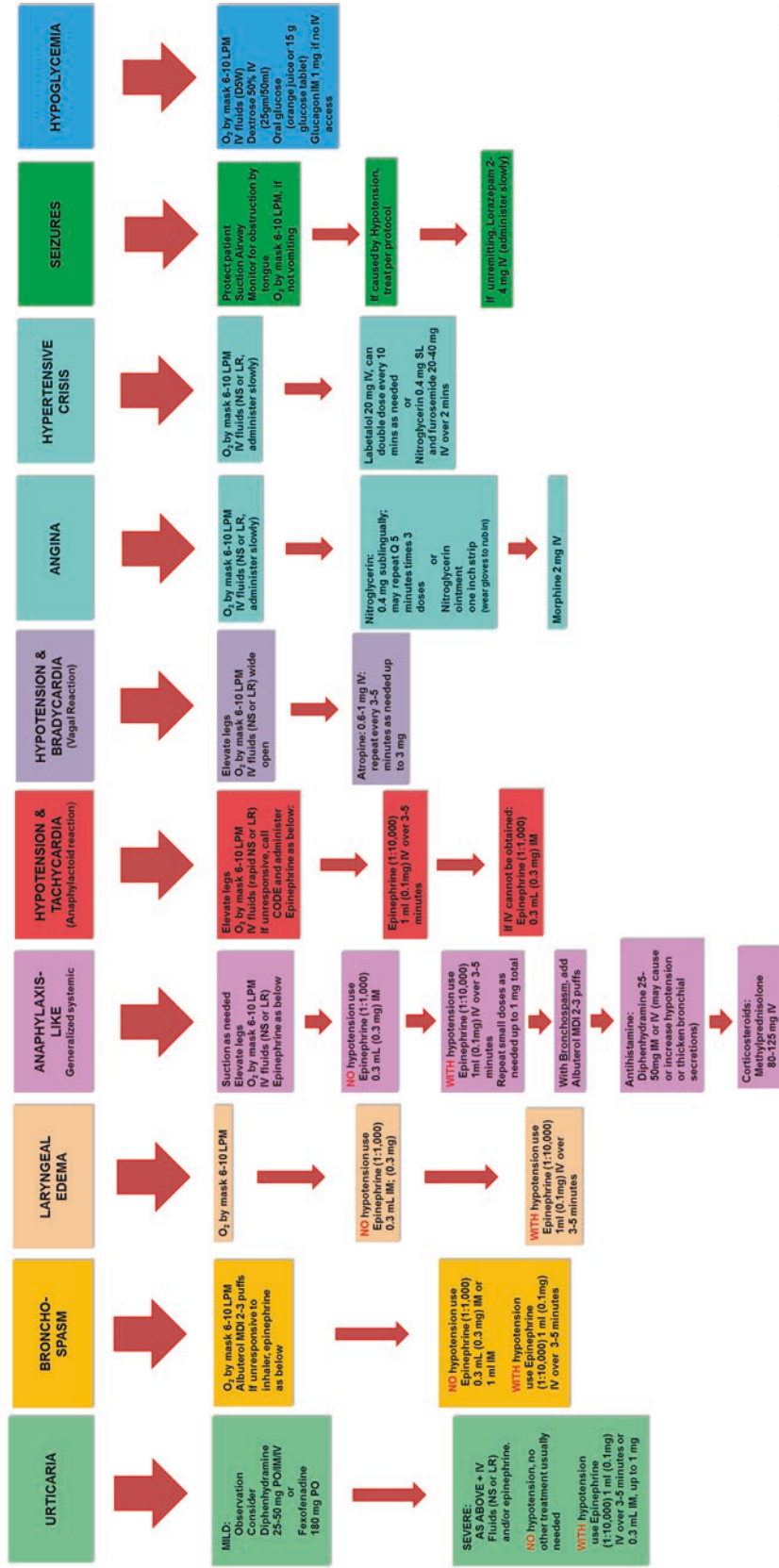
Steroids:

- Methylprednisolone 32 mg PO 12 h and 2 h prior to contrast administration.
- Dexamethasone 7.5 mg IV q 4 h for at least 2 doses prior to contrast.
- Prednisone tablet 50 mg, 1 tablet PO q6h. Patient should receive at least three doses prior to contrast.

Antihistamine: Diphenhydramine 25–50 mg intravenous or oral given 1 h prior to procedure.

Even a short course of steroids can induce hyperglycemia. Patients on the oral hypoglycemic metformin may have this drug held due to its association with lactic acidosis when contrast is administered, further exacerbating steroid-induced hyperglycemia.

