CLINICAL APPROPRIATENESS GUIDELINES

ADVANCED IMAGING

Appropriate Use Criteria: Oncologic Imaging

Key to Revisions	Indicates…
Blue	Insertions
~~**Red**~~	Deletions
Yellow highlighting	Major changes

EFFECTIVE MARCH 14, 2021
Proprietary

Approval and implementation dates for specific health plans may vary. Please consult the applicable health plan for more details.

AIM Specialty Health disclaims any responsibility for the completeness or accuracy of the information contained herein.

AIM SpecialtyHealth
8600 West Bryn Mawr Avenue
South Tower – Suite 800 Chicago, IL 60631
www.aimspecialtyhealth.com

Appropriate.Safe.Affordable

RBM07-0321.1

Table of Contents

Description and Application of the Guidelines

The AIM Clinical Appropriateness Guidelines (hereinafter “the AIM Clinical Appropriateness Guidelines” or the “Guidelines”) are designed to assist providers in making the most appropriate treatment decision for a specific clinical condition for an individual. As used by AIM, the Guidelines establish objective and evidence-based criteria for medical necessity determinations where possible. In the process, multiple functions are accomplished:

- To establish criteria for when services are medically necessary
- To assist the practitioner as an educational tool
- To encourage standardization of medical practice patterns
- To curtail the performance of inappropriate and/or duplicate services
- To advocate for patient safety concerns
- To enhance the quality of health care
- To promote the most efficient and cost-effective use of services

The AIM guideline development process complies with applicable accreditation standards, including the requirement that the Guidelines be developed with involvement from appropriate providers with current clinical expertise relevant to the Guidelines under review and be based on the most up-to-date clinical principles and best practices. Relevant citations are included in the References section attached to each Guideline. AIM reviews all of its Guidelines at least annually.

AIM makes its Guidelines publicly available on its website twenty-four hours a day, seven days a week. Copies of the AIM Clinical Appropriateness Guidelines are also available upon oral or written request. Although the Guidelines are publicly-available, AIM considers the Guidelines to be important, proprietary information of AIM, which cannot be sold, assigned, leased, licensed, reproduced or distributed without the written consent of AIM.

AIM applies objective and evidence-based criteria, and takes individual circumstances and the local delivery system into account when determining the medical appropriateness of health care services. The AIM Guidelines are just guidelines for the provision of specialty health services. These criteria are designed to guide both providers and reviewers to the most appropriate services based on a patient’s unique circumstances. In all cases, clinical judgment consistent with the standards of good medical practice should be used when applying the Guidelines. Guideline determinations are made based on the information provided at the time of the request. It is expected that medical necessity decisions may change as new information is provided or based on unique aspects of the patient’s condition. The treating clinician has final authority and responsibility for treatment decisions regarding the care of the patient and for justifying and demonstrating the existence of medical necessity for the requested service. The Guidelines are not a substitute for the experience and judgment of a physician or other health care professionals. Any clinician seeking to apply or consult the Guidelines is expected to use independent medical judgment in the context of individual clinical circumstances to determine any patient’s care or treatment.

The Guidelines do not address coverage, benefit or other plan specific issues. Applicable federal and state coverage mandates take precedence over these clinical guidelines. If requested by a health plan, AIM will review requests based on health plan medical policy/guidelines in lieu of the AIM Guidelines.

The Guidelines may also be used by the health plan or by AIM for purposes of provider education, or to review the medical necessity of services by any provider who has been notified of the need for medical necessity review, due to billing practices or claims that are not consistent with other providers in terms of frequency or some other manner.

General Clinical Guideline

Clinical Appropriateness Framework

Critical to any finding of clinical appropriateness under the guidelines for a specific diagnostic or therapeutic intervention are the following elements:

- Prior to any intervention, it is essential that the clinician confirm the diagnosis or establish its pretest likelihood based on a complete evaluation of the patient. This includes a history and physical examination and, where applicable, a review of relevant laboratory studies, diagnostic testing, and response to prior therapeutic intervention.
- The anticipated benefit of the recommended intervention should outweigh any potential harms that may result (net benefit).
- Current literature and/or standards of medical practice should support that the recommended intervention offers the greatest net benefit among competing alternatives.
- Based on the clinical evaluation, current literature, and standards of medical practice, there exists a reasonable likelihood that the intervention will change management and/or lead to an improved outcome for the patient.

If these elements are not established with respect to a given request, the determination of appropriateness will most likely require a peer-to-peer conversation to understand the individual and unique facts that would supersede the requirements set forth above. During the peer-to-peer conversation, factors such as patient acuity and setting of service may also be taken into account.

Simultaneous Ordering of Multiple Diagnostic or Therapeutic Interventions

Requests for multiple diagnostic or therapeutic interventions at the same time will often require a peer-to-peer conversation to understand the individual circumstances that support the medical necessity of performing all interventions simultaneously. This is based on the fact that appropriateness of additional intervention is often dependent on the outcome of the initial intervention.

Additionally, either of the following may apply:

- Current literature and/or standards of medical practice support that one of the requested diagnostic or therapeutic interventions is more appropriate in the clinical situation presented; or
- One of the diagnostic or therapeutic interventions requested is more likely to improve patient outcomes based on current literature and/or standards of medical practice.

Repeat Diagnostic Intervention

In general, repeated testing of the same anatomic location for the same indication should be limited to evaluation following an intervention, or when there is a change in clinical status such that additional testing is required to determine next steps in management. At times, it may be necessary to repeat a test using different techniques or protocols to clarify a finding or result of the original study.

Repeated testing for the same indication using the same or similar technology may be subject to additional review or require peer-to-peer conversation in the following scenarios:

Repeated diagnostic testing at the same facility due to technical issues

- Repeated diagnostic testing requested at a different facility due to provider preference or quality concerns
- Repeated diagnostic testing of the same anatomic area based on persistent symptoms with no clinical change, treatment, or intervention since the previous study
- Repeated diagnostic testing of the same anatomic area by different providers for the same member over a short period of time

Repeat Therapeutic Intervention

In general, repeated therapeutic intervention in the same anatomic area is considered appropriate when the prior intervention proved effective or beneficial and the expected duration of relief has lapsed. A repeat intervention requested prior to the expected duration of relief is not appropriate unless it can be confirmed that the prior intervention was never administered.

Oncologic Imaging

General Information/Overview

Scope

These guidelines address advanced imaging for oncologic conditions in both adult and pediatric populations. For interpretation of the Guidelines, and where not otherwise noted, “adult” refers to persons age 19 and older, and “pediatric” refers to persons age 18 and younger. Where separate indications exist, they are specified as **Adult** or **Pediatric**. Where not specified, indications and prerequisite information apply to persons of all ages. In addition, these guidelines for oncologic conditions will address ~~both~~ the following aspects of the care continuum:

- Screening for cancer~~: breast cancer (including suspected), colorectal cancer, and lung cancer~~
- Diagnosis of breast and prostate cancer
- ~~Documented~~ Diagnostic workup, management, and surveillance of documented malignancy: typically requires biopsy unless imaging findings are an accepted alternative to biopsy (hepatobiliary cancer, brain cancer or spinal cord cancer) OR are highly suspicious for cancer when biopsy is contraindicated or non-diagnostic.

For all other imaging related to tumor evaluation, please refer to the AIM Guidelines for Advanced Imaging of the anatomic region of concern.

See the Coding section for a list of modalities included in these guidelines.

Technology Considerations

Advanced imaging for oncologic conditions includes both anatomic and functional modalities. Judicious use of advanced imaging is important to minimize risk and to avoid duplication of information. Testing should be performed in a stepwise fashion, with follow-up imaging studies performed based on the need for information not provided by the initial study.

Computed tomography (CT) and **magnetic resonance imaging (MRI)** are the most widely used modalities to visualize anatomic detail. CT provides rapidly obtained, high-resolution images that yield information on lesion morphology, size, and location. CT is less prone to motion artifact than MRI, and is useful for evaluation of bones and soft tissue. Improved techniques such as multi-slice technology and enhanced image processing refine image quality and resolution. **Helical CT** may be preferable to conventional axial CT for oncologic imaging due to increased speed of image acquisition and ability to perform **computed tomography angiography (CTA),** which is useful to assess vascular structures associated with tumors. Disadvantages of CT include exposure to ionizing radiation and risks associated with infusion of iodinated contrast media, including allergic reactions or renal compromise. MRI provides similar information to CT; however, image acquisition is slower and thus more prone to motion artifact. MRI has higher resolution and is better able to detect subtle abnormalities in soft tissue. For this reason, it is often preferable for visualizing infiltrative tumors. The term MRI spine in these guidelines specifically references MRI cervical spine, thoracic spine, and/or lumbar spine. **Magnetic resonance angiography (MRA)** is the MR analog of CTA and is also useful to assess tumor blood supply. The presence of implantable devices such as pacemakers or defibrillators, a potential need for sedation in pediatric patients, and claustrophobia are the main limitations of MRI. Infusion of gadolinium may also confer an unacceptable risk in persons with advanced renal disease.

Multiparametric MRI (mpMRI) of the prostate utilizes detailed anatomical imaging (T2-weighted imaging) as well as at least two functional imaging sequences (diffusion-weighted imaging, diffusion weighted imaging with apparent diffusion coefficient, and/or dynamic intravenous contrast-enhanced imaging) for detailed visualization and characterization of the prostate.

Magnetic resonance spectroscopy (MRS) provides a biochemical profile of metabolic constituents in tissues and may be used as an adjunct in cases where standard MRI fails to distinguish between

diseased and healthy tissue. In oncologic imaging, it is used primarily to differentiate between residual brain tumor and necrotic tissue following treatment.

~~Functional imaging studies such as~~ **~~positron~~ Positron emission tomography (PET)** or positron emission tomography with computed tomography (PET-CT) (collectively PET/CT) provide functional information about ~~the~~ metabolic activity ~~of tumor~~. PET utilizes a radiotracer, typically 2-(fluorine-18) fluoro-2-deoxy-D-glucose (fluorodeoxyglucose or FDG), which accumulates in areas of high metabolic activity such as tumor cells. ~~Its~~ The utility of PET may be improved by overlaying the areas of high uptake with CT images in order to provide anatomic detail (PET-CT). PET/CT is most useful in detecting tumors with a high metabolic rate; tumors that are indolent or slow-growing are less likely to be detected using this modality. The lack of specificity for oncologic processes also results in FDG uptake occuring in benign etiologies such as physiologic lymphoid tissue uptake, infection, and benign tumors. Therefore, radiotracers have been in development that target cancer-specific cell surface transporters. 11C-choline and 18F-fluciclovine (Axumin) were approved by the U.S. Food and Drug Administration (FDA) in 2012 and 2016, respectively, for the detection of suspected prostate cancer recurrence. 68Ga-dotatate (NETSPOT) was approved by the FDA in 2016 as the first in-class PET/CT radiotracer for detection of well-differentiated neuroendocrine tumors (NET).

There are many radiotracers currently under development which target specific tumor types, and several are already in clinical use. As these continue to be evaluated in clinical practice, the use of this technology is expected to evolve and grow.

Definitions

Phases of the care continuum are broadly defined as follows:

- **Screening** – testing in the absence of an established or clinically suspected diagnosis ~~signs or symptoms of disease~~
- **Diagnosis** - testing based on a reasonable clinical suspicion of a particular condition or disorder
- **Diagnostic Workup** – initial staging of documented malignancy ~~testing based on a reasonable suspicion of a particular condition or disorder, usually due to the presence of signs or symptoms~~
- **Management** – testing to direct therapy of an established condition, which may include preoperative or postoperative imaging, or imaging performed to evaluate the response to nonsurgical intervention. In oncologic imaging, management applies to patients with measureable disease and to imaging performed before or after planned treatment intervention, therapy response, restaging or clinically suspected recurrence.
- **Surveillance** – periodic assessment following completion of therapy ~~in the absence of measurable disease~~ In oncologic imaging, surveillance applies to asymptomatic patients in remission and/or without measureable disease

  ~~*Note: "Initial treatment strategy" will be referred to as "Diagnostic Workup" and "Subsequent treatment strategy" as "Management" in order to align nomenclature throughout the AIM Clinical Appropriateness Guidelines for Advanced Imaging.*~~

  ~~*In the section for Oncologic Imaging, "Surveillance" specifically refers only to patients with no measurable disease. For patients with residual disease after completion of treatment, the criteria for "Management" apply.*~~

~~**Appropriate use category**~~ **Other terms used in this guideline:**

- Documented malignancy: Established cancer diagnosis, usually by biopsy. Biopsy may not be required when imaging findings are an accepted alternative (for instance hepatobiliary cancer, brain cancer or spinal cord cancer) OR are highly suspicious for cancer when biopsy is contraindicated or nondiagnostic.

- **Indicated** – Evidence supports use and is considered medically necessary and consistent with AIM's clinical appropriateness framework. Scenarios that follow "Indicated" are required by the clinical guideline. Scenarios that follow "Indicated" **with a note** are suggested but not required ~~by the clinical guideline~~ to establish medical necessity.
- ~~**As clinically indicated** – Evidence supports use and is medically necessary in certain clinical scenarios. Scenarios that follow "as clinically indicated" are required by the clinical guideline. Scenarios that follow "as clinically indicated" **with a note** are suggested but not required by the clinical guideline.~~
- **Not indicated** – Evidence does not support use and/or is not considered medically necessary and consistent with AIM's clinical appropriateness framework
- **Indeterminate lesion** – focal mass or mass-like finding identified on prior imaging that has not been confidently diagnosed as either benign or malignant based on imaging appearance and/or biopsy
- **Cannot be performed or is nondiagnostic – applies when the test:**
    - Is positive or indeterminate for clinically significant pathology when the information provided about the abnormality by the test is not sufficient to direct subsequent management
    - Is negative when the negative likelihood ratio of the test is both insufficient to confidently exclude the absence of suspected disease and unable to direct subsequent management. This typically applies in scenarios with moderate to high clinical pretest probability with negative testing or low pretest probability with clear evidence for net benefit
    - Has been previously nondiagnostic because of a persistent clinical factor (e.g., body habitus, immobility) that is very likely to make retesting nondiagnostic as well
    - Cannot be performed due to a medical contraindication (e.g., contrast nephrotoxicity, allergy, or in highly radiation sensitive populations such as pediatrics and pregnancy) or reasonable unavailability related to lack of local expertise or service availability.
- Standard or conventional imaging : Refers to imaging that does not require a PET/CT. Depending on the clinical scenario and individual patient circumstances, this may include computed tomography, magnetic resonance imaging, ultrasound and/or scintigraphy.
- Clinical suspicion: Documented signs, symptoms, lab and/or other diagnostic test results that sufficiently increase the pre-test likelihood of disease to warrant further advanced imaging evaluation to direct management. Includes symptom directed staging.

Statistical terminology[1]

- **Confidence interval (CI)** – range of values which is likely to contain the cited statistic. For example, 92% sensitivity (95% CI, 89%-95%) means that, while the sensitivity was calculated at 92% on the current study, there is a 95% chance that, if a study were to be repeated, the sensitivity on the repeat study would be in the range of 89%-95%.
- **Diagnostic accuracy** – ability of a test to discriminate between the target condition and health. Diagnostic accuracy is quantified using sensitivity and specificity, predictive values, and likelihood ratios.
- **Hazard ratio** – odds that an individual in the group with the higher hazard reaches the outcome first. Hazard ratio is analogous to odds ratio and is reported most commonly in time-to-event

analysis or survival analysis. A hazard ratio of 1 means that the hazard rates of the 2 groups are equivalent. A hazard ratio of greater than 1 or less than 1 means that there are differences in the hazard rates between the 2 groups.

