The coupling of diagnostic and therapeutic radiopharmaceuticals is important for the treatment of osteoblastic skeletal metastases.

Skeletal Scintigraphy
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**Background:** Skeletal scintigraphy remains a valuable tool in the initial and subsequent evaluation of the skeletal system in patients with a diagnosis of primary or metastatic neoplasms.

**Methods:** We discuss radiopharmaceuticals, nuclear medicine imaging techniques, and current as well as future oncological applications in the adult population. Pertinent literature was reviewed to describe the advantages and limitations of available technologies for the evaluation of skeletal metastatic disease. Evaluation of primary and metastatic skeletal disease using nuclear medicine and positron emission tomography techniques is discussed.

**Results:** Skeletal scintigraphy provides valuable information in the initial evaluation for the presence of osteoblastic skeletal metastases. Incremental advances on available radiopharmaceuticals (fludeoxyglucose $F_{18}$, sodium fluoride $F_{18}$), coupled with advances in imaging techniques and imaging devices (single photon emission computed tomography/computed tomography, positron emission tomography/computed tomography, positron emission tomography/magnetic resonance imaging), have had a significant impact on sensitivity, specificity, and accuracy rates for the detection of skeletal metastases.

**Conclusions:** Skeletal scintigraphy has a significant role in the initial diagnosis, staging, restaging, and treatment monitoring of patients with cancer and primary skeletal or metastatic disease. The coupling of diagnostic and therapeutic nuclear medicine agents in the setting of osteoblastic skeletal metastases is a valuable tool for the treatment for certain cancer types, including prostate cancer, and may become more widely used to treat other histologies as more data on other tumor types (eg, breast cancer, osteosarcoma) become available.

**Introduction**
Techniques in nuclear medicine remain a mainstay of the initial evaluation and staging of cancer as well as during restaging and treatment monitoring. Advanced imaging techniques such as single photon emission computed tomography (SPECT) and SPECT with computed tomography (CT) offer improved rates of sensitivity, specificity, and accuracy. Use of radiopharmaceuticals for positron emission tomography (PET) integrated with CT or magnetic resonance imaging (MRI) further increase the rate of diagnostic accuracy in this rapidly evolving technology. Thus, the coupling of diagnostic and therapeutic radiopharmaceuticals is important for the treatment of osteoblastic skeletal metastases.

**Skeletal System**
The skeletal system is dynamic and subject to internal and external stresses to which it must adapt. It is con-
structed of inorganic calcium hydroxyapatite crystal, an organic collagen matrix, and blood vessels. Normally, a constant balance exists in bone deposition by osteoblasts and bone resorption by osteoclasts.

**Radiopharmaceuticals**

Pharmaceuticals incorporate chemical compounds into the skeletal inorganic matrix. Ideally, they must be affordable, easy to produce, and stable; they must be rapidly absorbed by the desired target tissue; be cleared by nontarget tissue; limited in the amount of radiation they deposit into the body; and they must have favorable imaging characteristics. Radiopharmaceuticals used for diagnostic imaging are either γ-or positron-emitting. During their production, the active carrier (biologically active drug) and the radioactive compound (radionuclide) chemically combine to form the radiopharmaceutical agent.

For several decades, radiopharmaceuticals compounded with the radioactive tracer technetium Tc 99m were the most commonly utilized in clinical practice. Such examples include methylene diphosphonate (MDP) and hydroxymethylene diphosphonate (HMDP). The nonradioactive agents are stored at a local radiopharmacy, whereas the radioactive agent (eg, technetium Tc 99m) is produced from a generator system. Technetium Tc 99m is produced as the intermediate decay step for molybdenum 99 (half-life of 66 hours), which is produced by the fission of uranium 235. Technetium Tc 99m (half-life of 6 hours) then decays to its stable counterpart (half-life of 212,000 years).

Quality-control measures help to ensure these agents are safely produced and handled, and that their intended behavior is preserved for diagnostic imaging. Colloid formation from excess alumina in the technetium Tc 99m generation process will manifest as increased uptake in the liver and reticuloendothelial system. Subsequent production errors may include incomplete labeling of the pharmaceutical agent, which can cause an altered distribution in the body. Unlabeled "free" technetium Tc 99m increases radiotracer localization in several organs (eg, stomach, salivary glands, thyroid gland, kidneys).

