Interventional radiologists (IRs) play an integral role throughout the spectrum of oncologic care from diagnosis to therapy to palliation. The latest clinical trials and device innovations within interventional oncology are often directed at trying to “kill” cancer, which can leave us overlooking the important role we have in end-of-life care, where the outcomes are not measured in progression-free survival or overall survival, but rather in comfort, pain scales, the ability to sleep, and the time to say goodbye to loved ones. As interventional oncologists, our role is as much about helping our patients achieve a good death as it is trying to prevent it. This causes a difficult paradox for IRs to resolve—we recognize the inevitability of death for our patients, but as people and overall as a culture, it is more comfortable to deny or ignore death’s existence.

Although other medical specialties have addressed this by integrating hospice and palliative medicine education into general training paradigms, interventional radiology training has not traditionally focused on this concept, which leaves IRs ill prepared to have end-of-life discussions or feeling that it is not within our scope of practice. This may sometimes result in performing procedures that will help neither the patient’s survival nor quality of life. Conversely, we may inadvertently defer intervention in a patient with advanced cancer, citing that intervention may be futile. For the IR to provide effective palliative care, he/she must be willing to have a frank conversation directly with the patient about the goals of therapy and an understanding of what constitutes a “good death.”

Good death is a concept that arose from the hospice movement over 50 years ago. The National Academy of Medicine (formerly the Institute of Medicine) reports good death as “one that is free from avoidable distress and suffering for the patient, family, and caregivers, in general accord with the patient’s and family’s wishes and reasonably consistent with clinical, cultural, and ethical standards.”¹ When patients and family members are asked what constitutes good death, the near-universal top responses are pain-free death and control of the dying process.² This article briefly reviews the different sources of cancer pain and select interventions that have been demonstrated to have benefit in managing pain in the palliative setting, such as thermal ablation for the amelioration of metastatic musculoskeletal pain, nerve blocks for abdominal pain, and enteral tube placement for relief of symptoms from malignant bowel obstruction (MBO).

PAIN-FREE DEATH

Causes of pain in the cancer patient may be due to the direct local effects of tumor, medical treatments (iatrogenic), or psychological distress. It is estimated that 50% to 64% of patients with cancer suffer from at least moderate pain.³ Cancer pain can be classi-
fied as somatic, visceral, neuropathic, or mixed in 35%, 17%, 9%, and 39% of patients, respectively.4

Somatic Pain
Pain directly attributable from the local effects of the tumor is usually somatic. The most common location is in bone, with approximately 50% of cancer patients developing bone metastasis.5 Although the majority of metastatic bone lesions may be incidentally found and asymptomatic, those that do cause pain lead to significant morbidity, resulting in loss of work, mobility, and dependence on narcotic pain medication.

There are various non-interventional treatment options for bony metastasis, including local field external beam radiation, stereotactic radiosurgery, radionuclide therapy, receptor activator of nuclear factor-κβ ligand inhibitors (denosumab), bisphosphonates, and in select cases, surgery. Minimally invasive interventional procedures for the palliation of bone pain have been well studied.

For painful bone metastases, including vertebral metastases, percutaneous radiofrequency ablation, cryoablation, and percutaneous cementoplasty have proven to be effective in palliation of bone pain.6–10

On average, patients can expect to have a 2-point drop in their “worst” pain score after thermal ablation.6,7 Patient selection criteria include patients with pain limited to one or two sites of metastatic bone disease with pain that rates ≥4 on a pain scale of 0 to 10 and who are not suitable candidates or have failed other standard forms of therapy. Contraindications include tumors that are in direct contact with hollow viscera or neural elements, and in general, the edge of the ablation zone should be at least 1 cm away from the spinal cord, major motor nerves, brain, spinal artery, bowel, or bladder. There is no limit to the size of tumor that can be treated, as the goals of ablation are to target the bone–soft tissue interface to obliterate the sensory nerve fibers supplying the periosteum, mechanically decompress the volume of tumor, destroy the cytokine-producing tumor cells, and inhibit osteoclast activity.11 The routine use of validated pain scales,