- **Likelihood ratio** – ratio of an expected test result (positive or negative) in patients *with* the disease to an expected test result (positive or negative) in patients *without* the disease. Positive likelihood ratios, especially those greater than 10, help rule in a disease (i.e., they substantially raise the post-test probability of the disease, and hence make it very likely and the test very useful in identifying the disease). Negative likelihood ratios, especially those less than 0.1, help rule out a disease (i.e., they substantially decrease the post-test probability of disease, and hence make it very unlikely and the test very useful in excluding the disease).
- **Odds ratio** – odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. An odds ratio of 1 means that the exposure does not affect the odds of the outcome. An odds ratio greater than 1 means that the exposure is associated with higher odds of the outcome. An odds ratio less than 1 means that the exposure is associated with lower odds of the outcome.
- **Predictive value** – likelihood that a given test result correlates with the presence or absence of disease. Positive predictive value is defined as the number of true positives divided by the number of test positives. Negative predictive value is defined as the number of true negatives divided by the number of test negative patients. Predictive value is dependent on the prevalence of the condition.
- **Pretest probability** – probability that a given patient has a disease prior to testing. May be divided into very low (less than 5%), low (less than 20%), moderate (20%-75%), and high (greater than 75%) although these numbers may vary by condition.
- **Relative risk** – probability of an outcome when an exposure is present relative to the probability of the outcome occurring when the exposure is absent. Relative risk is analogous to odds ratio; however, relative risk is calculated by using percentages instead of odds. A relative risk of 1 means that there is no difference in risk between the 2 groups. A relative risk of greater than 1 means that the outcome is more likely to happen in the exposed group compared to the control group. A relative risk less than 1 means that the outcome is less likely to happen in the exposed group compared to the control group.
- **Sensitivity** – conditional probability that the test is positive, given that the patient has the disease. Defined as the true positive rate (number of true positives divided by the number of patients with disease). Excellent or high sensitivity is usually greater than 90%.
- **Specificity** – conditional probability that the test is negative, given that the patient does not have the disease. Defined as the true negative rate (number of true negatives divided by the number of patients without the disease). Excellent or high specificity is usually greater than 90%.

Staging systems referred to in the Guidelines:

- **AJCC staging**[2] – classification system developed by the American Joint Committee on Cancer for describing the extent of disease progression in cancer patients. It utilizes the TNM scoring system which takes into account Tumor size, the lymph Nodes affected, and Metastases.
- **Ann Arbor staging**[3] – system for staging Hodgkin lymphoma and non-Hodgkin lymphoma based on location of malignant tissue and on systemic symptoms due to the lymphoma.
- **Deauville criteria**[4] – internationally accepted response assessment criteria utilizing a five-point scoring system for the FDG avidity of a Hodgkin lymphoma or non-Hodgkin lymphoma tumor mass as seen on FDG-PET.

- **FIGO system**[5] – a cancer staging and classification system for gynecologic malignancies developed by the International Federation of Gynecology and Obstetrics.
- **Lugano classification**[6] – staging and response assessment system used for patients with non-Hodgkin lymphoma based on the Ann Arbor staging system. The Lugano criteria takes into account FDG-PET in response assessment.
- **RECIST**[7] (response evaluation criteria in solid tumors) – set of published rules jointly developed by the European Organization for Research and Treatment of Cancer, National Cancer Institute of the U.S., and the National Cancer Institute of Canada Clinical Trials Group to assess tumor response during treatment.

References

1. Simundic AM. Measures of Diagnostic Accuracy: Basic Definitions. EJIFCC,. 2009;19(4):203-11.
2. American Joint Committee on Cancer. AJCC Cancer Staging Manual. Amin MB, editor. Chicago: 2017.
3. Carbone PP, Kaplan HS, Musshoff K, et al. Report of the Committee on Hodgkin's Disease Staging Classification. Cancer Res. 1971;31(11):1860-1.
4. Juweid ME, Stroobants S, Hoekstra OS, et al. Use of positron emission tomography for response assessment of lymphoma: consensus of the Imaging Subcommittee of International Harmonization Project in Lymphoma. J Clin Oncol. 2007;25(5):571-8.
5. Benedet JL, Bender H, Jones H, 3rd, et al. FIGO staging classifications and clinical practice guidelines in the management of gynecologic cancers. FIGO Committee on Gynecologic Oncology. Int J Gynaecol Obstet. 2000;70(2):209-62.
6. Cheson BD, Fisher RI, Barrington SF, et al. Recommendations for initial evaluation, staging, and response assessment of Hodgkin and non-Hodgkin lymphoma: the Lugano classification. J Clin Oncol. 2014;32(27):3059-68.
7. Therasse P, Arbuck SG, Eisenhauer EA, et al. New guidelines to evaluate the response to treatment in solid tumors. European Organization for Research and Treatment of Cancer, National Cancer Institute of the United States, National Cancer Institute of Canada. J Natl Cancer Inst. 2000;92(3):205-16.

Clinical Indications

CT and MRI imaging is appropriate for symptom-directed management or perioperative evaluation of an established malignancy when not specifically excluded under individual cancer diagnoses.

Indications are presented in the following sections by tumor type.

Cancer Screening

Advanced imaging is indicated for screening of breast cancer, colorectal cancer, and lung cancer.

Breast cancer screening

Annual MRI breast is indicated in **ANY** of the following scenarios:

- Individuals who received radiation to the chest between ages 10 and 30
- Individuals with a genetic predisposition to breast cancer, in either themselves or a first-degree relative, which may include any of the following:
  - Bannayan-Riley-Ruvalcaba syndrome
  - *BRCA1* and *BRCA2* mutations
  - Cowden syndrome
  - Li-Fraumeni syndrome (TP53)
- Individuals known to have **ANY** of the following established genetic mutations:
  - *ATM*
  - *CDH1*
  - *CHEK2*
  - *PALB2*
  - *NBM*
  - *NF-1*
  - *PTEN*
- History of lobular carcinoma in situ (LCIS), atypical ductal hyperplasia (ADH), or atypical lobular hyperplasia (ALH) on biopsy
- Lifetime risk of 20% or greater as defined by the GAIL model, BOADICEA, BRCAPRO, Claus,Tyrer-Cuzick or other models that are largely dependent on family history

Rationale

While several recent studies have shown breast MRI to improve cancer detection in women with a personal history of breast cancer, the false positive rate remains extremely high, with one study reporting a false positive rate of 61%.[1,2] False positives are commonly seen in average-risk women screened for breast cancer with MRI, particularly those with dense breasts.[3] In a systematic review for the U.S. Preventive Services Task Force, the authors concluded that the effect of supplemental screening on breast cancer outcomes remains unclear.[4] However, additional imaging with MRI breast has been found to be beneficial in higher-risk groups.[5-12]

MRI mammography has been shown to be more sensitive but less specific than mammography.[6,13-16] In a review of 11 prospective, nonrandomized studies comparing screening MRI to mammography in women at high risk for breast cancer, the sensitivity of MRI was higher than mammography: 77% vs 39%, respectively. Similar to previous studies, the specificity of MRI was lower than mammography: 86% vs 95%. Comparing diagnostic odds ratios (positive defined as BI-RADS 3 or higher), the diagnostic odds ratio was 14.7 (6.1–35.6) for mammogram, 18.3 (11.7–28.7) for MRI, and 45.9 (17.5–120.9) for the MRI-mammogram combination. The combined modalities were superior in terms of sensitivity (94%) and specificity (77%) to either modality alone.[17] A prospective randomized trial showed that when MRI was added to screening ultrasound and mammography for high-risk patients, the sensitivity was 100% as compared to 44% for mammography and ultrasound alone.[18] Benefits in survival may also be seen,

particularly in patients with *BRCA1* and *BRCA2* mutations.[19,20] In a prospective trial using both mammography and MRI breast for screening of high-familial-risk women for breast cancer (N = 649), 19 cancers were detected by MRI only, 6 by mammography only, and 8 by both modalities combined, with 2 found on serial imaging. In patients with lobular carcinoma in situ and atypical hyperplasia, MRI was significantly more sensitive than mammography, but resulted in 3 times more benign biopsies.[21]

AIM Oncologic Imaging guidelines pertaining to breast cancer screening are in concordance with the National Comprehensive Cancer Network, American Cancer Society, and American College of Radiology recommendations.[22-24]

Colorectal cancer screening

CT colonography (CTC) is indicated in **ANY** of the following scenarios:

- **Screening CT colonography** is indicated for average risk individuals* as an alternative to conventional colonoscopy or double contrast barium enema at 5-year intervals, beginning at age 50

*Average risk:

- Age ≥ 50 yrs

- No personal history of colonic adenoma, serrated sessile polyp (SSP), or colorectal cancer (CRC)

- No personal history of inflammatory bowel disease

- Negative first-degree family history for CRC, confirmed advanced adenoma (i.e. high-grade dysplasia, ≥ 1 cm, villous or **tubulo**villous histology or an advanced SSP)

- **Diagnostic CT colonography** is indicated when **ANY** of the following conditions are present:
  - Coagulopathy
  - Complications from prior fiberoptic colonoscopy
  - Diverticulitis with increased risk of perforation
  - Failed or incomplete fiberoptic colonoscopy of the entire colon, due to inability to pass the colonoscope proximally (may be secondary to obstructing neoplasm, spasm, redundant colon, altered anatomy or scarring from previous surgery, stricture, or extrinsic compression)
  - Increased sedation risk, such as chronic obstructive pulmonary disease or previous adverse reaction to anesthesia
  - Known colonic obstruction when standard fiberoptic colonoscopy is contraindicated
  - Lifetime or long-term anticoagulation with increased patient risk if discontinued
  - Following screening CTC demonstrating 1-2 polyps which are 6-9 mm in size, for 3 year follow-up CTC

Rationale

~~Although CT colonography allows noninvasive screening of the colon, it also carries the risk of radiation exposure and detection of clinically insignificant extracolonic disease. A study by Chung et al. reported sensitivities of CT colonography for detecting polyps of 5 mm or smaller, of 6-9 mm, and of 10 mm or larger were 84%, 94%, and 100%, respectively.[25] In an update and systematic review of colorectal cancer screening for the U.S. Preventive Services Task Force, CT colonography with bowel preparation had sensitivity to detect adenomas 6 mm and larger, which was comparable with colonoscopy.[26] As reviewed in a meta-analysis of 24 studies (N = 4181), CT colonography appeared sensitive and specific in the detection of large and medium polyps: 86% and 86%.[27] In a review comparing primary CT colonography and optical colonoscopy, both screening strategies result in similar detection rates for advanced neoplasia (3%), although the numbers of polypectomies and complications were considerably higher in the optical colonoscopy group.[28]~~

~~In patients with positive fecal occult blood test and incomplete optical colonoscopy, CT colonography was able to identify either polyps or colorectal cancer in 50% of cases (21/42).[29] Another small study showed that CT colonography detected an additional 33% more lesions and had a sensitivity and specificity of 100% and 96% in patients with clinically suspected colorectal cancer and incomplete optical colonoscopy.[30] Based on the low sensitivity for detecting polyps, optical colonoscopy should be the preferred modality for cancer surveillance in patients with a history of colorectal cancer.[31]~~

CT Colonography (CTC) has the advantages of being noninvasive and not requiring sedation, but carries the risk of radiation exposure and detection of potentially clinically insignificant extracolonic findings; a positive finding by CTC still requires subsequent optical colonoscopy evaluation. However, CTC may be an acceptable screening alternative for many individuals at average risk for colorectal cancer. In the National CT Colongraphy trial (ACRIN 6664) organized by the American College of Radiology (ACR) Imaging Network, 2531 participants underwent CTC followed by traditional optical colonscopy.[25] CTC detected 90% of patients who had lesions measuring 10 mm of larger found by colonoscopy (sensitivity 90%, specificity 86%). In a review comparing CTC and optical colonoscopy, both screening strategies resulted in comparable detection rates for advanced neoplasia (3.2% for CTC, 3.4% for colonoscopy), although the numbers of polypectomies and complications were considerably higher in the optical colonoscopy group.[26] A population based study of 93 individuals with one or two polyps (6-9 mm) examined with 3 year surveillance CTC suggested that polyps of this size are unlikely to progress to advanced neoplasia within 3 years.[27]

AIM Oncologic Imaging guidelines pertaining to colorectal cancer screening are in concordance with the U.S. Preventive Services Task Force and National Comprehensive Cancer Network recommendations.[28,29]

Lung cancer screening

Annual low-dose CT is indicated when **ALL** of the following criteria are met:

- Age equal to or greater than 55 and less than or equal to 80
- 30 or greater pack-year history* of cigarette smoking or established asbestosis-related lung disease
- Current smoker or quit date within the past 15 years
- No signs or symptoms suggestive of underlying cancer
- No health problems that would be expected to substantially limit life expectancy or the ability to undergo an intervention with curative intent

**One pack-year of smoking equals smoking 1 pack (20 cigarettes) per day for 1 year or 7300 cigarettes annually.*

Rationale

Low dose lung cancer screening CT (LDCT) is an annual screening exam which utilizes specific protocols to image the lungs at an ultra-low dose of radiation. Screening CT for lung cancer can be beneficial; however, these benefits must be weighed against the risks of radiation exposure, ~~overdiagnosis~~over diagnosis, and false positives.[~~34~~,30] Previous studies have shown that screening with standard chest X-rays does not reduce the mortality rate from lung cancer. A 2011 National Cancer Institute-sponsored National Lung Screening Trial showed that people ages 55 to 74 with a history of heavy smoking were 20% less likely to die from lung cancer if they were screened with ~~low-dose helical CT~~LDCT than with standard screening chest X-rays,[~~35~~31] but those screened also experience higher overall rates of false positive results, invasive procedures, and serious complications.[~~36~~32]

At the end of 2013, the U.S. Preventive Services Task Force released the following recommendation summary: "The USPSTF [U.S. Preventive Services Task Force] recommends annual screening for lung cancer with ~~low-dose CT~~LDCT in adults aged 55 to 80 years who have a 30 pack-year smoking history and currently smoke or have quit within the past 15 years. Screening should be discontinued once a person has not smoked for 15 years or develops a health problem that substantially limits life expectancy or the ability or willingness to have curative lung surgery."[~~37~~,33] One multi-center study also found that in subjects with past asbestos exposure, the presence of smoking history, fibrotic plus emphysema changes, and pleural effusion were correlated with an increased prevalence of lung cancer. [34]

AIM AIM Oncologic Imaging guidelines pertaining to lung cancer screening are in concordance with the American Cancer Society, American College of Chest Physicians, American Society of Clinical Oncology, and U.S. Preventive Services Task Force recommendations.[~~34,37-39~~31, 33, 35, 36]

Pancreatic cancer screening

Annual CT or MRI (preferred) is indicated as an alternative to endoscopic ultrasound in **ANY** of the following scenarios:

- Peutz-Jeghers (LKB1/STK11 mutations)
- Family atypical multiple mole melanoma (FAMMM; CDKN2A p16 mutation)
- First degree relative (FDR) and at least one other blood relative with pancreatic cancer
- BRCA 2 with a FDR or at least two blood relatives with pancreatic cancer

- First degree relative (FDR) with pancreatic cancer and any ONE of the following germline mutations
  - PALB2
  - Lynch syndrome (MLH1, MSH2 OR MSH6 mutations)
  - BRCA
  - ATM

Rationale

Emerging data regarding the efficacy of pancreatic cancer screening in select individuals has largely been limited to individuals with known pathogenic/likely pathogenic germline variants in a pancreatic cancer susceptibility gene (as listed above) or those with strong family history, utilizing contrast MRI/MRCP and/or EUS. Potential benefits of screening include a suggestion of tumor downgrading and improved mortality, compared to historical data, with 75%-90% of screen-detected malignancy being surgically resectable at diagnosis.[37, 38] Longer term studies are needed to determine if this downstaging translates to improved survival, as evidence suggests that long term survival is common in patients presenting with stage I sporadic ductal adenocarcinoma, and further data is needed to better define the threshold for biopsy and surgical intervention given the frequency with which pancreatic abnormalities are seen (42% of high risk individuals in one study had at least one pancreatic mass/cyst and/or duct abnormality).[39]