After the intravenous administration of technetium Tc 99m MDP or HMDP, the bone rapidly extracts the radiopharmaceutical agent. The distribution of the radiopharmaceutical agent may depend on regional blood flow, but it is generally dependent on osteogenic activity. Areas of active bone turnover, such as areas of formation or repair, have relative higher uptake levels than areas of mature, undisturbed bone. Although peak bone uptake (approximately 50% of dose administered) occurs at approximately 1 hour after injection, the peak target-to-background occurs 6 hours after injection — by which time the tracer is nearly one-half decayed. Typically, skeletal scintigrams with technetium Tc 99m MDP or HMDP are imaged 3 to 4 hours after the intravenous radiotracer is administered to balance the target-to-background ratio with the rate of radioactive decay, in conjunction with the radiation dose as low as reasonably achievable.

Technetium Tc 99m MDP or HMDP binds to skeletal bone by chemisorption in the hydroxyapatite mineral bone matrix. However, areas of amorphous calcium phosphate will also bind to technetium Tc 99m MDP or HMDP. For clinical purposes, the typical dose range of technetium Tc 99m MDP/HMDP is 20 to 30 mCi (740–1110 MBq), and the surface of the bone receives the highest dose (estimated at 0.23 rad/mCi [0.063 mGy/MBq]).

Primary or metastatic skeletal neoplasms may have increased binding of sodium fluoride F 18 upon their initial presentation. Sodium fluoride F 18 is a positron emitter with a half-life of 110 minutes. The US Food and Drug Administration approved this agent for intravenous use in 1972. Clinical interest was again stimulated in 1993. Use of PET/CT is now widespread, and sodium fluoride F 18 is manufactured and distributed across the country. The affinity of sodium fluoride F 18 for osteoblastic processes is nearly 100%. It also has a nearly 100% first-pass extraction fraction from the blood pool. It localizes via chemisorption, forming fluorapatite in areas of actively mineralizing bone. Diagnostic imaging can be obtained after 30 to 60 minutes of intravenous administration. Because it is a positron emitter, multiplanar tomography can be obtained with prior and current-generation positron-imaging devices. The Society of Nuclear Medicine and Molecular Imaging has published guidelines for its use.

Clinically, the typical dose range of sodium fluoride F 18 is 5 to 10 mCi (185–370 MBq), and the organ receiving the highest dose is the urinary bladder (estimated at 0.81 rad/mCi [0.22 mGy/MBq]). Because of its favorable characteristics, sodium fluoride F 18 can be administered at a lower dose than technetium Tc 99m, thereby maintaining safety despite a higher level of exposure to energy radiation. Providing the patient with adequate hydration before its administration and allowing the patient to frequently void are important for minimizing the radiation dose (Fig 1).

**Imaging Protocols**

**Technetium Tc99m Compounds**

Imaging protocols can be tailored to the clinical question being addressed. Dynamic imaging (blood flow phase, blood pool, soft-tissue phase) after the administration of radiopharmaceuticals can be performed. Tailoring may be useful in certain clinical scenarios, such as infection, trauma, the loosening of hardware, chronic regional pain syndrome, and in the assessment of imaging.
bone-graft viability. The entire skeletal system should be imaged. Imaging can be obtained in a single, continuous pass from multiple projections, or as numerous “spot” images until the entire skeleton is imaged.

**Sodium Fluoride F 18**

Due to the high extraction fraction and shorter half-life of sodium fluoride F 18, lower absolute specific activity of this radiopharmaceutical can be administered relative to other bone-seeking compounds. In addition, imaging can be obtained sooner, usually 30 to 90 minutes after intravenous administration. In general, imaging of the entire skeleton is obtained per established protocols for each specific device (PET, PET/CT, PET/MRI) in a tomographic fashion for subsequent, multiplanar reconstruction.

**Imaging Devices**

**Gamma Camera**

The gamma camera system is available in several configurations; the basic design has been available for many years. Its configurations are based on the number of detector “heads” utilized, which include single-, dual-, and triple-head configurations. Planar imaging (2-dimensional) is the most commonly utilized. Continuous-acquisition, whole-body anterior and posterior imaging can be obtained by allowing the detector(s) head(s) to remain stationary while the patient lies still in a supine position on the camera bed, which moves at a slow rate. Alternatively, static (spot) imaging of specific body sections can be obtained by allowing the detector(s) and the patient to remain stationary for a set amount of time or a set amount of radiotracer-detected events (counts). Commonly, physicians may combine anterior and posterior whole-body imaging with complementary, static imaging from alternate projections to achieve maximal skeletal coverage. These scans are then displayed using uniform window/level settings or can be archived for later interpretation and review.