Figure 1. Percutaneous internal fixation. A 56-year-old woman with multiple myeloma and extensive lytic lesions throughout the axial and appendicular skeleton presented with debilitating right hip pain due to a 5-cm lytic lesion in the right acetabulum (arrow) (A). Under cone-beam CT and fluoroscopic guidance, a 3.2-mm K-wire (arrow) was advanced through the ischial ramus using a cranial trajectory along the ilioischial line, through the lytic lesion, and into the superior aspect of the ilium (B). An 8-mm-diameter X 13-cm titanium alloy, fully threaded cannulated screw was advanced over the wire. Three 11-g needles (arrowheads) were placed and used to inject methyl methacrylate under direct fluoroscopic visualization to ensure adequate filling of the lytic lesion, cement coverage along the screw, and prevention of cement extravasation into the hip joint. Cement injection through each needle was stopped when cement abutted the hip joint (C). Coronal and sagittal reconstructions from postprocedure cone-beam CT confirmed screw fixation across the lesion, cement distribution throughout the lytic right acetabular lesion, and absence of extravasation into the joint space (D).
such as the Brief Pain Inventory and the Memorial Pain Assessment Card, are valuable tools for scoring pain severity and provide baseline data for assessment of pain relief postintervention. The patient’s opioid analgesic use can also be recorded and translated into a morphine-equivalent dose for future comparisons.

An emerging trend in treatment of musculoskeletal metastases is incorporation of percutaneous internal fixation interventions,\textsuperscript{12-14} which allow the IR to treat and palliate pathologic, insufficiency, and impending pathologic fracture due to osteolytic metastases.\textsuperscript{12} The use of percutaneous screw fixation permits fracture stabilization, resulting in pain palliation. Typically, nondisplaced fractures of the sacrum, iliac crest, acetabulum roof, pubic ramus, and proximal femur are suitable for percutaneous screw fixation with the idea that the screws should be inserted perpendicularly to and across the fracture line (Figure 1).

Arterial embolization, a technique within the armamentarium of any IR, should not be forgotten as a possible tool for pain palliation for musculoskeletal metastases. The onset of symptomatic relief after transarterial embolization can be as early as 12 hours after the procedure and may last up to 3 to 9 months for metastatic lesions.\textsuperscript{15} Rossi et al\textsuperscript{16} reported on a subset of over 309 embolizations performed in 243 patients for pain palliation of bone metastases. A clinical response was achieved in 97% of procedures and associated with a more than 50% reduction in pain score and analgesic use. The mean duration of pain relief was 8.1 months (range, 1–12 months). Patients who experienced recurrent pain did so at a reduced intensity, and repeat embolizations were performed successfully with subsequent pain relief. Although any hypervascular metastasis is amenable to transarterial embolization, patients with metastases secondary to renal cell and thyroid carcinomas have historically had better responses to embolization therapy as compared with patients with bone metastases related to lung cancer.\textsuperscript{15,16}

**Visceral Pain**

Visceral pain in cancer patients is usually difficult to localize and commonly presents as midline or diffuse abdominal pain. It is often described as achy or a pressure sensation rather than the sharp pain associated with somatic pain mechanisms. Visceral pain originates from organs or body cavity linings such as pleura or peritoneum, and treatment is often aimed at the afferent nerve fibers that transmit these pain signals. Opioids are the gold standard for the treatment of visceral pain but have unfortunate side effects such as somnolence, addiction, and constipation, which can exacerbate visceral pain symptoms and interfere with a patient’s quality of life. Interventional radiologic approaches to treatment of visceral pain center on disruption of afferent pain signals and relief of organ distention.

Celiac ganglion and splanchnic nerve blocks are designed to disrupt afferent pain signals and are often used in patients with upper gastrointestinal malignancies and severe abdominal pain.\textsuperscript{17} To perform a celiac ganglion neurolysis, 15 to 20 mL of 98% ethanol is administered from one or
two needles that are placed using CT guidance and from a posterior approach inferior to the celiac artery at the diaphragm (Figure 2). Technical success rates approach 100%, major complications are low (2%), and patients often report partial or complete pain relief (70%–90%). Although typically reserved for failure of opioid analgesia, with the current opioid epidemic and evidence that neurolysis is more effective earlier in the course of malignancy, this intervention should be considered early in a patient’s disease course.