AIM Oncologic Imaging guidelines pertaining to pancreatic cancer screening are based on the National Comprehensive Cancer Network and the International Cancer of the Pancreas Screening (CAPS) Consortium.[40, 41]

References

1. Cho N, Han W, Han BK, et al. Breast cancer screening with mammography plus ultrasonography or magnetic resonance imaging in women 50 years or younger at diagnosis and treated with breast conservation therapy. JAMA Oncology. 2017;3(11):1495-502. PMID: 28655029
2. Brennan S, Liberman L, Dershaw DD, et al. Breast MRI screening of women with a personal history of breast cancer. AJR Am J Roentgenol. 2010;195(2):510-6. PMID: 20651211
3. Nelson HD, Pappas M, Cantor A, et al. Harms of breast cancer screening: systematic review to update the 2009 U.S. Preventive Services Task Force recommendation. Ann Intern Med. 2016;164(4):256-67. PMID: 26756737
4. Melnikow J, Fenton JJ, Whitlock EP, et al. Supplemental screening for breast cancer in women with dense breasts: a systematic review for the U.S. Preventive Services Task Force. Ann Intern Med. 2016;164(4):268-78. PMID: 26757021
5. Afonso N, Bouwman D. Lobular carcinoma in situ. Eur J Cancer Prev. 2008;17(4):312-6. PMID: 18562954
6. Degnim AC, Visscher DW, Berman HK, et al. Stratification of breast cancer risk in women with atypia: a Mayo cohort study. J Clin Oncol. 2007;25(19):2671-7. PMID: 17563394
7. Zhou WB, Xue DQ, Liu XA, et al. The influence of family history and histological stratification on breast cancer risk in women with benign breast disease: a meta-analysis. J Cancer Res Clin Oncol. 2011;137(7):1053-60. PMID: 21499874
8. Friedlander LC, Roth SO, Gavenonis SC. Results of MR imaging screening for breast cancer in high-risk patients with lobular carcinoma in situ. Radiology. 2011;261(2):421-7. PMID: 21900618
9. Sung JS, Malak SF, Bajaj P, et al. Screening breast MR imaging in women with a history of lobular carcinoma in situ. Radiology. 2011;261(2):414-20. PMID: 21900617
10. Raikhlin A, Curpen B, Warner E, et al. Breast MRI as an adjunct to mammography for breast cancer screening in high-risk patients: retrospective review.[Erratum appears in AJR Am J Roentgenol. 2015 May;204(5):1137; PMID: 25905954]. AJR Am J Roentgenol. 2015;204(4):889-97. PMID: 25794083
11. Riedl CC, Luft N, Bernhart C, et al. Triple-modality screening trial for familial breast cancer underlines the importance of magnetic resonance imaging and questions the role of mammography and ultrasound regardless of patient mutation status, age, and breast density. J Clin Oncol. 2015;33(10):1128-35. PMID: 25713430
12. Hodgson DC, Cotton C, Crystal P, et al. Impact of early breast cancer screening on mortality among young survivors of childhood Hodgkin's lymphoma.[Erratum appears in J Natl Cancer Inst. 2016 Apr;108(4). pii: djw102. doi: 10.1093/jnci/djw102; PMID: 27032726]. J Natl Cancer Inst. 2016;108(7). PMID: 26933010
13. Hagen AI, Kvistad KA, Maehle L, et al. Sensitivity of MRI versus conventional screening in the diagnosis of BRCA-associated breast cancer in a national prospective series. Breast. 2007;16(4):367-74. PMID: 17317184

14. Evans DG, Howell A. Are we ready for online tools in decision making for BRCA1/2 mutation carriers? J Clin Oncol. 2012;30(5):471-3. PMID: 22231044

15. Leach MO, Boggis CR, Dixon AK, et al. Screening with magnetic resonance imaging and mammography of a UK population at high familial risk of breast cancer: a prospective multicentre cohort study (MARIBS).[Erratum appears in Lancet. 2005 May 28-Jun 3;365(9474):1848]. Lancet. 2005;365(9473):1769-78. PMID: 15910949

16. Sardanelli F, Podo F, D'Agnolo G, et al. Multicenter comparative multimodality surveillance of women at genetic-familial high risk for breast cancer (HIBCRIT study): interim results. Radiology. 2007;242(3):698-715. PMID: 17244718

17. Warner E, Messersmith H, Causer P, et al. Systematic review: using magnetic resonance imaging to screen women at high risk for breast cancer. Ann Intern Med. 2008;148(9):671-9. PMID: 18458280

18. Berg WA, Zhang Z, Lehrer D, et al. Detection of breast cancer with addition of annual screening ultrasound or a single screening MRI to mammography in women with elevated breast cancer risk. JAMA. 2012;307(13):1394-404. PMID: 22474203

19. Rijnsburger AJ, Obdeijn IM, Kaas R, et al. BRCA1-associated breast cancers present differently from BRCA2-associated and familial cases: long-term follow-up of the Dutch MRISC Screening Study. J Clin Oncol. 2010;28(36):5265-73. PMID: 21079137

20. Passaperuma K, Warner E, Causer PA, et al. Long-term results of screening with magnetic resonance imaging in women with BRCA mutations. British Journal of Cancer. 2012;107(1):24-30. PMID: 22588560

21. Port ER, Park A, Borgen PI, et al. Results of MRI screening for breast cancer in high-risk patients with LCIS and atypical hyperplasia. Ann Surg Oncol. 2007;14(3):1051-7. PMID: 17206485

22. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Breast Cancer Screening and Diagnosis (Version 1.2019). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.

23. Oeffinger KC, Fontham ET, Etzioni R, et al. Breast cancer screening for women at average risk: 2015 guideline update from the American Cancer Society.[Erratum appears in JAMA. 2016 Apr 5;315(13):1406; PMID: 27046378]. JAMA Intern Med. 2015;314(15):1599-614. PMID: 26501536

24. Mainiero MB, Moy L, Baron P, et al. ACR Appropriateness Criteria® breast cancer screening. J Am Coll Radiol. 2017;14(11S):S383-S90. PMID: 29101979

25. Johnson CD. Chen MH, Toledano AY, et al. Accuracy of CT Colonography for detection of large adenomas and cancers. N Engl J Med 2008; 359: 1207-1217. PMID: 18799557

26. Kim DH, Pickhardt PJ, Taylor AJ, et al. CT colonography versus colonoscopy for the detection of advanced neoplasia. N Engl J Med. 2007;357(14):1403-12. PMID: 17914041

27. Tutein Nolthenius CJ, Boellaard TN, de Haan MC, et al. Evolution of Screen-Detected Small (6-9 mm) Polyps After a 3-Year Surveillance Interval: Assessment of Growth With CTC Colonography Compared With Histopathology. Am J Gastroenterol 2015; 110: 1682-1690. PMID: 26482858

28. Bibbins-Domingo K, Grossman DC, Curry SJ, et al. Screening for colorectal cancer: US Preventive Services Task Force recommendation statement.[Erratum appears in JAMA. 2016 Aug 2;316(5):545; PMID: 27483080], [Erratum appears in JAMA. 2017 Jun 6;317(21):2239; PMID: 28586871], [Summary for patients in JAMA. 2016 Jun 21;315(23):2635; PMID: 27305107],. JAMA. 2016;315(23):2564-75. PMID: 27304597

29. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Colorectal Cancer Screening (Version 1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2020.

30. Bach PB, Mirkin JN, Oliver TK, et al. Benefits and harms of CT screening for lung cancer: a systematic review. JAMA. 2012;307(22):2418-29. PMID: 22610500

31. Aberle DR, Adams AM, Berg CD, et al. Reduced lung-cancer mortality with low-dose computed tomographic screening. N Engl J Med. 2011;365(5):395-409. PMID: 21714641

32. Chiles C. Lung cancer screening with low-dose computed tomography. Radiol Clin North Am. 2014;52(1):27-46. PMID: 24267709

33. Moyer VA, Force USPST. Screening for lung cancer: U.S. Preventive Services Task Force recommendation statement.[Summary for patients in Ann Intern Med. 2014 Mar 4;160(5):I-40; PMID: 24378963]. Ann Intern Med. 2014;160(5):330-8. PMID: 24378917

34. Kato K, Gemba K, Ashizawa K, et al. Low-dose chest computed tomography screening of subjects exposed to asbestos. Eur J Radiology. 2018; 101:124-8

~~34~~35. Mazzone PJ, Silvestri GA, Patel S, et al. Screening for lung cancer: CHEST guideline and expert panel report. Chest. 2018;153(4):954-85. PMID: 29374513

~~35~~36. Wender R, Fontham ET, Barrera E, Jr., et al. American Cancer Society lung cancer screening guidelines. CA Cancer J Clin. 2013;63(2):107-17. PMID: 23315954

~~36~~37. Canto MI, Almario JA, Schulick RD, et al. Gastroenterology 2018; 155: 740-751

~~37~~38. Vasen H, Ibrahim I, Ponce CG, et al. J Clinical Oncology 2016; 34:2010-2019

~~38~~39. Canto MI, Hruban RH, Fishman EK, et al. Gastroenterology. 2012; 142: 796-804.

~~39~~40. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Genetic/Familial High-Risk Assessment: Breast, Ovarian and Pancreatic (Version 1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.

41. Goggings M, Overbeek KA, Brand R, et al. Management of patients with increased risk for familial pancreatic cancer: updated recommendations from the International Cancer of the Pancreas Screening (CAPS) Consortium. Gut. 2020;69(1): 7-17. PMID: 31672839

Anal Cancer

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented anal cancer.

Imaging Study	Diagnostic Workup	Management	Screening and Surveillance
CT chest	Indicated	~~As clinically indicated~~ Indicated (note: DRE exam of choice)	~~As clinically indicated~~ Indicated (note: especially useful in T3-4 tumors in first 3 years)
CT abdomen and pelvis	Indicated	~~As clinically indicated~~ Indicated (note: DRE exam of choice)	~~As clinically indicated~~ Indicated (note: especially useful in T3-4 tumors in first 3 years)
MRI pelvis	Indicated	Indicated	Indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated when standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for metastatic disease	~~As clinically indicated~~ Indicated in ANY of the following scenarios: • Radiation planning for definitive treatment only • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease • ~~Restaging of local recurrence when salvage surgery is planned~~	Not indicated

Note: PET/CT does not replace a diagnostic CT scan.

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Anal cancer, which arises from the cells of the anal canal or anal margin, accounts for 3% of all gastrointestinal cancers. The most common histological subtype is squamous cell carcinoma. Risk factors for developing anal cancer include high-risk sexual behavior, tobacco use, and infection with human papillomavirus or human immunodeficiency virus. The most common presentation is rectal bleeding or pain.

DIAGNOSTIC WORKUP

Anal cancer is staged using the American Joint Committee on Cancer TNM system. The vast majority of patients with locoregional disease will undergo concurrent chemoradiation treatment regardless of tumor or nodal staging. Evaluation of pelvic lymph nodes with CT or MRI Pelvis is recommended for initial staging, as is CT of the Chest and Abdomen to assess disseminated disease (since veins of the anal region are part of the venous network associated with systemic circulation).[3]

PET/CT ~~scan in initial staging and radiation planning allows for better assessment of nodal metastases~~ can be used to verify staging before treatment, which may alter the radiation plan for curative combined modality therapy. PET/CT has been reported to be useful in the evaluation of pelvic lymph nodes, even when appearing normal-sized

by CT. A meta-analysis of 12 studies found that CT and PET had a sensitivity of 60% and 99%, respectively, for the detection of primary disease. Compared with conventional imaging, PET upstaged 15% and downstaged another 15% of nodal disease. This led to a change in nodal staging in 28% and TNM staging in 41% of patients.[1] A more recent meta-analysis published by Mahmud et al. found a pooled sensitivity of 99% for PET or PET/CT and 67% for CT scan alone. PET imaging also had a sensitivity of 93% and specificity of 76% for detecting nodal disease. A total of 5.1% to 37.5% of patients were upstaged and 8.2% to 26.7% were downstaged with 12.5% to 59.3% of patients requiring treatment changes. However, the majority of the changes in treatment were in radiation planning.[2]

MANAGEMENT

Following completion of concurrent chemoradiation therapy, the National Comprehensive Cancer Network (NCCN) recommends that initial follow up of anal cancer include digital rectal exam 8 to 12 weeks after treatment. Patients with persistent disease but without evidence of progression may be managed with close ~~followup~~follow-up for up to 6 months to ensure complete response after completion of radiation and chemotherapy. In the event of biopsy-proven progressive disease or recurrence, reimaging can be performed with conventional advanced imaging or PET/CT scan when salvage surgery is indicated.[3] The 5-year overall survival was 64% in a small study of 39 patients treated with radical salvage surgery.[4]

SCREENING AND SURVEILLANCE

Local recurrence of early stage disease is detectable by exam or anoscopy. For patients at high risk for recurrence (locally advanced [T3/T4], inguinal node positive, or locally persistent/progressive/recurrent anal squamous cell cancer), surveillance may include CT chest, CT or MRI abdomen~~, and/~~-pelvis with contrast annually for a duration of 3 years per the NCCN guidelines.[3] However, due to the lack of prospective trials and because most recurrences are locoregional, the European Society of Medical Oncology, European Society of Surgical Oncology, and the European Society for Radiotherapy and Oncology do not endorse routine advanced imaging.[5]

References

1. Jones M, Hruby G, Solomon M, et al. The role of FDG-PET in the initial staging and response assessment of anal cancer: a systematic review and meta-analysis. Ann Surg Oncol. 2015;22(11):3574-81. PMID: 25652048
2. Mahmud A, Poon R, Jonker D. PET imaging in anal canal cancer: a systematic review and meta-analysis. Br J Radiol. 2017;90(1080):20170370. PMID: 28972796
3. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Anal Carcinoma (Version ~~1.2019~~2.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.
4. Mullen JT, Rodriguez-Bigas MA, Chang GJ, et al. Results of surgical salvage after failed chemoradiation therapy for epidermoid carcinoma of the anal canal. Ann Surg Oncol. 2007;14(2):478-83. PMID: 17103253
5. Glynne-Jones R, Nilsson PJ, Aschele C, et al. Anal cancer: ESMO-ESSO-ESTRO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2014;25 Suppl 3:iii10-20. PMID: 25001200

Bladder, Renal Pelvis, and Ureter Cancer

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented bladder, renal pelvis, and ureter cancer.

Bladder, Renal Pelvis, and Ureter Cancers: Noninvasive

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated (note: not generally needed with non-muscle invasive bladder cancer)	~~As clinically indicated~~ Indicated (note: not generally needed with non-muscle invasive bladder cancer)	~~As clinically indicated~~ Indicated (note: not generally needed with non-muscle invasive bladder cancer)
CT abdomen and pelvis	Indicated	~~As clinically indicated~~ Indicated	Indicated (note: for baseline imaging after completion of planned treatment and especially useful for high risk patients)
MRI pelvis	~~As clinically indicated~~ Indicated for local staging of sessile or high-grade tumors (as an adjunct to CT imaging)	Not indicated	Not indicated
FDG-PET/CT	Not indicated	Not indicated	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Bladder, Renal Pelvis, and Ureter Cancers: Invasive

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated (note: chest X-ray is sufficient in most cases. CT especially useful when chest X-ray is abnormal OR in high-risk patients (T3/T4 disease or as stage T2 with hydronephrosis or high-risk histological features))	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
CT abdomen and pelvis	Indicated	~~As clinically indicated~~ Indicated	Indicated (note: especially useful for first 5 years)
MRI brain	Indicated for symptomatic or high-risk patients (T3/T4 disease or as stage T2 with hydronephrosis or high-risk histological features)	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
MRI pelvis	Indicated for local staging (as an adjunct to CT imaging)	Not indicated	Not indicated

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
FDG-PET/CT	~~As clinically indicated~~ Indicated in EITHER of the following scenarios: • Evaluation of stage II or stage III bladder cancer prior to surgery when standard imaging cannot be performed or is nondiagnostic for metastatic disease • When bone metastasis is suspected based on signs and symptoms and standard imaging ~~has not demonstrated bone lesions~~ cannot be performed os is nondiagnostic	~~As clinically indicated~~ Indicated in ~~EITHER of~~ the following scenario~~s~~: • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease • ~~When objective signs or symptoms of disease are present and CT or MRI has not clearly demonstrated recurrence or progression~~	Not indicated

Note: PET is not indicated in bladder tumors which have not invaded the muscle (stage < cT2).