**Single Photon Emission Computed Tomography**

The gamma camera systems can generate multiplanar (3-dimensional) imaging by recording radiotracer emission events while rotating the detector heads around a patient. This technique is known as SPECT. The patient remains stationary, usually in a supine position, while the detector(s) head(s) rotate around him or her. The rotation can be set as a fixed or variable rotation and is defined by its radius. The detector(s) head(s) record radiotracer emission events of the patient from multiple projection steps that will be reconstructed at a later time in multiple planes. These steps can be defined by time, counts, or both time and counts. The amount of steps taken to generate a single image can also be adjusted. To image an area larger...
than the coverage size of the detector head(s) (eg, the entire body), multiple, sequential series of tomography must be obtained, which can take longer when compared with the time it takes to obtain whole-body planar imaging. Typically, these examinations are performed at dedicated computer workstations with software that can reconstruct these data in multiple planes and are optimized for display and interpretation.

**Single Photon Emission Computed Tomography/Computed Tomography**

Camera systems combining SPECT capabilities with radiological CT have been available since the early 2000s. These gamma camera systems benefit from the added anatomical localization offered by imaging inline acquisition and registration. For the technology to work, the patient must lie still on the imaging table while the detector head(s) record the radiotracer-emission events. CT is obtained while the patient continues to remain still in the same position; the data are subsequently registered. The order in which SPECT or CT is acquired can be tailored to the specific scenario evaluated. Low-dose CT can be performed for attenuation correction and image registration purpose, or it can be performed with diagnostic-quality CT parameters, similar to stand-alone CT scanners, for diagnostic purposes.

Similar to SPECT, the imaging data are usually exported to dedicated workstations with software capable of multiplanar reconstruction and display. These workstations can combine data from both SPECT and CT to generate co-registered scans. These are usually displayed with the CT data as background gray-scale imaging and the SPECT data displayed as color overlay. In general, both image sets can be independently reviewed. Technological developments have made it possible to normalize data from SPECT based on attenuation correction parameters obtained from CT, with corrections made for patient weight and height and administered dose-decay correction calculations, thus enabling the calculation of standardized uptake values, similar to those that have been available with PET for many years. The quantitative analysis of abnormality detection is now possible and it is quite promising; however, the value of such analyses has yet to be determined.

**Positron Emission Tomography, Positron Emission Tomography/Computed Tomography, and Positron Emission Tomography/Magnetic Resonance Imaging**

The design of PET scanners varies due to the gamma camera system designs: The detectors are static, and so is the patient. The most commonly used design has a full ring of detectors that can be several rows deep. The radiotracer emissions — in this case, positrons — are recorded as the emitted positrons decay by emitting a pair of photons in nearly opposite directions (~ 180 degrees). The detection events recorded by the detector ring are filtered based on a set time gap (electronic collimation) that allows the computerized system to count these recorded events as being true or false. When these events are recorded as being true, the origin of the positron decay is plotted in space and recorded to generate an image. Many of these true events need to be recorded to generate a diagnostic imaging map so that the radiopharmaceutical decay is accurate. The imaging table with the patient will move in and out of the detector ring to generate a whole-body map. Tomographic images are then reconstructed in multiple planes for interpretation.

To use the PET data, corrections must be made based on the attenuation of the photons by the body as well as the rate of radiotracer decay. Therefore, an attenuation map of the patient must be generated and decay correction factors applied. The height and weight of the patient must also be recorded for these calculations. The attenuation correction map can be generated in several ways. Historically, an external radiation source was used to record the transmission of radiation through the patient (called transmission imaging), which was then used to generate an attenuation correction map, subsequently applying this information to generate the attenuation-corrected PET imaging. However, since the development of the PET/CT hybrid system, the attenuation correction map of CT replaced the transmission attenuation map while also delivering the benefit of having co-registered anatomical CT imaging for precise lesion localization. CT used for attenuation correction can be obtained as a lower dose or as a diagnostic-quality dose. Other diagnostic parameters such as breath-holding, the administration of intravenous or oral contrast, and multiphasic vascular enhancement imaging, can be performed using these systems. However, such a discussion is beyond the scope of this article.