ADULT Acute Reactions to Contrast Media Algorithm



Based Upon ACR 2017 Guidelines

Fig. 5.1 American College of Radiology 2017 guidelines for contrast reactions. Created based on data from [8] (Figure adapted from original created by Mark Golub, MD, Michael Hanshew, and Lee Jensen, MD)

Procedure Plan

One of the biggest challenges in assessing a patient in a clinic or hospital bed is anticipating how that patient will respond in a procedure setting, and what aspects of the procedure can be tailored to the patient. Here are some tips to consider:

- Determine if the patient can lie still, follow directions, and cooperate. If a patient is confused or agitated or reports paradoxical reactions to standard analgesics or anxiolytics, moderate sedation may not be easy, effective, or safe. An anesthesia consult may be indicated.
- A patient may appear eupneic and non-distressed sitting in bed or a chair but may desaturate or develop back pain when placed supine with little or no head elevation. Sometimes this can be managed with modifications to procedural approach or positioning.
- Assess and identify individual anatomic differences. Familiarity with the procedure and the patient's anatomy is needed to make an optimal procedure plan.

Key Point

ASA Classification:

Class I A normal healthy patient

Class II A patient with mild systemic disease

Class III A patient with severe systemic disease

Class IV A patient with severe systemic disease that is a constant threat to life

Class V A moribund patient who is not expected to survive without the operation

Class VI A declared brain-dead patient whose organs are being removed for donor purposes

Post-procedure Management

There must be a procedure note in the EMR prior to discharge or transfer to an inpatient bed [18]. The minimum required elements include the name of the primary surgeon and assistants, procedures performed and a brief description of each procedure, findings, estimated blood loss, specimens removed, and postoperative diagnosis.

Most IR practices have four tiers of post-procedure observation: rapid discharge directly from IR, a short period of observation in IR, less than 24-h observation in an inpatient bed, or transfer to an acute care bed or a longer-term observation unit. Admission and observation practices are both attending- and institution-dependent.

Patients should be seen by a licensed independent professional prior to discharge from IR, or before they leave the department for an inpatient bed. Assess the access site,

pulses, vital signs, patient level of consciousness, and ensure that orders are in place for care on the new care unit.

If a patient is being discharged to home, return to baseline neurologic status must be documented if sedation was administered [13, 15]. The American Society of Anesthesiologists has developed a practice guideline for sedation and analgesia by non-anesthesiologists. It is this guideline that most all hospital sedation policies are based on and includes monitoring of patients until vital signs and level of consciousness return to baseline [13]. Outpatients who receive sedation must have a ride home and must be accompanied by a responsible adult.

Post-procedure orders are required for even brief post-procedure observation. For most patients having a very short observation in IR, these orders are included in department protocols. For patients who will be transferred to a holding area or hospital bed, standard order sets are often available in the EMR. If a patient is being admitted to a service other than IR, contact the receiving team immediately following the procedure and document the conversation in the procedure note. Provide a description of the procedure performed, share any post-procedure concerns or special considerations, and relay contact information. Enter or give the receiving team the option to enter, post-procedure orders.

Post-procedure orders should include the following:

- Activity: Specify duration of bedrest, positioning, and when the head of bed can be elevated. Also specify limb movement restrictions as indicated.
- Diet: If advancing diet, include both starting and ending diet. These orders often quickly advance patients to a regular diet.
- Vital signs: Indicate how frequently vital signs must be checked. Place specific orders regarding evaluation of pulses (frequency and when to contact the IR). A skin marker can be used to identify location and quality of pulses immediately post procedure to ensure consistent evaluation.
- Meds: If a hospital or facility does not allow patients to take medications from home, order their home medications through the hospital pharmacy. Specific medications related to the procedure, such as post-procedural antibiotics, antiemetics, and pain management medications should also be ordered prior to transfer from the procedural area.
- Contact guidelines: Who to call (pager/cell number) and when (T > 38.5c, hematoma, pulse quality change).

Hospital Admission

Many practices will utilize hospitalists or other services for post-procedure observation, requiring careful communication and coordination of services. Admission to an IR service ensures that post-procedure orders are entered correctly and

that post-procedure adverse events are quickly identified and managed [1–3, 10–12]. This requires a knowledge of admission procedures, intrahospital care requirements, and discharge standards.

Admitting a patient to IR assumes responsibility for all aspects of patient safety. The IR ensures home medications are matched to appropriate counterparts on the hospital formulary, manages glucose levels in patients who have altered both their routine dosing and their caloric intake for procedure, and responds to changes in vital signs or laboratory values. It is entirely appropriate to consult other services for guidance, but all orders should be entered by the primary team.

IR practices with admitting privileges may have a resident, nurse practitioner (NP), or physician assistant (PA) as first call; however, an IR attending must be available at all times and round daily on any inpatient on the IR service [10]. Rounds should evaluate post-procedural patients as well as consult patients. Every visit to a patient should be documented by a brief note in the EMR. Many physicians are reluctant to write a note after a brief visit, but this documentation is just as important as the more formal note following daily scheduled rounds. Maintain continuity of care when there are multiple caregivers by instituting a post-call hand-off in the morning and a second handoff in the afternoon to the next on-call person.