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Cancers of the urinary tract, including kidney, renal pelvis, ureter, bladder, and urethra, comprise the sixth most common cancer in men and women. Outside of the kidney, the most common histology of urinary tract cancer is urothelial carcinoma (also called transitional cell carcinoma), accounting for 90% of tumors. Risk factors for urothelial cancer include tobacco use and occupational exposure to carcinogens. The most common presentation of urinary tract cancer includes hematuria, pain from local or metastatic disease, and voiding symptoms.

DIAGNOSTIC WORKUP

Staging utilizes the American Joint Committee on Cancer TNM system. Bladder cancer is further classified as muscle invasive or non-muscle invasive. Imaging is used to further assess the local tumor, lymph nodes, and distant metastases.

CT abdomen and pelvis with excretory imaging ~~is the preferred study for the~~can be used for staging of invasive locally advanced bladder cancer.[1] Although CT provides adequate visualization of tumors and allows for assessment of the upper urinary tract, it does not have the same capability as MRI pelvis for local staging of bladder cancer. ~~In clinical situations where CT abdomen and pelvis with excretory imaging is inadequate, an MRI pelvis may be indicated.~~ Compared to CT, MRI has the added benefit of high soft tissue contrast and direct multiplanar imaging capabilities, allowing for accurate tumor evaluation and better visualization of the bladder dome, trigone, and adjacent structures. The reported accuracy of MRI in overall staging of bladder cancer varies from 60% to 85%, whereas local staging ranges from 73% to 96%.[2] Both CT and MRI have comparable accuracy for staging lymph nodes: 73% to 90%.[3] In the event that iodinated or gadolinium-based contrast cannot be used, renal ultrasound and/or CT without contrast (particularly when PET/CT is not utilized) may be used in conjunction with retrograde urography. The NCCN does not recommend routine evaluation of bone metastases for non-muscle invasive urothelial cancer, and only recommends bone scintigraphy for muscle invasive urothelial cancer in symptomatic, high-risk patients or those with laboratory indicators of bone metastasis.[4, 5]

The utility of PET/CT prior to planned cystectomy has been studied prospectively. In a study by Goodfellow et al., PET/CT was able to detect metastatic disease outside the pelvis with a sensitivity of 54% compared to 41% for the staging CT (N = 207). Both ~~scans~~ modalities had similar specificities of 97% and 98%.[6] In 2 additional studies, management was changed in 6%-27% of the patients based on new findings on PET/CT not detected by conventional CT.[7, 8] A meta-analysis of PET/CT in urinary bladder cancer showed pooled sensitivity and specificity of PET/CT for primary lesion detection were 90% and 100%, respectively. ~~The pooled sensitivity and specificity of PET/CT for staging or restaging metastatic lesions of bladder cancer were 82% and 89%, respectively.~~ The authors concluded that diagnostic accuracy of PET/CT was good in metastatic lesions of urinary bladder cancer, but due to the small number of patients and limited number of studies analyzed, the diagnostic capability of FDG-PET or PET/CT in detection of primary bladder wall lesions could not be assessed.[9] ~~Another review and meta-analysis by Soubra et al. showed a slightly lower sensitivity and specificity at 58% and 95%, respectively, for detecting lymph node metastases.[10]~~ Although PET shows promise as a useful clinical tool for staging of bladder cancer~~, especially~~ outside of the pelvis, ~~it should only be used to confirm resectability prior to planned surgical intervention for stage II and III bladder/urothelial cancers, and~~ currently its use is a National Comprehensive Cancer Network (NCCN) category 2B recommendation.[4]

Additional metastatic workup with MRI of the brain and bone scan should not be routinely ordered unless localizing labs or symptoms are present.[11, 12]10,11 The imaging recommendations for renal pelvis and urothelial carcinoma of the ureter for ≤ T1 disease should be guided by recommendations for noninvasive bladder cancer and for ≥ T2 disease should be guided by recommendations for invasive bladder cancer.[13]12

MANAGEMENT

There is limited evidence to favor one imaging modality over another for tumor evaluation following initial therapy. Results for the bladder cohort from the national oncologic PET registry showed that FDG-PET used for chemotherapy monitoring changed management in 52% of patients.[14]13 This study included all disease stages and did not report the comparative effects of other imaging modalities on treatment.

SCREENING AND SURVEILLANCE

The majority of recurrences after cystectomy are asymptomatic and routine surveillance is indicated. The most common sites of recurrence are the peritoneum, lymph nodes, liver, bone, lungs, and adrenal glands with late recurrences occurring in the upper urinary tract.[15]-14 Early detection of asymptomatic recurrence has been shown to positively impact survival.[16]-15 To completely assess these areas for potential metastases, chest X-ray and CT abdomen and pelvis with excretory imaging are the imaging modalities recommended by NCCN.[4] CT scan of the abdomen and pelvis with and without contrast may replace CT abdomen and pelvis with excretory imaging after 2 years.

References

1. Chang SS, Bochner BH, Chou R, et al. Treatment of non-metastatic muscle-invasive bladder cancer: AUA/ASCO/ASTRO/SUO guideline. J Urol. 2017;198(3):552-9. PMID: 28456635
2. Tekes A, Kamel I, Imam K, et al. Dynamic MRI of bladder cancer: evaluation of staging accuracy. AJR Am J Roentgenol. 2005;184(1):121-7. PMID: 15615961
3. Barentsz JO, Jager GJ, van Vierzen PB, et al. Staging urinary bladder cancer after transurethral biopsy: value of fast dynamic contrast-enhanced MR imaging. Radiology. 1996;201(1):185-93. PMID: 8816542
4. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Bladder Cancer (Version 1.2019)5.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 20192020.
5. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Kidney Cancer (Version 4.2019)2.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 20192020.
6. Goodfellow H, Viney Z, Hughes P, et al. Role of fluorodeoxyglucose positron emission tomography (FDG PET)-computed tomography (CT) in the staging of bladder cancer. BJU Int. 2014;114(3):389-95. PMID: 24341486
7. Kollberg P, Almquist H, Blackberg M, et al. [(18)F]Fluorodeoxyglucose - positron emission tomography/computed tomography improves staging in patients with high-risk muscle-invasive bladder cancer scheduled for radical cystectomy. Scand J Urol. 2015;49(4):296-301. PMID: 25623843
8. Kibel AS, Dehdashti F, Katz MD, et al. Prospective study of [18F]fluorodeoxyglucose positron emission tomography/computed tomography for staging of muscle-invasive bladder carcinoma. J Clin Oncol. 2009;27(26):4314-20. PMID: 19652070
9. Lu YY, Chen JH, Liang JA, et al. Clinical value of FDG PET or PET/CT in urinary bladder cancer: a systemic review and meta-analysis. Eur J Radiol. 2012;81(9):2411-6. PMID: 21899971
10. Soubra A, Hayward D, Dahm P, et al. The diagnostic accuracy of 18F-fluorodeoxyglucose positron emission tomography and computed tomography in staging bladder cancer: a single-institution study and a systematic review with meta-analysis. World J Urol. 2016;34(9):1229-37. PMID: 26847182
11. Shinagare AB, Ramaiya NH, Jagannathan JP, et al. Metastatic pattern of bladder cancer: correlation with the characteristics of the primary tumor. AJR Am J Roentgenol. 2011;196(1):117-22. PMID: 21178055
12. 11. Anderson TS, Regine WF, Kryscio R, et al. Neurologic complications of bladder carcinoma: a review of 359 cases. Cancer. 2003;97(9):2267-72. PMID: 12712482
13. 12. Roupret M, Babjuk M, Comperat E, et al. European guidelines on upper tract urothelial carcinomas: 2013 update. Eur Urol. 2013;63(6):1059-71. PMID: 23540953
14. 13. Hillner BE, Siegel BA, Hanna L, et al. Impact of 18F-FDG PET used after initial treatment of cancer: comparison of the National Oncologic PET Registry 2006 and 2009 cohorts. J Nucl Med. 2012;53(5):831-7. PMID: 22448033
15. 14. Soukup V, Babjuk M, Bellmunt J, et al. Follow-up after surgical treatment of bladder cancer: a critical analysis of the literature. Eur Urol. 2012;62(2):290-302. PMID: 22609313

~~16~~15. Giannarini G, Kessler TM, Thoeny HC, et al. Do patients benefit from routine follow-up to detect recurrences after radical cystectomy and ileal orthotopic bladder substitution? Eur Urol. 2010;58(4):486-94. PMID: 20541311

Brain and Spinal Cord Malignancy

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented primary central nervous system cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated (note: especially useful when systemic involvement is clinically suspected)	Not indicated	Not indicated
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: especially useful when systemic involvement is clinically suspected)	Not indicated	Not indicated
MRI brain	Indicated	~~As clinically indicated~~ Indicated for evaluation of suspected or known primary CNS cancer or brain metastases	Indicated
MRI spine	~~As clinically indicated~~ Indicated (note: especially useful for intracranial and spinal ependymoma, medulloblastoma, primary spinal cord tumors, leptomeningeal disease, and symptomatic or cerebrospinal fluid-positive primary central nervous system lymphoma)	~~As clinically indicated~~ Indicated for evaluation of suspected or known primary CNS cancer or spinal metastases	Indicated for primary CNS cancers affecting the spinal cord
fMRI	~~As clinically indicated~~ Indicated for preoperative neurosurgical planning, as a replacement for a Wada test or direct electrical stimulation mapping	Indicated for preoperative neurosurgical planning, as a replacement for a Wada test or direct electrical stimulation mapping	Not indicated
MR ~~perfusion/~~ angiography	Not indicated	Indicated for evaluation of vascular supply to tumor	Not indicated
MR spectroscopy	Not indicated	~~As clinically indicated~~ Indicated to differentiate	Not indicated

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
		recurrent or residual brain tumor from post-therapy changes, such as delayed radiation necrosis	
FDG-PET/CT brain	~~As clinically indicated for primary central nervous system cancer~~ ~~Not~~ indicated	~~As clinically indicated~~ Indicated for differentiation of posttreatment scarring from residual or recurrent disease	Not indicated
FDG-PET/CT whole body	Indicated for evaluation of possible systemic disease in proven CNS lymphoma	Not indicated	Not indicated

Note: CT head or CT myelogram are imaging alternatives when MRI cannot be performed or is not available.

Note: Commonly used radiolabeled tracers for PET brain are not currently reviewed at AIM.

Rationale

Primary brain and spinal cord tumors encompass a large and heterogeneous group of cancers that range from benign to highly aggressive. Glioblastomas are the most common high-grade primary central nervous system cancer, and comprise about 15% of primary brain cancers.[1] Risk factors for brain and spinal cord cancers include genetic predisposition and radiation exposure. The most common presentation is focal neurological symptoms based on the region of brain involved.

DIAGNOSTIC WORKUP

The World Health Organization Classification of Tumors of the Central Nervous System is used to classify and grade gliomas. All patients require an MRI of the brain for initial evaluation unless contraindicated. Spine imaging is indicated for intracranial and spinal ependymoma, medulloblastoma, primary spinal cord tumors, leptomeningeal disease, and symptomatic or cerebrospinal fluid-positive central nervous system lymphoma. Imaging is also indicated for central nervous system lymphomas to assess for possible systemic involvement; one study found that PET/CT body had a significantly higher sensitivity (94%-98%) than CT and resulted in change in management in 34% of patients.[4]

Per NCCN, MR ~~spectroscopy, MR perfusion, and~~spectroscopy and PET brain imaging are not generally useful in the initial evaluation of primary central nervous system cancers. ~~Systemic imaging is also indicated for central nervous system lymphomas; one study found that PET/CT body had a significantly higher sensitivity (94%-98%) than CT imaging and resulted in change in management in 34% of patients.~~ However, the evidence to date is limited and PET imaging is currently a National Comprehensive Cancer Network (NCCN) level 2B recommendation.[2, 3-4]

MANAGEMENT

MR ~~perfusion/~~angiography, fMRI, MRS, or PET brain scan may be used to differentiate radiation necrosis from active tumor.[5] ~~Limited data have confirmed the utility of MR perfusion in identifying tumor response in high-grade gliomas.[6]~~ In a study comparing MRI to MRS, MRS plus diffusion-weighted imaging sequences was found to have above 95% sensitivity and specificity for distinguishing bacterial abscess from cystic tumor.[7, 6] In a meta-analysis comparing the accuracy of MRS to PET, there was no significant difference between the two modalities.[8, 7]

SCREENING AND SURVEILLANCE

AIM Oncologic Imaging guidelines for monitoring of primary central nervous system cancers are in concordance with both NCCN Nervous System Cancers guidelines as well as the European Society for Medical Oncology High-Grade Malignant Glioma guidelines.[9, 10, 8, 9]

References

1. Young RM, Jamshidi A, Davis G, et al. Current trends in the surgical management and treatment of adult glioblastoma. Ann Transl Med. 2015;3(9):121. PMID: 26207249

2. Blum RH, Seymour JF, Wirth A, et al. Frequent impact of [18F]fluorodeoxyglucose positron emission tomography on the staging and management of patients with indolent non-Hodgkin's lymphoma. Clin Lymphoma. 2003;4(1):43-9. PMID: 12837154

3. Wohrer S, Jaeger U, Kletter K, et al. 18F-fluoro-deoxy-glucose positron emission tomography (18F-FDG-PET) visualizes follicular lymphoma irrespective of grading. Ann Oncol. 2006;17(5):780-4. PMID: 16497824

4. Mohile NA, Deangelis LM, Abrey LE. The utility of body FDG PET in staging primary central nervous system lymphoma. Neuro-oncol. 2008;10(2):223-8. PMID: 18287338

5. Wen PY, Macdonald DR, Reardon DA, et al. Updated response assessment criteria for high-grade gliomas: response assessment in neuro-oncology working group. J Clin Oncol. 2010;28(11):1963-72. PMID: 20231676

6. ~~Tsien C, Galban CJ, Chenevert TL, et al. Parametric response map as an imaging biomarker to distinguish progression from pseudoprogression in high-grade glioma. J Clin Oncol. 2010;28(13):2293-9. PMID: 20368564~~

~~7.~~ Lai PH, Hsu SS, Ding SW, et al. Proton magnetic resonance spectroscopy and diffusion-weighted imaging in intracranial cystic mass lesions. Surg Neurol. 2007;68 Suppl 1:S25-36. PMID: 17963918

~~8~~7. Wang X, Hu X, Xie P, et al. Comparison of magnetic resonance spectroscopy and positron emission tomography in detection of tumor recurrence in posttreatment of glioma: a diagnostic meta-analysis. Asia Pac J Clin Oncol. 2015;11(2):97-105. PMID: 24783970

~~9~~8. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Central Nervous System Cancers (Version ~~1.2019~~2.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

~~10~~9. Stupp R, Brada M, van den Bent MJ, et al. High-grade glioma: ESMO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2014;25 Suppl 3:iii93-101. PMID: 24782454

Breast Cancer

Advanced imaging is considered medically necessary for the diagnostic workup and management of suspected or documented breast cancer. Routine surveillance imaging following completion of therapy is not considered medically necessary.