Available hybrid PET/MRI systems offer the advantage of the simultaneous acquisition of data from both PET and MRI while also delivering less total radiation exposure to the patient, because MRI replaces CT for image registration, attenuation correction, and precise lesion localization. Other advantages include its soft-tissue contrast resolution, functional MRI capabilities, and clear advantages in neurological, gastrointestinal, and musculoskeletal imaging. However, MRI has disadvantages, including its limited performance for attenuation correction mapping when evaluating structures such as cortical bone (which usually does not generate a magnetic resonance signal); its susceptibility to patient motion; additional time needed to obtain imaging if the machine is in diagnostic mode (multiple sequences are obtained); and its significant cost. At the time of publi-
cation, PET/MRI is not reimbursed by the US Centers of Medicare & Medicaid Services as a single modality.

**Indications**

Most skeletal scintigrams performed in clinical practice are for the evaluation of skeletal metastatic disease in patients with diagnosed neoplastic disease. The most common primary neoplastic processes evaluated for skeletal metastatic disease in adults include breast, prostate, and lung cancers, which are also the leading cancers diagnosed and the leading causes of cancer-related death in American adults.6

Skeletal scintigraphy plays a primary role in the evaluation and management of cancer. The technology is sensitive for detecting skeletal abnormalities, providing the benefit of whole-body evaluation, with multiplanar capabilities such as fusion capabilities with CT using SPECT/CT devices. Up to 75% of patients diagnosed with a malignancy who present with pain will have evidence of skeletal metastatic disease when evaluated by a clinician. Moreover, a significant number of asymptomatic patients with cancer will have evidence of skeletal metastatic disease on scintigraphic examinations.7

Most skeletal metastases are distributed throughout the axial skeletal system, within the red marrow, as well as the proximal appendicular skeleton such as the humerus and femur. As skeletal metastases grow and erode the cortical bone, the reparative process begins and increased osteoblastic activity ensues, increasing the detection rate of radiotracers, which, notably, localize to the areas of attempted bone deposition, not the tumor lytic process itself. Purely osteoblastic metastases can be identified as areas of increased uptake. However, the detection level of purely lytic metastatic lesions is decreased until a pathological fracture is present or the bony destruction is such that osteoblastic activity secondarily occurs. Mild changes (5%–10%) in bony turnover can be detected with this technology, whereas approximately 50% mineralization loss is needed for radiographical detection.8 Prostate and breast cancers are examples of traditionally mostly osteoblastic metastatic processes, whereas renal cell carcinoma, multiple myeloma, and thyroid carcinoma are examples typical of lytic metastatic processes. Some tumors have a mixed lytic/blastic presentation such as lung and esophageal cancers.

Sensitivity of skeletal scintigraphy is also affected by the imaging technique utilized. The sensitivity rate of planar skeletal scintigraphy is reported to be between 70% and 90%; however, the sensitivity rate of additional tomographic evaluation, such as SPECT and SPECT/CT, can be as high as 95% in select series.8

Patients with widespread, metastatic skeletal disease who undergo treatment and imaging during the early phases of therapy may demonstrate “flare phenomenon.” This scenario usually occurs early during therapy, when skeletal scintigraphy shows suspected progression of disease based on the numerous new lesions identified, sometimes concordant with worsening symptoms (most commonly pain). However, on follow-up skeletal scintigraphy, lesions regress in uptake (usually 4–6 months after treatment) concordant with the resolution of symptoms as well as increased sclerosis of the metastatic lesions usually identified on CT.

Fig 2. — Widespread, metastatic skeletal disease on superscan.
With regard to skeletal metastases, sodium fluoride F 18 is commonly used in the setting of breast, prostate, and lung cancers. Bone is the most common site of breast cancer metastases, reaching an incidence of up to 85% in advanced cases. Schirrmeister et al compared sodium fluoride F 18 PET with skeletal scintigraphy and SPECT for use in breast and lung cancers and found that sodium fluoride F 18 PET detected 64 bone metastases in 17 patients compared with 29 metastases detected in 11 patients with skeletal scintigraphy. Damle et al studied 72 histologically proven cases of invasive ductal carcinoma and found that sodium fluoride F 18 PET/CT had the highest rates of sensitivity (100%) and accuracy (91.67%) but lower rates of specificity (75%) when compared with fludeoxyglucose F 18 PET/CT (100%, Fig 3).

Bone is a common site of metastatic disease after lymph nodes in patients with prostate cancer. Even-Sapir et al found that sensitivity and specificity rates for detecting bone metastases were 70% and 57% for bone scintigraphy, 92% and 82% for bone SPECT, 100% and 62% for sodium fluoride F 18 PET, and 100% and 100% for sodium fluoride F 18 PET/CT, respectively. They concluded that sodium fluoride F 18 PET/CT is a sensitive and specific imaging modality for detecting bone metastases in prostate cancer (Fig 4).