Admission orders may be required before a patient can be moved to an inpatient bed. These orders are somewhat different from specific post-procedure orders. Some hospitals have specific units for post-procedure patients, which do not require a full hospital admission (often called short stay units, with a maximum stay time of 24 h). Other hospitals or units require all patients to be fully admitted, regardless of their post-procedure or observation status. Below is a time-tested resident's mnemonic for admission orders ADCC VANDALISM:

- Admit to: floor, service, MD
- Diagnosis
- Code status
- Call house officer parameters (when to call the house officer)
- Vital signs: frequency, indicate if pulses need to be checked and with which frequency
- Allergies
- Nursing: sequential compression devices (SCDs), incentive spirometry, I&O frequency
- Diet: target and current diet
- Activity: duration of immobilization and target activity
- Labs
- IV fluids: periprocedural fluid orders often do not carry over to the floor
- Studies: exams that need to be ordered
- Medications: home medications must be entered as well as appropriate inpatient medications

Discharge

Most hospitals have early discharge initiatives to allow time to prepare rooms for admitting new post-procedure patients. Interventional radiology is well suited to provide timely discharge of their overnight observation patients. Many IR practices have clinical benchmarks to expedite safe and efficient discharge. The specific criteria will vary based on the procedure performed, but the following are appropriate for most patients:

- Tolerating a diet.
- Able to void after urinary catheter removal.
- Morning laboratory results have been assessed.
- A family member or responsible adult is available to transport the patient home.
- Pain is controlled by oral medication.
- Puncture or access site is without complication. Document in the final examination the exact condition of the puncture site.

Discharge orders and instructions should include:

- Criteria on when and how to contact the department or when to call 911
- Restrictions on diet, activity, driving, lifting, or returning to work
- Medications, including reconciliation of pre-procedure medications, with new medications added
- Orders for outpatient imaging or phlebotomy, including when and where labs are to be drawn
- Appointments for return to IR clinic or referring physician clinic

If the patient underwent device implantation (stent, catheter, filter, etc.), they should receive the device name and lot number. Many manufacturers provide a wallet-sized card with this information. Ensure this information goes with the patient, as it is often forgotten the day after the procedure.

Careful evaluation of the patient and thorough family communication will help avoid complications or readmission. Many hospitals have nurses who call discharged patients one or more times in the days to weeks after a procedure to assist the patient with questions or problems, catch complications early, and reduce readmission.

Follow-up Visits

Evaluation in the IR clinic following a procedure combined with prompt communication with the referring team will close the loop for continuity of care. Identify your departmental guidelines regarding who to schedule for clinic and at what duration after the procedure. Patients with chronic

issues may be evaluated at regular intervals, to facilitate early intervention when symptoms or imaging indicate.

Ensure that the referring physician and the patient's primary care provider receive a copy of your formal procedure note, discharge summary, and follow-up office visit notes. Routing via the EMR is often sufficient, but a brief summary letter is always well received.

IR Clinic

Patient referrals from primary physicians as well as from other specialists should be seen in a dedicated IR clinic. Multidisciplinary clinics that focus on a particular disease, such as venous disease, arterial disease, woman's health, or specialized clinics such as hereditary hemorrhagic telangiectasia, can provide patients access to opinions from an IR and all other relevant experts involved in the treatment of their condition. If recent ultrasound or cross-sectional imaging is required, but not available prior to the office visit, arrange imaging for the day of the visit, prior to the appointment, to facilitate assessment and treatment planning.

The documentation in an office visit is similar to an inpatient consult and pre-procedure assessment. Many patients come to the clinic knowing that they will have a specific procedure, and the clinic visit is focused on pre-procedure preparation. Patients with more complex clinical situations may be seen in clinic for evaluation prior to any recommendation for intervention. A relationship is formed with the patient, which benefits the patient and the referring physician. Both will readily contact IR later for advice. Patient anxiety is reduced, and this can improve the procedure day experience. The IR team that only performs procedures without appropriate clinic visits denies the patient a valuable resource and support and loses the opportunity to develop more positive relationships with patients and referring physicians.

Once a plan has been determined, the office visit focuses on creating a smooth procedural experience. Key elements include obtaining consent, discussing code status, prescribing contrast allergy and antibiotic prophylaxis as indicated, and providing oral and written instructions for fasting, the holding and tapering of anticoagulation or hyperglycemic medications. During this visit, the IR will also order any laboratory blood work that may simplify preparation on the day of the procedure. If the EMR allows, place pre-procedure orders for the day of the procedure, including perioperative medications to be given. This work-up in clinic will ensure the patient arrives for the procedure completely prepared.

If no procedure is indicated, arrange follow-up for the patient with the IR or the referring physician, ordering imaging or other tests as needed. The patient should leave the office with either (1) a procedure scheduled, (2) a follow-up appointment, (3) a referral back to their primary provider, or

(4) referral to another specialist who may be best able to evaluate or treat their condition.

Conclusion

Interventional radiologists, like physicians in any procedure-based specialty, must work with referring physicians to provide expert evaluation and management. Mastery of diagnostic radiology combined with the clinical acumen acquired in IR ensures that the proper procedure is performed in the correct manner, at the right time, and that the patient's safety is maximized throughout the time they are in the care of the IR team.

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