Visceral pain from viscous organs is transmitted through visceral nociceptors and sensory fibers that are activated by distension during MBO, which is a common symptom in terminal cancer patients, occurring in up to 42% of ovarian and 24% of colorectal cancer patients. Surgical management of MBO has been associated with mortality rates of up to 40%, and the standard of care has shifted toward placing endoscopic or percutaneous gastrostomies for palliation, allowing patients to remove nasogastric tubes and complete the transition to home or hospice care.

Standard techniques for the placement of image-guided gastrostomies are usually sufficient; however, there are subsets of patients who have unsuitable anatomy for or contraindications to percutaneous or endoscopic gastrostomies and are not surgical candidates. In these cases, percutaneous transesophageal gastrostomy tubes, pioneered in Japan, are effective at providing palliation.

A phase 2 study of percutaneous transesophageal gastrostomy tubes demonstrated a technical success rate of 100% and successful pain palliation achieved in 30 of 33 patients (Figure 3).

Percutaneous CT and fluoroscopy-guided diverting catheter colostomies have similarly been shown to relieve pain in 89% of patients with large bowel obstruction who are not surgical candidates.

CONTROL OF THE DYING PROCESS: EMERGENT PALLIATIVE PROCEDURES

Control of the dying process is fundamental to the patient’s and their family’s concept of good death.
This includes the idea of a death scene and trying to control how, who, where, and when it occurs. It also includes the ability to say goodbye to loved ones, make any necessary financial arrangements, and meet with clergy members/receive religious comfort. Patients with advanced cancer may present with medical emergencies that not only threaten their life but also their ability to control their dying process. Interventional treatments in this setting do not have an impact on the disease outcome but rather provide patients with time. Interventions on these patients have been well described, particularly embolization for patients who present with gastrointestinal bleeding, hemoptysis, and epistaxis. These procedures are a temporizing measure for the acutely ill patient, and while they do not increase a patient’s survival, they often provide the opportunity for a patient to take control of the dying process and to retain quality of life at the end of life (Figure 4).

**ADVANCED DIRECTIVES IN INTERVENTIONAL RADIOLOGY**

Many patients have advanced directives for their health care wishes concerning end-of-life care. A do-not-resuscitate (DNR) order is limited in its scope to a few clinical scenarios and deals with a patient’s negative authority to refuse specific treatments and should not be interpreted to mean that a patient does not want anything done. Providers often make inaccurate assumptions about more broad medical treatments because of an active DNR order. In a survey of 155 medical and surgical residents, nearly 33% of respondents said they would not give antibiotics to a patient with a DNR order. The clinical IR should avoid this pitfall of drawing inaccurate conclusions about goals of care from a DNR order. Each consult is unique and requires an individualized approach and discussion with the patient and family. Even in terminal cancer patients, an invasive procedure may have benefits. The treating...
oncologist is invaluable in assessing these patients and providing prognostic information, but they should not be a proxy for a personal discussion with the patient regarding goals of therapy.

Once the decision has been made to perform a procedure in a patient with an advanced directive, the status of the DNR order needs to be addressed with the patient and/or family. When patients undergo procedures in an interventional suite or operating room with sedation or anesthesia, they may incur adverse events that are readily reversible, and the continuation or suspension of the DNR orders should be directly discussed prior to the procedure. The American College of Surgeons position statement on this topic states that policies that automatically enforce or cancel DNR orders in the operating room “do not sufficiently support a patient’s right to self-determination.”29 Required reconsideration (or the discussion of how the DNR will be applied during the perioperative period) of the DNR order could result in a temporary lifting or revision of the DNR order in the perioperative period, or in its strict adherence. The same approach of required reconsideration should be the practice of IRs providing palliative interventions. The outcome of the required reconsideration discussion needs to be documented in the medical record and communicated to all members of the periprocedural team.

CONCLUSION

IRs play an integral role in the care of the cancer patient and are often involved in end-of-life care. Any consult on a terminal cancer patient, with or without a DNR order, requires careful medical and ethical decision making that must be explored by the IR with the patient, family, and multidisciplinary care team. Embracing the concept of good death and willingness to have end-of-life discussions will help with the decision to offer palliative interventional procedures for terminal cancer patients.