Exclusion of bone metastases is important in non–small-cell lung cancer because the disease may be curable by surgery. Sodium fluoride F 18 PET/CT has been shown to have a higher rate of accuracy in the evaluation of bone metastases in lung cancer when compared with bone scintigraphy alone or bone SPECT/CT. Krüger et al compared fludeoxyglucose F 18 PET/CT with sodium fluoride F 18 PET and bone scintigraphy with regard to bone metastases in lung cancer. Concordant bone metastases were found on fludeoxyglucose F 18 PET/CT and sodium fluoride F 18 PET in 13 of 18 patients. Sodium fluoride F 18 PET detected bone metastases in 4 of the study patients who had false-negative findings on fludeoxyglucose F 18 PET/CT.

Therapeutic agents that target osteoblastic metastases include strontium Sr 89, samarium Sm 153, and radium Ra 223. Traditionally, diagnostic skeletal scintigraphy was used in the initial evaluation of patients with osteoblastic metastases. The purpose of pretherapeutic imaging is for patient selection and to determine the burden of osteoblastic disease. Using a diagnostic imaging radiotracer in combination with a therapeutic radiotracer is not new, as it has been a model for the treatment of thyroid cancer. The coupling of diagnostic and therapeutic nuclear medicine agents for the management and treatment of osteoblastic metastases has served as a model for other diagnostic and therapeutic radiopharmaceutical combinations in other disease therapies (eg, lymphoma, neuroendocrine tumors).
However, further discussion is beyond the scope of this publication, but such an example is illustrated in Fig 5.

**Sodium Fluoride F 18 Positron Emission Tomography/Computed Tomography in Primary Skeletal Malignancies**

Primary bone tumors are rare neoplasms that can occur in children and young adults, accounting for 5% and 0.2% of malignancies, respectively. A role may exist for sodium fluoride F 18 PET/CT with regard to grading, staging, and evaluating response to therapy in such primary skeletal malignancies.

Osteosarcoma is the most common malignant primary bone tumor, accounting for 35% of bone tumors; its incidence peaks in the second decade of life. The literature is limited regarding the use of sodium fluoride F 18 PET/CT for the management of osteosarcomas. However, preliminary findings have been reported in small studies. For example, Hoh et al evaluated 13 patients with malignant bone lesions, 4 of which were confirmed to represent osteosarcoma. Patients with untreated osteosarcoma demonstrated the highest tumor-to-normal bone activity ratios compared with the other malignant lesions, and, in 1 study patient, the activity was reduced following the use of chemotherapy and immunotherapy. Although research is still needed, these findings suggest that quantitative sodium fluoride F 18 PET/CT may have some utility in monitoring therapeutic response. Increased uptake has also been shown in patients with proven pulmonary metastatic disease related to osteosarcoma. CT of the chest is the standard imaging modality for staging/restaging purposes; however, when compared with fludeoxyglucose F 18, sodium fluoride F 18 PET/CT may have added utility because pulmonary metastases due to osteosarcoma and Ewing sarcoma tend not to be fludeoxyglucose F 18 avid, regardless of their size.

Ewing sarcoma is the third most common malignant bone tumor, accounting for 16% of cases. Most cases are diagnosed within the first or second decades of life; increasing age is associated with a poor prognosis. The bones of the chest wall, the long bones of the lower extremities, and the pelvis are commonly involved, with metastasis routinely involving other bones and the lungs. In most cases, imaging involves CT of the chest and technetium Tc 99m MDP bone scintigraphy to evaluate for metastasis. Fludeoxyglucose F 18 PET can identify the extent of disease, although its role in the workup of Ewing sarcoma is unclear. No research studies are evaluating the use of sodium fluoride F 18 PET/CT in Ewing sarcoma, although Mosci et al have shown that such lesions have intense uptake. Thus, additional research is needed to define the potential role of sodium fluoride F 18 PET/CT in Ewing sarcoma.

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Fig 4A–B. — (A) Sodium fluoride F 18 PET/CT showing osteoblastic skeletal metastases in a patient with prostate cancer. (B) Fludeoxyglucose F 18 PET/CT showing numerous, metabolically active metastases in the same patient, some involving the skeletal system. The metastases were not visible on prior skeletal scintigraphy.