Imaging Study	Suspected Cancer	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Not indicated	Indicated for stage IIIA-IV	~~As clinically indicated~~ Indicated	Not indicated
CT abdomen and pelvis	Not indicated	Indicated for stage IIIA-IV	~~As clinically indicated~~ Indicated	Not indicated
MRI breast	Indicated in ANY of the following scenarios: • Single follow-up MRI at 6 months following a breast MRI with BI-RADS category 3 findings • Differentiation of palpable mass from surgical scar tissue • Lesion characterization when other imaging examinations, such as ultrasound and mammography, and physical examination are inconclusive for the presence of breast cancer, and biopsy cannot be performed • Metastatic cancer of unknown primary and suspected to be of breast origin and/or axillary adenopathy and no mammographic or physical findings of	Indicated in EITHER of the following scenarios: • To determine the extent of disease in biopsy-proven invasive carcinoma and ductal carcinoma in situ • To define the relationship of the tumor to the fascia and its extension into the pectoralis major, serratus anterior, and/or intercostal muscles prior to surgery	Indicated in ANY of the following scenarios: • To assess response to neoadjuvant chemotherapy prior to surgery • Post-lumpectomy with close or positive margins to evaluate for residual disease • Suspected recurrence in patients with tissue transfer flaps (rectus, latissimus dorsi, and gluteal) post-reconstruction • Suspected recurrence in women with a prior history of breast cancer when clinical, mammographic, and/or sonographic findings are inconclusive	~~Not indicated~~ Screening – see breast cancer screening Surveillance - In women with a personal history of breast cancer after breast conserving therapy or unilateral mastectomy who meet criteria for breast screening

Imaging Study	Suspected Cancer	Diagnostic Workup	Management	Screening & Surveillance
	primary breast carcinoma			
FDG-PET/CT	Not indicated	~~As clinically indicated~~ Indicated in ~~ANY~~EITHER of the following scenarios: • ~~Standard imaging studies are equivocal or nondiagnostic for metastatic disease~~ • Locally advanced disease (stage IIIA-IIIC) has been established and standard imaging ~~does not clearly demonstrate~~ cannot be performed or is nondiagnostic for metastatic disease • Clinical suspicion for metastatic disease when standard imaging cannot be performed or is non diagnostic for metastatic disease • ~~Symptom-directed staging has been performed and is equivocal or suspicious for metastatic disease~~	~~As clinically indicated~~ Indicated in ~~EITHER~~ ANY of the following scenarios: • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease • ~~Suspected worsening of disease based on objective signs or symptoms (such as rising tumor markers),~~ Clinical suspicion for worsening of disease when standard imaging has not clearly identified a site of recurrence or progression • Restaging/treatment response when bone is the only site of measureable disease in the chest, abdomen, and pelvis	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Breast cancer is the most common cancer in women. Invasive ductal carcinoma and invasive lobular carcinoma are the two main histological subtypes of breast cancer, accounting for 91% of all diagnoses.[1] Incidence increases with age and risk factors include family history, use of hormone replacement therapy, use of oral contraceptives and benign breast disease. Most cases of breast cancer are detected by mammographic screening or self-examination.

SUSPECTED CANCER

Imaging cannot replace tissue diagnosis, and suspicious lesions should be biopsied. MRI breast may be indicated in high-risk patients without a positive biopsy. MRI breast has been shown to have improved sensitivity over conventional mammographic imaging; however, limited data exists to support the use of MRI in patients with a lumpy, dense, clinically negative breast exam and normal conventional imaging. Although the risk of malignancy

with a mammogram designated as BI-RADS 3 is relatively low (0.3%-2%), some experts recommend follow-up with MRI in this scenario.

DIAGNOSTIC WORKUP

Breast cancer is staged using the American Joint Committee on Cancer TNM system. Advanced imaging should be guided by stage and other presenting symptoms. In a large single-institution retrospective study of newly diagnosed asymptomatic breast cancer, bone scan detected bony metastases in 6% of patients (stage I 5%, stage II 6%, and stage III 14%), liver ultrasound detected hepatic metastases in 0.7% of patients (stage I or II 0% and stage III 6%), and chest X-ray detected lung metastases in 0.9% of patients (stage I or II 0% and stage III 7%). However, there was an unacceptably high rate of false positives: 6% for bone scans, 6% for liver ultrasounds, and 3% for chest X-rays.[2] Ravaioli et al. reported the rate of metastases detection in asymptomatic breast cancer patients was 1.46% for stage I and II versus 10.68% for stage III.[3] A review of 20 studies similarly showed that bone scan detected skeletal metastases in 0.5%-6.8% of those with stage I, 2.4%-8.8% with stage II, and 8.3%-24.5% with stage III breast cancer. The detection of liver and bone metastases ranged from 0%-1.7% in stage I-II patients and 1.7%-2% for stage III patients. False-positive rates were 10%-22% for bone scan, 33%-66% for liver ultrasonography, and 0%-23% for chest radiography.[4] Based on the poor sensitivity and specificity of imaging in asymptomatic early stage breast cancer, imaging should be reserved for evaluation of specific signs or symptoms suggestive of metastatic disease.

The NCCN recommends the use of sentinel lymph node detection in patients with Stage I-III and clinically lymph node-negative breast cancer performed prior to systemic therapy or in selected patients after systemic therapy. The use of sentinel lymph node detection has been shown to decrease extent and morbidity of surgery without compromise to outcome. Patients with higher stage disease may require full lymph node dissections.[5, 6, 7]

The use of PET or PET/CT is not indicated in the routine staging of clinical stage I, stage II or operable stage III (T3 N1) breast cancer, supported by studies detailing the high false-negative rate in the detection of lesions that are small (<1 cm), low sensitivity for detecting axillary nodal metastases, low probability of these patients having detectable metastatic disease, and high rate of false-positive scans.[8-11] In the setting of metastatic disease found on conventional imaging, there is insufficient data and limited evidence to show PET scan alters treatment. ~~Recent studies have found that PET/CT imaging changed the initial treatment in 1%-8% of patients with early-stage breast cancer.~~ In a prospective study (N=178) by Jeong et al., patients without clinically detected axillary node metastases had virtually no benefit from PET/CT scan; management was changed in only 1.7% of patients.[8,12] However, f~~F~~or locally advanced disease, a higher proportion~~,~~ (7%-13%) had changes in management based on PET/CT imaging.[9-13] ~~Additionally, a prospective multicenter study evaluating the use PET/CT in detecting axillary metastases found sensitivity and specificity to be 61% and 80%, respectively.[10] A review of 21 studies showed that PET/CT had equivalent specificity when compared to MRI but had a substantially worse sensitivity, 64% versus 82%, respectively.[11] In advanced breast cancer, a handful of studies have shown potential benefit to PET imaging in detecting distant metastases over conventional imaging.[12, 13] In the largest of the prospective studies, the overall sensitivity and specificity of PET/CT for detecting distant metastases were 100% and 98%, respectively, whereas the sensitivity and specificity of conventional imaging were 60% and 83%, respectively. PET/CT led to a change in the initial staging in 42% of patients.[14] In a recent meta-analysis of six studies, Sun et al. found PET/CT had a sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of 99%, 95%, 21.1, and 0.02 compared to conventional imaging 57%, 88%, 4.8, and 0.49 for detecting distant metastases.[15]~~ The National Comprehensive Cancer Network (NCCN) has designated PET/CT scan as optional, ~~as a category 2B option.~~most helpful in situations where standard staging studies are equivocal or suspicious, especially in the setting of locally advanced or metastatic disease. [5]

The utility of preoperative MRI breast is controversial and is not universally recommended. In 2 prospective trials, the rate of postoperative re-excision was unaffected by preoperative MRI.[~~16, 17~~14,15] In a meta-analysis of 4 studies by ~~Nehmat~~ Houssami et al., (N=3169 patients), there was no difference in the rate of local recurrence or disease-free survival at 8 years for patients receiving a preoperative breast MRI compared with those without preoperative imaging.[~~18~~16] The NCCN designates MRI breast as an optional imaging test.[5]

MANAGEMENT

MRI breast been shown to inaccurately estimate the size of the residual tumor.[~~19~~-17] In the phase III INTENS trial, ultrasound was able to more accurately predict pathological residual tumor as compared to MRI.[~~20~~-18]

Response to therapy based on PET/CT imaging has been correlated with longer time to progression but whether this translates into improved patient outcomes is unknown.[~~21~~-19] In a comparative study of 17 single-institution, nonrandomized, observational studies, PET/CT response correlated with changes in tumor volume as determined by bone scan, MRI, and/or CT; however, performance compared to conventional modalities and overall clinical impact could not be determined.[~~22~~-20] PET imaging is designated ~~category 2B~~as optional by the NCCN.[5] In the unique scenario of bone-only metastases, the AIM External Expert Advisory Board allows for disease monitoring with PET imaging, as restaging with CT or MRI is expected to result in suboptimal distinction between treated and residual/recurrent bone disease.

SCREENING AND SURVEILLANCE

Both the American Society of Clinical Oncology and the NCCN discourage the use of advanced body imaging for surveillance of treated, asymptomatic breast cancer.[~~5, 23~~-5, 21] Early detection has not been shown to provide an advantage in survival or the ability to palliate recurrent disease and there is no evidence to support the use of CT, MRI, or PET scan.[~~24~~-9]

The use of breast MRI in follow-up of women with prior breast cancer is undefined, but may be considered in women treated with breast conserving therapy with high lifetime risk (greater than 20% based on models largely dependent on family history). Rates of contralateral breast cancer after breast-conserving therapy (eg lumpectomy) or mastectomy are reported to be increased in women with BRCA1/2 mutations when compared with patients with sporadic breast cancer.[22-24]

References

1. Li CI, Uribe DJ, Daling JR. Clinical characteristics of different histologic types of breast cancer. British Journal of Cancer. 2005;93(9):1046-52. PMID: 16175185
2. Puglisi F, Follador A, Minisini AM, et al. Baseline staging tests after a new diagnosis of breast cancer: further evidence of their limited indications. Ann Oncol. 2005;16(2):263-6. PMID: 15668281
3. Ravaioli A, Pasini G, Polselli A, et al. Staging of breast cancer: new recommended standard procedure. Breast Cancer Res Treat. 2002;72(1):53-60. PMID: 12000220
4. Myers RE, Johnston M, Pritchard K, et al. Baseline staging tests in primary breast cancer: a practice guideline. Cmaj. 2001;164(10):1439-44. PMID: 11387916
5. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Breast Cancer (Version ~~3.2018~~4.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2018.~~2020
6. Food and Drug Administration (FDA). Lymphoseek (technetium Tc 99m tilmanocept) injection, for subcutaneous, intradermal, subareolar, or peritumoral use, (2016) Available from: https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/202207s005lbl.pdf.
7. Food and Drug Administration (FDA). Kit for the preparation of technetium tc 99m sulfur colloid injection for subcutaneous, intraperitoneal, intravenous, and oral use, (1978) Available from: https://www.accessdata.fda.gov/drugsatfda_docs/label/2011/017858s034lbl.pdf.
8. Kumar R, Chauhan A, Zhuang H, et al. Clinicopathologic factors associated with false negative FDG-PET in primary breast cancer. Breast Cancer Res Treat 2006; 98:267-274. PMID: 16555126
9. Podoloff DA, Advani RH, Allred C, et al. NCCN task force report: positron emission tomography (PET)/computed tomography (CT) scanning in cancer. J Natl Compr Canc Netw 2007;5 Suppl 1:1-1. PMID: 17509259
10. Rosen EL, Eubank WB, Mankoff DA. FDG PET, PET/CT and breast cancer imaging. Radiographics 2007;27 Suppl 1:S215-229. PMID: 18180228
11. Wahl RL, Siegel BA, Coleman RE, Gatsonis CG. Prospective multicenter study of axillary nodal staging by positron emission tomography in breast cancer: a report of the staging breast cancer with PET Study Group. J Clin Oncol 2004;22:277-285. PMID 14722036
12. Jeong YJ, Kang DY, Yoon HJ, et al. Additional value of F-18 FDG PET/CT for initial staging in breast cancer with clinically negative axillary nodes. Breast Cancer Res Treat. 2014;145(1):137-42. PMID: 24682676
~~9~~13. Caresia Aroztegui AP, Garcia Vicente AM, Alvarez Ruiz S, et al. 18F-FDG PET/CT in breast cancer: Evidence-based recommendations in initial staging. Tumour Biol. 2017;39(10):1010428317728285. PMID: 29025377
~~10. Wahl RL, Siegel BA, Coleman RE, et al. Prospective multicenter study of axillary nodal staging by positron emission tomography in breast cancer: a report of the staging breast cancer with PET Study Group. J Clin Oncol. 2004;22(2):277-85. PMID: 14722036~~
~~11. Liang X, Yu J, Wen B, et al. MRI and FDG-PET/CT based assessment of axillary lymph node metastasis in early breast cancer: a meta-analysis. Clin Radiol. 2017;72(4):295-301. PMID: 28139203~~
~~12. Niikura N, Costelloe CM, Madewell JE, et al. FDG PET/CT compared with conventional imaging in the detection of distant metastases of primary breast cancer. Oncologist. 2011;16(8):1111-9. PMID: 21765193~~
~~13. Groheux D, Moretti JL, Baillet G, et al. Effect of (18)F-FDG PET/CT imaging in patients with clinical Stage II and III breast cancer. Int J Radiat Oncol Biol Phys. 2008;71(3):695-704. PMID: 18436392~~
~~14. Fuster D, Duch J, Paredes P, et al. Preoperative staging of large primary breast cancer with [18F]fluorodeoxyglucose positron emission tomography/computed tomography compared with conventional imaging procedures. J Clin Oncol. 2008;26(29):4746-51. PMID: 18695254~~
~~15. Sun Z, Yi YL, Liu Y, et al. Comparison of whole-body PET/PET-CT and conventional imaging procedures for distant metastasis staging in patients with breast cancer: a meta-analysis. Eur J Gynaecol Oncol. 2015;36(6):672-6. PMID: 26775349~~16~~14~~. Peters NH, van Esser S, van den Bosch MA, et al. Preoperative MRI and surgical management in patients with nonpalpable breast cancer: the MONET - randomised controlled trial. Eur J Cancer. 2011;47(6):879-86. PMID: 21195605

~~17~~15. Turnbull LW, Brown SR, Olivier C, et al. Multicentre randomised controlled trial examining the cost-effectiveness of contrast-enhanced high field magnetic resonance imaging in women with primary breast cancer scheduled for wide local excision (COMICE). Health Technol Assess. 2010;14(1):1-182. PMID: 20025837

~~18~~16. Houssami N, Turner R, Macaskill P, et al. An individual person data meta-analysis of preoperative magnetic resonance imaging and breast cancer recurrence. J Clin Oncol. 2014;32(5):392-401. PMID: 24395846

~~19~~17. Martincich L, Montemurro F, Cirillo S, et al. Role of Magnetic Resonance Imaging in the prediction of tumor response in patients with locally advanced breast cancer receiving neoadjuvant chemo-therapy. Radiol Med (Torino). 2003;106(1-2):51-8. PMID: 12951551

~~20~~18. Vriens BE, de Vries B, Lobbes MB, et al. Ultrasound is at least as good as magnetic resonance imaging in predicting tumour size post-neoadjuvant chemotherapy in breast cancer. Eur J Cancer. 2016;52:67-76. PMID: 26650831

~~21~~19. Huyge V, Garcia C, Alexiou J, et al. Heterogeneity of metabolic response to systemic therapy in metastatic breast cancer patients. Clin Oncol (R Coll Radiol). 2010;22(10):818-27. PMID: 20554438

~~22~~20. Lee CI, Gold LS, Nelson HD, et al. Comparative effectiveness of imaging modalities to determine metastatic breast cancer treatment response. Breast. 2015;24(1):3-11. PMID: 25479913

~~23~~21. Runowicz CD, Leach CR, Henry NL, et al. American Cancer Society/American Society of Clinical Oncology breast cancer survivorship care guideline. CA Cancer J Clin. 2016;66(1):43-73. PMID: 26641959

~~24. Podoloff DA, Advani RH, Allred C, et al. NCCN task force report: positron emission tomography (PET)/computed tomography (CT) scanning in cancer. J Natl Compr Canc Netw. 2007;5 Suppl 1:S1-22; quiz S3-2. PMID: 17509259~~

22. Kirova YM, Stoppa-Lyonnet D, Savignoni A, et al. Risk of breast cancer recurrence and contralateral breast cancer in relation to BRCA1 and BRCA2 mutation status following breast-conserving surgery and radiotherapy. Eur J Cancer 2005;41:2304-2311. PMID: 16140006

23. Metcalfe K, Lynch HT, Ghadirian P, et al. Contralateral breast cancer in BRCA1 and BRCA2 mutation carriers. J Clin Oncol 2004;22:2328-2335. PMID: 15197194

24. Pierce LJ, Levin AM, Rebbeck TR, et al. Ten-year multi-institutional results of breast conserving surgert and radiotherapy in BRCA1/2-associated stage I/II breast cancer. J Clin Oncol 2006;24:2437-2443. PMID: 16636335

Cancers of Unknown Primary / Cancers Not Otherwise Specified

The following imaging criteria may be utilized for cancers not addressed elsewhere in the Oncologic Imaging guidelines, including cancers of unknown primary.

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented malignancy.

Imaging Modality	Diagnostic Workup	Management	Screening and Surveillance
CT chest	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected
CT abdomen and pelvis	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected
MRI imaging	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected	~~As clinically indicated~~ Indicated based on specific cancer or cancer type suspected
FDG-PET/CT	~~As clinically indicated~~ Indicated when standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic in determining the extent of disease	~~As clinically indicated~~ Indicated when standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic in determining the extent of disease	Not indicated

Note: For malignancy of unknown origin involving the cervical lymph nodes, please see "Head and Neck Cancer"

Rationale

Cancer of unknown primary (CUP) accounts for 2% of all cancer diagnoses.[1] Based on histopathologic features, CUP is further subdivided into four categories: adenocarcinoma, squamous cell carcinoma, neuroendocrine carcinomas, and poorly differentiated carcinomas. Further testing should be guided by patient history and physical, pattern of disease spread, and clinical factors. In the majority of CUP, the underlying malignancy is never identified and treatment often is empiric based on histopathologic subtype. As CUP often present as metastatic disease, prognosis is poor with 80% of patients having a median overall survival of only 6 months.[2] This section addresses both cancers of unknown primary as well as cancers not otherwise specified in AIM Clinical Appropriateness Guidelines section for Oncologic Imaging.

DIAGNOSTIC WORKUP

For malignancy of unknown origin involving the cervical lymph nodes but suspected to be of Head/Neck origin, please see "Head and Neck Cancer" guidelines.

The initial work-up for cancers of unknown primary should include a history and physical, laboratory evaluation, and imaging studies. CT ~~imaging~~ of the chest, abdomen, and pelvis is commonly used to identify the primary ~~cancer of~~ cancer, assess extent of disease, and select for sites amenable to biopsy.[3] PET imaging is increasingly being used as part of the diagnosis of CUP. A meta-analysis and systematic review on the use of PET/CT in patients with CUP found that primary tumors were detected in 37% of 433 patients from 11 studies, with pooled sensitivity and specificity both at 84%.~~18925401~~[4] Another study found that PET/CT detected more primary sites (24%-40%) than CT or MRI (20%-27%).[4–5] NCCN-, however, does not recommend routine use of PET imaging for CUP due to a lack of prospective randomized studies comparing PET imaging to conventional imaging.[7–8] Special consideration should be given to patients presenting with a solitary metastasis where localized intervention is planned and to cervical nodal metastases of unknown origin. In a comprehensive review of patients with a solitary metastasis, PET imaging changed management in 34% of patients relative to conventional imaging. Fourteen percent of patients underwent surgery with curative intent.[5] [6] In a systematic review and meta-analysis of patients with cervical nodal metastases of unknown origin, the primary

tumor detection rate, sensitivity, and specificity of PET-CT were 0.44 (95% CI, 0.31-0.58), 0.97 (95% CI, 0.63-0.99), and 0.68 (95% CI, 0.49-0.83). Area under the curve was 0.83 (95% CI, 0.80-0.86).[6-7] ~~For malignancy of unknown origin involving the cervical lymph nodes, please see "Head and Neck Cancer".~~

~~The~~The initial work-up of patients with cancer not otherwise specified should include imaging of the primary neoplastic process and assessment for systemic involvement if warranted. Specific imaging recommendations vary with underlying pathologic diagnosis, staging, and patient factors. Because of the many nuances associated with cancer evaluation, peer-to-peer discussions will often be necessary to determine appropriateness of advanced imaging.

MANAGEMENT

For patients with either active disease or localized disease in remission, follow-up frequency should be determined by clinical need with additional diagnostic tests based on symptomatology.[7-8]

Subsequent imaging strategy for cancer not otherwise specified varies with underlying pathologic diagnosis and staging. In general terms, imaging used in the initial detection of the cancer may be used to assess for treatment response.

SCREENING AND SURVEILLANCE

For patients with either active disease or localized disease in remission, follow-up frequency should be determined by clinical need with additional diagnostic tests based on symptomatology. [7-8]

The type and frequency of surveillance imaging for cancer not otherwise specified is dependent on the underlying pathologic diagnosis and staging. When indicated, CT imaging can be used in most cancers, with PET rarely indicated for surveillance.

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2018. CA Cancer J Clin. 2018;68(1):7-30. PMID: 29313949
2. Losa F, Soler G, Casado A, et al. SEOM clinical guideline on unknown primary cancer (2017). Clin Transl Oncol. 2018;20(1):89-96. PMID: 29230692
3. Kim KW, Krajewski KM, Jagannathan JP, et al. Cancer of unknown primary sites: what radiologists need to know and what oncologists want to know. AJR Am J Roentgenol. 2013;200(3):484-92. PMID: 23436835
4. Kwee TC, Kwee RM. Combined FDG-PET/CT for the Detection of Unknown Primary Tumors: Systematic Review and Meta-Analysis. Eur Radiol, 2009;19(3):731-44. PMID 18925401
5. Ambrosini V, Nanni C, Rubello D, et al. 18F-FDG PET/CT in the assessment of carcinoma of unknown primary origin. Radiol Med (Torino). 2006;111(8):1146-55. PMID: 17171520
~~5~~6. Seve P, Billotey C, Broussolle C, et al. The role of 2-deoxy-2-[F-18]fluoro-D-glucose positron emission tomography in disseminated carcinoma of unknown primary site. Cancer. 2007;109(2):292-9. PMID: 17167760
~~6~~7. Zhu L, Wang N. 18F-fluorodeoxyglucose positron emission tomography-computed tomography as a diagnostic tool in patients with cervical nodal metastases of unknown primary site: a meta-analysis. Surg Oncol. 2013;22(3):190-4. PMID: 23849685
~~7~~8. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Occult Primary (Cancer of Unknown Primary [CUP]) (Version ~~2.2019~~3.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

Cervical Cancer

Advanced imaging is considered medically necessary for diagnostic workup and management of documented cervical cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated (note: CXR usually sufficient for Stage I)	~~As clinically indicated~~ Indicated	Not indicated
CT abdomen and pelvis	Indicated (note: CXR usually sufficient for Stage I)	Indicated (note: especially useful 3-6 months after completion of therapy if PET imaging not done)	Not indicated
MRI pelvis	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: especially useful 3-6 months after completion of therapy OR in patients who have undergone fertility-sparing surgery)	Not indicated
FDG-PET/CT	Indicated for patients with a definitive diagnosis of stage IB1 or higher as an alternative to CT chest, abdomen, and pelvis	Indicated in ~~EITHER~~ ANY of the following scenarios ~~(preferred for stage IB2-IV cervical cancer):~~ • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease • Assessment of response to definitive chemoradiation when performed at least 12 weeks following therapy • Signs or symptoms concerning for recurrent or metastatic disease, for stage II and higher cervical cancer	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Ninety-five percent of cervical cancers are classified as either squamous cell carcinomas (the majority) or adenocarcinomas.[1] Other rare histologies include neuroendocrine carcinoma, small cell carcinoma, lymphoma, and rhabdomyosarcoma. Risk factors for cervical cancer include immunosuppression, high-risk sexual behavior and infection with human papillomavirus.

DIAGNOSTIC WORKUP

Cervical cancer is staged using the FIGO system. Pelvis MRI is most useful for determination of tumor location, size, invasion, and presence of regional nodal disease.[2, 3] A systematic review of 57 single-institution trials showed MRI was more accurate than CT for overall staging of cervical cancer.[4] ~~However, a~~A retrospective American College of Radiology Imaging Network/Gynecology Oncology Group (ACRIN/GOG) study comparing MRI and CT for early-stage cervical cancer found that contrast-enhanced multi-detector CT was equivalent to MRI for overall preoperative staging~~.~~, but MRI performed significantly better for visualization of the primary tumor and detection of parametrial invasion.[5] In a second ACRIN ~~6651~~/GOG ~~183~~ Intergroup Study, MRI was superior to CT and clinical examination for evaluating uterine body involvement and measuring tumor size.[6] This benefit was also seen for preoperative selection of women for fertility-sparing surgery and for evaluation of residual tumor in the cervix after a cone biopsy with negative margins. In a small retrospective study in patients with negative margins after conization,

MRI was 100% concordant in showing no residual cancer.[7] MRI may also play a role in radiation planning to aid with CT contouring.[8]

The NCCN recommends sentinel lymph node detection in patients with Stage IA1 with LVI, IA2, 1B1, and IIA1 and clinically lymph node-negative cervical cancer. The use of sentinel lymph node detection has been shown to decrease extent and morbidity of surgery without compromise to outcome. Patients with higher stage disease may require full lymph node dissections.[9, 10]

~~CT and~~ PET/CT ~~are both~~is a useful ~~modalities~~ modality for evaluating for extrauterine disease.[11, 12] ~~The results of studies comparing PET/CT to CT alone for evaluation of nodal involvement are mixed, although PET/CT performs better in advanced disease.[13] In the prospective ACRIN 6671/GOG 0233 trial, PET/CT did not show significantly higher specificity in detecting abdominal lymph node metastasis in advanced cervical cancer when compared to CT alone and showed only marginally higher sensitivity (P = .05).[14]~~ Lin et al. reported a PET sensitivity of 85.7%, specificity of 94.4%, and accuracy of 92% for detecting para-aortic lymph node metastasis in CT-negative advanced cervical cancer patients.[15] Another review also concluded that PET/CT appeared better than conventional imaging for detection of metastatic lymph nodes with a reported sensitivity of 78%-84% for PET/CT, 72% for MRI, and only 47% for CT alone.[16] ~~Pretreatment PET/CT may also play a role in radiation planning with respect to nodal volume. In a Phase III randomized trial, pretreatment PET imaging and detection of para-aortic lymph nodes decreased the need for extended-field concurrent chemoradiation therapy, but did not improve overall survival, disease-free survival, or freedom from extrapelvic metastasis.[17]~~ Per NCCN, whole body PET/CT is preferred for stage IB1/IB2 disease prior to fertility sparing treatment, and for stage IB3 and higher disease as part of initial work-up (level of evidence category 2A).[9]

MANAGEMENT

PET imaging is preferred for patients with high risk stage IB2 or above disease treated with definitive chemoradiation therapy. Early data suggest PET/CT during and/or after concurrent chemoradiation therapy may be a useful test for predicting local and distant failures and overall survival.[17] ~~It is still unclear whether PET/CT affects overall management with resultant improvements in outcome.~~ In the setting of recurrent disease, PET/CT has reported sensitivities ranging from 90.3%-92.7% and specificities ranging from 81%-100%.[18] NCCN designates whole-body PET/CT as preferred for follow-up of stage IIA1-IVA disease, with imaging as indicated based on symptomatology and clinical concern for recurrent/metastatic disease.[9]

SCREENING AND SURVEILLANCE

In the setting of fertility-sparing surgery, MRI is commonly used for postoperative follow up. In a single-institution study, serial MRI follow up detected recurrent cervical cancer at a rate of 4%. Review of the literature shows that the recurrence rate after trachelectomy varies from 0%-25%.[19,20]

Routine surveillance is not indicated in cervical cancer patients treated with radical hysterectomy, radiation, or concurrent chemotherapy, in accordance with National Comprehensive Cancer Network guidelines and Society of Gynecologic Oncology recommendations.[9, 21]

References

1. Adegoke O, Kulasingam S, Virnig B. Cervical cancer trends in the United States: a 35-year population-based analysis. J Womens Health (Larchmt). 2012;21(10):1031-7. PMID: 22816437
2. Balleyguier C, Sala E, Da Cunha T, et al. Staging of uterine cervical cancer with MRI: guidelines of the European Society of Urogenital Radiology. Eur Radiol. 2011;21(5):1102-10. PMID: 21063710
3. Sala E, Rockall AG, Freeman SJ, et al. The added role of MR imaging in treatment stratification of patients with gynecologic malignancies: what the radiologist needs to know. Radiology. 2013;266(3):717-40. PMID: 23431227
4. Patel S, Liyanage SH, Sahdev A, et al. Imaging of endometrial and cervical cancer. Insights imaging. 2010;1(5-6):309-28. PMID: 22347925
5. Hricak H, Gatsonis C, Coakley FV, et al. Early invasive cervical cancer: CT and MR imaging in preoperative evaluation - ACRIN/GOG comparative study of diagnostic performance and interobserver variability. Radiology. 2007;245(2):491-8. PMID: 17940305
6. Mitchell DG, Snyder B, Coakley F, et al. Early invasive cervical cancer: tumor delineation by magnetic resonance imaging, computed tomography, and clinical examination, verified by pathologic results, in the ACRIN 6651/GOG 183 Intergroup Study. J Clin Oncol. 2006;24(36):5687-94. PMID: 17179104
7. Lakhman Y, Akin O, Park KJ, et al. Stage IB1 cervical cancer: role of preoperative MR imaging in selection of patients for fertility-sparing radical trachelectomy. Radiology. 2013;269(1):149-58. PMID: 23788721
8. Wang F, Tang Q, Lv G, et al. Comparison of computed tomography and magnetic resonance imaging in cervical cancer brachytherapy: A systematic review. Brachytherapy. 2017;16(2):353-65. PMID: 27965118
9. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Cervical Cancer (Version ~~3.2019~~1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

10. Food and Drug Administration (FDA). Lymphoseek (technetium Tc 99m tilmanocept) injection, for subcutaneous, intradermal, subareolar, or peritumoral use, (2016) Available from: https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/202207s005lbl.pdf.