PET/CT = positron emission tomography/computed tomography.
Multiple myeloma (MM) is a neoplastic proliferation of plasma cells in the bone marrow, most commonly affecting elderly persons. Workup for suspected MM includes a radiographical bone survey, bone marrow aspiration, and biopsy.\textsuperscript{16,20} Radiographically, MM typically presents as small lytic lesions and commonly involves the vertebrae, ribs, skull, and pelvis.\textsuperscript{16,21} Technetium Tc 99m MDP scintigraphy is not commonly performed secondary to lack of uptake in the lytic lesions. Research is being conducted regarding the use of sodium fluoride F 18 PET/CT in MM, and preliminary results indicate that the potential for quantitation may provide benefit compared with traditional bone scintigraphy.\textsuperscript{16}

**Positron Emission Tomography/Magnetic Resonance Imaging in Skeletal Metastatic Disease**

The success of PET/CT in clinical practice has yielded an interest and need for research using other advanced, hybrid imaging modalities such as PET/MRI. Initially, PET/MRI fusion was retrospectively performed and limited to brain imaging. However, technological advancements have led to the ability to incorporate a full-fledged PET scanner into the MRI gantry.\textsuperscript{4,22}

A small, prospective study reported a higher rate of accuracy for whole-body MRI (91\%) than for fludeoxyglucose F 18 PET/CT (78\%) in detecting skeletal metastases.\textsuperscript{23} The rates of sensitivity were 94\% for MRI and 78\% for fludeoxyglucose F 18 PET/CT, with similar specificity rates noted (76\% and 80\%, respectively).\textsuperscript{23} The improved rate of sensitivity of MRI may have been related to the size of the lesions, which may have gone undetected on fludeoxyglucose F 18 PET and CT. The smallest detectable bone metastasis was 2 mm on MRI compared with 5 mm on fludeoxyglucose F 18 PET/CT.\textsuperscript{23}

Thus, additional research is necessary, but it may be likely that PET/MRI will improve the detection of bone metastases; thus, there is interest in it as an imaging method because it could exceed certain capabilities of PET/CT.\textsuperscript{24}

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**Fig 5A–B.** — Patient with prostate cancer and skeletal metastases. (A) Diagnostic skeletal scintigraphy and (B) therapeutic skeletal scintigraphy. HDAP = hydroxymethylene diphosphonate.
Data regarding integrated PET/MRI for staging malignant primary bone tumors are lacking. However, although PET/MRI may not improve rates of accuracy over MRI alone in evaluating the primary tumor, Buchbender et al. propose that a role may exist for whole-body PET/MRI as a staging examination. They also suggest that the PET component of the examination may help guide biopsies and maximize the rate of accuracy for staging and grading. A potential advantage of integrated PET/MRI in malignant primary bone tumors is the ability of MRI to accurately locally stage the tumor, with PET serving as a sensitive, metabolic, whole-body staging examination.

In a retrospective review of 117 patients with sarcoma, Tateishi et al. found that fludeoxyglucose F 18 PET/CT had sensitivity and specificity rates of 88% and 97%, respectively, and it was significantly more accurate for nodal staging in malignant bone tumors than conventional staging modalities (MRI of the primary tumor and whole-body CT). Therefore, PET/MRI may have similar utility in detecting lymph-node metastases from malignant bone tumors. MRI and fludeoxyglucose F 18 PET/CT have also been shown to have utility in restaging and evaluating therapeutic response in patients with primary skeletal malignancies. Combining the 2 modalities with PET/MRI offers an exciting opportunity for additional research on this topic.
Conclusions

Skeletal scintigraphy provides valuable information in the initial evaluation of the presence of osteoblastic skeletal metastases. Incremental advances in the use of radiopharmaceuticals (fluodeoxyglucose F 18, sodium fluoride F 18), coupled with advances in imaging techniques and imaging devices (single photon emission computed tomography/computed tomography, positron emission tomography/computed tomography, positron emission tomography/magnetic resonance imaging), have had a significant impact in rates of sensitivity, specificity, and accuracy for detecting skeletal metastases. These advances directly impact disease management and patient outcomes. The coupling of diagnostic and therapeutic nuclear medicine agents in the setting of osteoblastic skeletal metastases is a valuable tool for the treatment for certain cancer types (eg, prostate cancer) and may become more widely used to treat other histologies as more data on other tumor types (eg, breast cancer, osteosarcoma) become available.

References