11. Subak LL, Hricak H, Powell CB, et al. Cervical carcinoma: computed tomography and magnetic resonance imaging for preoperative staging. Obstet Gynecol. 1995;86(1):43-50. PMID: 7784021

12. Pannu HK, Fishman EK. Evaluation of cervical cancer by computed tomography: current status. Cancer. 2003;98(9 Suppl):2039-43. PMID: 14603540

~~13. Signorelli M, Guerra L, Montanelli L, et al. Preoperative staging of cervical cancer: is 18-FDG-PET/CT really effective in patients with early stage disease? Gynecol Oncol. 2011;123(2):236-40. PMID: 21855972~~

~~14. Atri M, Zhang Z, Dehdashti F, et al. Utility of PET-CT to evaluate retroperitoneal lymph node metastasis in advanced cervical cancer: Results of ACRIN6671/GOG0233 trial. Gynecol Oncol. 2016;142(3):413-9. PMID: 27178725~~

~~15~~13. Lin WC, Hung YC, Yeh LS, et al. Usefulness of (18)F-fluorodeoxyglucose positron emission tomography to detect para-aortic lymph nodal metastasis in advanced cervical cancer with negative computed tomography findings. Gynecol Oncol. 2003;89(1):73-6. PMID: 12694656

~~16~~14. Havrilesky LJ, Kulasingam SL, Matchar DB, et al. FDG-PET for management of cervical and ovarian cancer. Gynecol Oncol. 2005;97(1):183-91. PMID: 15790456

~~17. Lin SY, Tsai CS, Chang YC, et al. The Role of Pretreatment FDG-PET in Treating Cervical Cancer Patients With Enlarged Pelvic Lymph Node(s) Shown on MRI: A Phase 3 Randomized Trial With Long-Term Follow-Up. Int J Radiat Oncol Biol Phys. 2015;92(3):577-85. PMID: 25936817~~

~~18~~17. Liu FY, Lai CH, Yang LY, et al. Utility of (18)F-FDG PET/CT in patients with advanced squamous cell carcinoma of the uterine cervix receiving concurrent chemoradiotherapy: a parallel study of a prospective randomized trial. Eur J Nucl Med Mol Imaging. 2016;43(10):1812-23. PMID: 27160224

~~19~~18. Sironi S, Picchio M, Landoni C, et al. Post-therapy surveillance of patients with uterine cancers: value of integrated FDG PET/CT in the detection of recurrence. Eur J Nucl Med Mol Imaging. 2007;34(4):472-9. PMID: 17106701

~~20~~19. Chung HH, Jo H, Kang WJ, et al. Clinical impact of integrated PET/CT on the management of suspected cervical cancer recurrence. Gynecol Oncol. 2007;104(3):529-34. PMID: 17049971

~~21~~20. Sahdev A, Jones J, Shepherd JH, et al. MR imaging appearances of the female pelvis after trachelectomy. Radiographics. 2005;25(1):41-52. PMID: 15653585

~~22~~21. Salani R, Khanna N, Frimer M, et al. An update on post-treatment surveillance and diagnosis of recurrence in women with gynecologic malignancies: Society of Gynecologic Oncology (SGO) recommendations. Gynecol Oncol. 2017;146(1):3-10. PMID: 28372871

Colorectal Cancer

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented colorectal cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated for known or suspected invasive cancerf	~~As clinically indicated~~ Indicated for known or suspected invasive cancer	Indicated annually for Stage II or higher colorectal cancer ~~colorectal cancer with ANY of the following high-risk features:~~ ~~• Lymphatic or venous invasion~~ ~~• Lymph node involvement~~ ~~• Perineural invasion~~ ~~• Poorly differentiated tumor~~ ~~• T4 tumor~~ ~~• Associated with bowel obstruction~~ ~~• Close, indeterminate, or positive margins~~ ~~• Fewer than 12 nodes examined at surgery~~ ~~• Localized perforation~~ ~~Especially useful in first 5 years~~
CT abdomen and pelvis	Indicated for known or suspected invasive cancer	~~As clinically indicated~~ Indicated for known or suspected invasive cancer	Indicated annually for Stage II or higher colorectal cancer ~~colorectal cancer with ANY of the following high-risk features:~~ ~~• Lymphatic or venous invasion~~ ~~• Lymph node involvement~~ ~~• Perineural invasion~~ ~~• Poorly differentiated tumor~~ ~~• T4 tumor~~ ~~• Associated with bowel obstruction~~ ~~• Close, indeterminate, or positive margins~~ ~~• Fewer than 12 nodes examined at surgery~~ ~~• Localized perforation~~ ~~Especially useful in first 5 years~~
MRI pelvis	Indicated for known or suspected invasive cancer rectal cancer ONLY	~~As clinically indicated for~~ Indicated for known or suspected invasive rectal cancer ONLY	~~Not Indicated~~ Indicated following transanal local excision for Stage II or higher rectal cancer only
FDG-PET/CT	~~As clinically indicated in EITHER of the following scenarios:~~	~~As clinically indicated~~ Indicated in ANY of the following scenarios:	Not indicated

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
	~~● Standard imaging (CT or US) suggests resectable metastatic disease and confirmation will impact the decision regarding curative surgery~~ ~~● Indeterminate lesions greater than 1 cm in diameter are identified on standard imaging and are not amenable to biopsy (or biopsy is considered high risk)~~ Indicated when standard imaging (CT Chest, Abdomen and Pelvis) cannot be performed or is non-diagnostic for surgically curable metastatic disease	● CT is equivocal for metastatic disease and lesion(s) is/are greater than 1 cm in diameter ● CT demonstrates recurrence that is potentially curable with surgery ● CT does not demonstrate a focus of recurrence but carcinoembryonic antigen (CEA) level is rising ● Signs or symptoms are suggestive of recurrence and CT is contraindicated	

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Colorectal cancer is the third most common cancer in both men and women. Over 90% of cancers originating from the colon and rectum are adenocarcinomas. Incidence is higher in males and increases with age; other risk factors include alcohol use, dietary factors, obesity, smoking, and lack of physical exercise. There is a strong association with inflammatory bowel disease, and up to 10% of colorectal cancers are due to genetic factors. Tumors may be discovered on screening colonoscopy. Other presentations include bloody stool, abdominal pain, anemia, and obstructive symptoms.

DIAGNOSTIC WORKUP

Colorectal cancer is staged using the American Joint Committee on Cancer TNM system. For colon cancer, the NCCN recommends CT chest, abdomen and pelvis ~~CT is used~~ for initial ~~locoregional assessment of the primary tumor~~staging ~~to assess degree of invasion and lymph node involvement as well as metastatic disease~~.[7] In a meta-analysis of 19 studies evaluating CT imaging in preoperative colorectal staging, the pooled sensitivity and specificity for detection of tumor invasion were 86% (95% CI, 78%-92%) and 78% (95% CI, 71%-84%). Similarly, the values for nodal detection were 70% (95% CI, 63%-73%) and 78% (95% CI, 73%-82%). In a subgroup analysis, studies utilizing multi-detector CT fared better than conventional CT.[1] Results from this meta-analysis are consistent with the findings of several other studies.[2-7,2-6] ~~The use of bone scintigraphy for staging of asymptomatic patients is not recommended by the NCCN.[8, 9]~~

~~The initial staging evaluation for rectal cancer requires the addition of a~~ MRI pelvis or endoscopic rectal ultrasound (ERUS) is indicated for the initial staging of rectal cancer, in addition to CT chest and abdomen.[8] In the prospective MERCURY II trial, MRI pelvis was able to accurately assess the low rectal plane which resulted in avoidance of overtreatment through selective preoperative therapy and substantially fewer pathologically positive circumferential resection margins.[10,9] ~~Although CT is commonly ordered preoperatively, it often does not impact management. A retrospective study of 180 patients reported that preoperative CT only changed management in 2% of patients.[5] In a review of CT chest preoperative imaging, 9% were discovered to have indeterminate lung lesions with only 1% of the total population found to have metastatic cancer.[11]~~

PET/CT does not supplant a diagnostic contrast enhanced CT, and should only be used to evaluate an equivocal finding or in patients with strong contraindications to IV contrast. Two studies found that PET/CT was not superior to CT for routine preoperative staging of colorectal cancer. In a study by Furukawa et al., PET/CT findings resulted in treatment changes in only 2% of patients who had bone and distant lymph node metastases detected only by PET/CT. In one case, CT imaging detected lung metastases that were not demonstrated on PET.[12,10] ~~Another study comparing pretreatment CT to PET/CT in the setting of locally advanced rectal cancer receiving preoperative chemoradiation resulted in PET/CT detecting all 10 patients with confirmed metastatic disease while CT alone detected 9 of them.[13]~~

PET/CT may be useful in identifying additional sites of extrahepatic metastases, but a positive impact on overall management and survival has not been definitively established. In the setting of resectable M1 disease, Moulton et al. found that PET/CT compared with CT alone did not influence survival. Surgical management was affected in 8% of patients, in which only 2.7% were deemed to no longer be surgical candidates. In addition, the false positive rate of PET/CT was 8.4%.[14,11] However, a meta-analysis of 18 studies suggests that FDG PET/CT is highly accurate for the detection of liver metastases on a per-patient basis but less accurate on a per-lesion basis. Compared to MRI, PET was less sensitive but more specific, and impacted management in about 25% of patients.[15,12]

MANAGEMENT

Response to neoadjuvant therapy can be seen in as many as 60% and complete response in as many as 18% of patients with rectal cancer.[16, 17,13,14] In the prospective MERCURY study, MRI assessment of tumor response and circumferential resection margin was correlated with positive survival outcomes. [18,15] A recent meta-analysis by de Jong et al., however, concluded that MRI, CT, and ERUS could not be used to predict complete response of locally advanced rectal cancer, and had poor accuracy for predicting lymph node involvement and tumor invasion in the circumferential resection margin.[19,16]

Chemotherapy may reduce the sensitivity of PET for the detection of liver metastases, likely due to metabolic inhibition caused by cytotoxic therapies.[20, 21,17,18] False negative rates of 87% have been reported for PET scans performed within 4 weeks of chemotherapy.[22,19] False positive PET/CT scans may also result from tissue inflammation after surgery.

In the uncommon setting of a rising carcinoembryonic antigen (CEA) and CT scans which have not identified a site of recurrence, PET/CT is a consideration; however, it is very unlikely that surgically curable recurrent disease will may not be identified. It is notable that almost half of elevated CEAs after R0 resection are false positives and serial CTs at 3-month intervals until CEA stabilizes or normalizes or until disease is identified is often the preferred approach. When the CEA level is above 15ng/mL, false negatives are rare.[23,20] Based on a pooled analysis for detection of colorectal cancer recurrence, the sensitivity of CEA ranges from 68% for a threshold of 10 µg/L to 82% for a threshold of 2.5 µg/L and the specificity ranges from 97% for a threshold of 10 µg/L to 80% for a threshold of 2.5 µg/L.[24,21] A meta-analysis of 11 studies estimated sensitivity and specificity and positive and negative likelihood ratios of FDG-PET/CT in the detection of tumor recurrence in colorectal cancer patients with elevated CEA to be 94.1%, 77.2%, 4.70, and 0.06, respectively.[25,22]

SCREENING AND SURVEILLANCE

Surveillance CT chest, abdomen and pelvis is indicated for stage II and higher colon cancer per the NCCN (every 12 months for a total for 5 years for stage II/III; and every 6 months x 2 years, then every 6-12 months for a total of 5 years for stage IV disease).[7] For patients who have undergone local transanal excision of rectal cancer, the NCCN recommends surveillance imaging with MRI or EUS of the rectum every 3-6 months for 2 years, then every 6 months for a total of 5 years.[8]

Although PET/CT detects recurrence earlier in some patients, these benefits are offset by both false positive and false negative results. A trial randomizing patients (N = 130) treated with curative resection to conventional surveillance alone or conventional surveillance plus PET/CT scan found no significant difference in detection of recurrence between the 2 groups. The use of PET/CT in the setting of metastatic colorectal cancer treated with definitive therapy is also not indicated. A recent retrospective study failed to show a correlation with frequency of imaging and effect on time to second procedure or median survival duration.[26,23]

For surveillance of colorectal cancer, AIM Oncologic Imaging guidelines are in concordance with the American Society of Clinical Oncology recommendations, National Comprehensive Cancer Network (NCCN) Guidelines for Colon Cancer, and NCCN Guidelines for Rectal Cancer.[8, 9, 27,7,8, 24]

References

1. Dighe S, Purkayastha S, Swift I, et al. Diagnostic precision of CT in local staging of colon cancers: a meta-analysis. Clin Radiol. 2010;65(9):708-19. PMID: 20696298
2. Dighe S, Blake H, Koh MD, et al. Accuracy of multidetector computed tomography in identifying poor prognostic factors in colonic cancer. Br J Surg. 2010;97(9):1407-15. PMID: 20564305
3. Dighe S, Swift I, Magill L, et al. Accuracy of radiological staging in identifying high-risk colon cancer patients suitable for neoadjuvant chemotherapy: a multicentre experience. Colorectal Dis. 2012;14(4):438-44. PMID: 21689323
4. Hundt W, Braunschweig R, Reiser M. Evaluation of spiral CT in staging of colon and rectum carcinoma. Eur Radiol. 1999;9(1):78-84. PMID: 9933385
5. McAndrew MR, Saba AK. Efficacy of routine preoperative computed tomography scans in colon cancer. Am Surg. 1999;65(3):205-8. PMID: 10075291
6. Nerad E, Lahaye MJ, Maas M, et al. Diagnostic accuracy of CT for local staging of colon cancer: a systematic review and meta-analysis. AJR Am J Roentgenol. 2016;207(5):984-95. PMID: 27490941

~~7~~6. Smith NJ, Bees N, Barbachano Y, et al. Preoperative computed tomography staging of nonmetastatic colon cancer predicts outcome: implications for clinical trials. British Journal of Cancer. 2007;96(7):1030-6. PMID: 17353925

~~8~~7. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Colon Cancer (Version ~~4.2018~~3.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

~~9~~8. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Rectal Cancer (Version ~~3.2018~~4.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

~~10~~9. Battersby NJ, How P, Moran B, et al. Prospective validation of a low rectal cancer magnetic resonance imaging staging system and development of a local recurrence risk stratification model: the MERCURY II study. Ann Surg. 2016;263(4):751-60. PMID: 25822672

~~11~~10. ~~1. Nordholm-Carstensen A, Wille-Jorgensen PA, Jorgensen LN, et al. Indeterminate pulmonary nodules at colorectal cancer staging: a systematic review of predictive parameters for malignancy. Ann Surg Oncol. 2013;20(12):4022-30. PMID: 23812771~~

~~12.~~ Furukawa H, Ikuma H, Seki A, et al. Positron emission tomography scanning is not superior to whole body multidetector helical computed tomography in the preoperative staging of colorectal cancer. Gut. 2006;55(7):1007-11. PMID: 16361308

~~13. Nahas CS, Akhurst T, Yeung H, et al. Positron emission tomography detection of distant metastatic or synchronous disease in patients with locally advanced rectal cancer receiving preoperative chemoradiation.[Erratum appears in Ann Surg Oncol. 2008 Apr;15(4):1265 Note: Leibold, Tobias [added]]. Ann Surg Oncol. 2008;15(3):704-11. PMID: 17882490~~

~~14~~11. ~~.~~ Moulton CA, Gu CS, Law CH, et al. Effect of PET before liver resection on surgical management for colorectal adenocarcinoma metastases: a randomized clinical trial. JAMA. 2014;311(18):1863-9. PMID: 24825641

~~15~~12. Maffione AM, Lopci E, Bluemel C, et al. Diagnostic accuracy and impact on management of (18)F-FDG PET and PET/CT in colorectal liver metastasis: a meta-analysis and systematic review. Eur J Nucl Med Mol Imaging. 2015;42(1):152-63. PMID: 25319712

~~16~~13. Park IJ, You YN, Agarwal A, et al. Neoadjuvant treatment response as an early response indicator for patients with rectal cancer. J Clin Oncol. 2012;30(15):1770-6. PMID: 22493423

~~17~~14. Das P, Skibber JM, Rodriguez-Bigas MA, et al. Predictors of tumor response and downstaging in patients who receive preoperative chemoradiation for rectal cancer. Cancer. 2007;109(9):1750-5. PMID: 17387743

~~18~~15. Patel UB, Taylor F, Blomqvist L, et al. Magnetic resonance imaging-detected tumor response for locally advanced rectal cancer predicts survival outcomes: MERCURY experience. J Clin Oncol. 2011;29(28):3753-60. PMID: 21876084

~~19~~16. de Jong EA, ten Berge JC, Dwarkasing RS, et al. The accuracy of MRI, endorectal ultrasonography, and computed tomography in predicting the response of locally advanced rectal cancer after preoperative therapy: A metaanalysis. Surgery. 2016;159(3):688-99. PMID: 26619929

~~20~~17. Akhurst T, Kates TJ, Mazumdar M, et al. Recent chemotherapy reduces the sensitivity of [18F]fluorodeoxyglucose positron emission tomography in the detection of colorectal metastases. J Clin Oncol. 2005;23(34):8713-6. PMID: 16314631

~~21~~18. van Kessel CS, Buckens CF, van den Bosch MA, et al. Preoperative imaging of colorectal liver metastases after neoadjuvant chemotherapy: a meta-analysis. Ann Surg Oncol. 2012;19(9):2805-13. PMID: 22396005

~~22~~19. Glazer ES, Beaty K, Abdalla EK, et al. Effectiveness of positron emission tomography for predicting chemotherapy response in colorectal cancer liver metastases. Arch Surg. 2010;145(4):340-5; discussion 5. PMID: 20404283

~~23~~20. Litvak A, Cercek A, Segal N, et al. False-positive elevations of carcinoembryonic antigen in patients with a history of resected colorectal cancer. J Natl Compr Canc Netw. 2014;12(6):907-13. PMID: 24925201

~~24~~21. Nicholson BD, Shinkins B, Mant D. Blood measurement of carcinoembryonic antigen Level for detecting recurrence of colorectal cancer. Jama. 2016;316(12):1310-1. PMID: 27673308

~~25~~22. Lu YY, Chen JH, Chien CR, et al. Use of FDG-PET or PET/CT to detect recurrent colorectal cancer in patients with elevated CEA: a systematic review and meta-analysis. Int J Colorectal Dis. 2013;28(8):1039-47. PMID: 23407908

~~26~~23. Hyder O, Dodson RM, Mayo SC, et al. Post-treatment surveillance of patients with colorectal cancer with surgically treated liver metastases. Surgery. 2013;154(2):256-65. PMID: 23889953

~~27~~24. Meyerhardt JA, Mangu PB, Flynn PJ, et al. Follow-up care, surveillance protocol, and secondary prevention measures for survivors of colorectal cancer: American Society of Clinical Oncology clinical practice guideline endorsement. J Clin Oncol. 2013;31(35):4465-70. PMID: 24220554

Esophageal and Gastroesophageal Junction Cancers

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented esophageal and gastroesophageal junction cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated	Indicated (note: especially useful if PET imaging not done)	~~As clinically indicated~~ Indicated (note: especially useful in first 2-3 years)
CT abdomen	Indicated	Indicated (note: especially useful if PET imaging not done)	~~As clinically indicated~~ Indicated (note: especially useful in first 2-3 years)
CT pelvis	~~As clinically indicated~~ Indicated based on clinical suspicion for pelvic disease	~~As clinically indicated~~ Indicated based on clinical suspicion for pelvic disease ~~(note: most useful with distal lesions)~~	~~As clinically indicated~~ Indicated based on clinical suspicion for pelvic disease ~~(note: not typically required)~~
FDG-PET/CT	Indicated when standard imaging ~~studies are equivocal or nondiagnostic for~~ cannot be performed or does not demonstrate M1 metastatic disease	Indicated in ANY of the following scenarios: • Radiation planning for preoperative or definitive treatment only • Assessment of response to chemoradiation (as definitive treatment or prior to surgery) when performed at least 5 weeks after completion of therapy • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Esophageal cancer is the seventh most common cause of cancer-related mortality in men. Over 90% of esophageal cancers are either squamous cell carcinoma or adenocarcinoma.[1] Risk factors for squamous cell carcinoma include tobacco and alcohol use, while adenocarcinoma is associated with gastroesophageal reflux disease and Barrett's esophagus. The most common presentation is symptoms due to obstruction (such as dysphagia or odynophagia), or symptoms caused by distant metastases.

DIAGNOSTIC WORKUP

Esophageal cancer is staged using the American Joint Committee on Cancer TNM system. The role of endoscopic ultrasound is to evaluate tumor depth and lymph node involvement. The overall accuracy of endoscopic ultrasound (EUS) for this component of staging is in the 80% to 90% range. In a meta-analysis which also included high grade esophageal dysplasia, surgical or endoscopic mucosal resection pathologic staging compared to EUS had a T-stage concordance of only 65%.[2] Nonetheless, EUS is still considered superior to CT, MRI, and PET for

locoregional staging.[3-5] NCCN recommends chest/abdominal CT with oral and IV contrast for initial workup; pelvic CT with contrast only as clinically indicated.[10]

~~CT is being replaced as the sole modality for detection of metastatic disease.~~While CT is the most widely used modality for detection of distant metastases (M1 disease), the addition of FDG-PET improves detection of lesions that may remain occult on CT, allowing proper patient selection for surgical resection. A meta-analysis of 31 articles found PET/CT to be more accurate than CT for identifying metastatic disease: sensitivity and specificity were 71% (95% CI, 0.62-0.79) and 93% (95% CI, 0.89-0.97) for FDG-PET and 52% (95% CI, 0.33-0.71) and 91% (95% CI, 0.86-0.96) for CT, respectively.[3] In the prospective American College of Surgeons Oncology Group trial Z0060, PET scan identified an additional 5% of biopsy-confirmed distant metastatic disease as compared to conventional imaging.[6] In 2 additional studies, PET/CT resulted in avoidance of futile surgery in up to 17% of patients and change in management of 38.2% of cases.[7]

MANAGEMENT

~~The benefit of PET/CT over standard CT following neoadjuvant therapy has not been clearly shown. Both modalities allow for detection of new metastatic disease as well as for assessment of tumor response. PET/CT has been used to assess M~~metabolic response~~, which has been~~ by PET/CT has been suggested as a surrogate marker for prognosis. In the largest of these studies, the prospective MUNICON ~~(Metabolic response evalUatioN for Individualisation of neoadjuvant Chemotherapy in oesOphageal and oesophagogastric adeNocarcinoma)~~ phase II trial (N=110) showed that post-treatment PET correlated with treatment response and event-free survival (29.7 months in metabolic responders and 14.1 months in nonresponders, Hazard Ratio, 2.18, P = .002).[8] Conversely, in a review from 2017 that included 13 studies (N = 697), Cremonesi et al. noted that 8 studies supported interim PET, while 5 studies found no benefit in terms of pathological complete response and/or outcome.[9] The National Comprehensive Cancer Network (NCCN) recommends PET/CT as a preferred modality after preoperative or definitive chemoradiation (level 2A recommendation), at least 5-8 weeks after completion of therapy.[10] ~~Several studies have demonstrated that PET/CT has poor accuracy in determining local tumor response, especially at the microscopic level. The National Comprehensive Cancer Network (NCCN) recommends that PET/CT should not be the sole determinant for selection of patients after neoadjuvant chemoradiation therapy and categorizes PET/CT as a Level 2B recommendation.[10] There is, however, general agreement that PET/CT is useful in detecting metastases prior to potentially curative surgery, and this remains the primary indication for its use.[11-13]~~

SCREENING AND SURVEILLANCE

The majority of esophageal and gastroesophageal junction cancer recurrences present as distant metastases within the first 1 to 3 years. Based on the NCCN Guidelines for Esophageal and Esophagogastric Junction Cancers, surveillance imaging ~~is appropriate for stage T1b or higher disease~~can be considered for up to 3 years if the patient is likely to tolerate additional curative-intent therapy for recurrence.[10]

References

1. Enzinger PC, Mayer RJ. Esophageal cancer. N Engl J Med. 2003;349(23):2241-52. PMID: 14657432
2. Young PE, Gentry AB, Acosta RD, et al. Endoscopic ultrasound does not accurately stage early adenocarcinoma or high-grade dysplasia of the esophagus. Clin Gastroenterol Hepatol. 2010;8(12):1037-41. PMID: 20831900
3. van Vliet EP, Heijenbrok-Kal MH, Hunink MG, et al. Staging investigations for oesophageal cancer: a meta-analysis. Br J Cancer. 2008;98(3):547-57. PMID: 18212745
4. Keswani RN, Early DS, Edmundowicz SA, et al. Routine positron emission tomography does not alter nodal staging in patients undergoing EUS-guided FNA for esophageal cancer. Gastrointest Endosc. 2009;69(7):1210-7. PMID: 19012886
5. Flamen P, Lerut A, Van Cutsem E, et al. Utility of positron emission tomography for the staging of patients with potentially operable esophageal carcinoma. J Clin Oncol. 2000;18(18):3202-10. PMID: 10986052
6. Meyers BF, Downey RJ, Decker PA, et al. The utility of positron emission tomography in staging of potentially operable carcinoma of the thoracic esophagus: results of the American College of Surgeons Oncology Group Z0060 trial. J Thorac Cardiovasc Surg. 2007;133(3):738-45. PMID: 17320575
7. Flanagan FL, Dehdashti F, Siegel BA, et al. Staging of esophageal cancer with 18F-fluorodeoxyglucose positron emission tomography. AJR Am J Roentgenol. 1997;168(2):417-24. PMID: 9016218
8. Lordick F, Ott K, Krause BJ, et al. PET to assess early metabolic response and to guide treatment of adenocarcinoma of the oesophagogastric junction: the MUNICON phase II trial. Lancet Oncol. 2007;8(9):797-805. PMID: 17693134
9. Cremonesi M, Garibaldi C, Timmerman R, et al. Interim 18F-FDG-PET/CT during chemo-radiotherapy in the management of oesophageal cancer patients. a systematic review. Radiother Oncol. 2017;125(2):200-12. PMID: 29029833

10. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Esophageal and Esophagogastric Cancers (Version 2.~~2019~~2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

~~11. Bruzzi JF, Swisher SG, Truong MT, et al. Detection of interval distant metastases: clinical utility of integrated CT-PET imaging in patients with esophageal carcinoma after neoadjuvant therapy. Cancer. 2007;109(1):125-34. PMID: 17146785~~

~~12. Klaeser B, Nitzsche E, Schuller JC, et al. Limited predictive value of FDG-PET for response assessment in the preoperative treatment of esophageal cancer: results of a prospective multi-center trial (SAKK 75/02). Onkologie. 2009;32(12):724-30. PMID: 20016233~~

~~13. van Heijl M, Omloo JM, van Berge Henegouwen MI, et al. Fluorodeoxyglucose positron emission tomography for evaluating early response during neoadjuvant chemoradiotherapy in patients with potentially curable esophageal cancer. Ann Surg. 2011;253(1):56-63. PMID: 21233607~~

Gastric Cancer

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented gastric cancer.

Imaging Study	Diagnostic Workup	Management	Screening and Surveillance
CT chest	Indicated	Indicated	~~As clinically indicated~~ Indicated (note: especially useful in first 5 years)
CT abdomen and pelvis	Indicated	Indicated	~~As clinically indicated~~ Indicated (note: especially useful in first 5 years)
FDG-PET/CT	Indicated for tumors initially stage IB or higher when standard imaging ~~does not clearly demonstrate~~ cannot be performed or does not demonstrate M1 metastatic disease and the patient is a candidate for curative surgery	~~As clinically indicated~~ Indicated in ANY of the following scenarios: • Radiation planning for preoperative or definitive treatment only • To determine resectability of residual disease following completion of primary (neoadjuvant) treatment, when follow-up evaluation with standard modalities does not demonstrate metastatic disease • Clinical suspicion for recurrent disease when standard ~~modalities are equivocal or~~ imaging cannot be performed or is nondiagnostic ~~for recurrent disease~~	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

The incidence of gastric cancer has declined over the past 10 years, but it remains one of the leading causes of death worldwide. The most common histologic type is adenocarcinoma. Presenting symptoms may include weight loss, pain, bleeding, or dysphagia. More advanced disease can manifest as ascites and symptoms related to distant metastases.

DIAGNOSTIC WORKUP

Gastric cancer is staged using the American Joint Committee on Cancer TNM system. Endoscopic ultrasound (EUS) is used to obtain pathologic confirmation of malignancy and local tumor staging, with advanced imaging used to assess lymph nodes and metastases. In a meta-analysis of 50 studies, EUS for assessment of locoregional disease showed sensitivity and specificity rates for distinguishing T1 from T2 cancers of 85% and 90%, respectively. Sensitivity and specificity for distinguishing T1/2 from T3/4 tumors were 86% and 90%,

respectively. When used to evaluate lymph nodes, EUS had a lower diagnostic yield with sensitivity and specificity of 83% and 67%, respectively.[1] A second meta-analysis reported accuracy rates for tumor staging at 75% and nodal staging at 64% with a sensitivity of 74% and specificity of 80%.[2] In a third systematic review comparing EUS, CT, and MRI, the diagnostic accuracy of overall T staging for EUS, multidetector CT, and MRI varied between 65% to 92.1%, 77.1% to 88.9%, and 71.4% to 82.6%, respectively. The authors concluded that although efficacy was similar, EUS remains the standard of care.[3]

The accuracy of CT for assessing primary tumor is only 50%-70% and for nodal staging 50%-64%.[4,5] CT performs better with regard to metastatic disease, with an accuracy of 79%-84%.[6] In contrast, FDG-PET has a lower accuracy rate because of the low FDG uptake common to diffuse and mucinous gastric tumor types.[7,8]

~~In general, PET is less useful for staging of gastric cancer than for other tumor types. Compared to CT, FDG-PET has significantly lower sensitivity in the detection of local lymph node involvement (78% vs 56%), but with higher specificity (62% vs. 92%).[7] Moreover, the use of PET has not led to improved survival in patients with detectable tumors vs those with nondetectable tumors (P = .85).[8]~~ However, cCombining PET and CT leads to improved accuracy in preoperative staging (68%) compared to PET (47%) or CT (53%) alone, and in a single-institution retrospective study, changed management in 38% of patients.[9] ~~However, the decision to proceed to surgery was not significantly impacted by PET/CT.~~ The major advantage conferred by PET is improved specificity over CT for the detection of distant metastases (M1 disease). Smyth et al. reported in a prospective study that PET/CT identified an additional 10% occult metastatic lesions in patients with locally advanced disease, compared to preoperative CT imaging, EUS, and laparoscopy.[10] FDG PET/CT is recommended if no evidence of M1 disease by standard imaging and if clinically indicated (may not be appropriate for T1 disease) by NCCN (level of evidence category 2A).[16]

MANAGEMENT

The results of studies showing response to therapy as evidenced by FDG-PET have been mixed. A prospective observation trial by Vallbohmer et al. showed no correlations between interval PET findings and change in FDG avidity to response or prognosis.[11] In another study, survival of patients without FDG-avid disease was not significantly different from FDG-avid non-responders.[12] In the setting of recurrent disease, a retrospective study showed overall sensitivity and specificity of 78% and 82% for PET compared to 74% and 85% for CT, respectively.[13] Therefore, NCCN recommends chest/abdominal/pelvic CT scan for medically fit patients after the completion of preoperative therapy (chemotherapy or chemoradiation) and before surgical intervention, with PET as clinically indicated.[16]

SCREENING AND SURVEILLANCE

The majority of gastric cancer recurrences occur locoregionally in the lymph nodes and peritoneum, followed by the liver. A retrospective Italian trial, which included patients with T1-4 N0-3 M0 gastric cancer who had undergone D2 dissection, found that 94% recurred within 2 years and 98% recurred within 3 years. Of the recurrences, only 3.2% were treated with curative intent.[14] In a review of 5 articles that included 810 patients, intense surveillance with CT imaging did not show an improvement in survival.[15] Based on the National Comprehensive Cancer Network Guidelines for Gastric Cancer, surveillance imaging for patients with stage II or greater gastric cancer ~~is~~ can be done as clinically indicated based on symptoms and concern for recurrence; after 5 years, additional follow-up may be considered based on risk factors and comorbidities.~~for up to 5 years following completion of therapy.~~[16]

References

1. Mocellin S, Pasquali S. Diagnostic accuracy of endoscopic ultrasonography (EUS) for the preoperative locoregional staging of primary gastric cancer. Cochrane Database Syst Rev. 2015(2):CD009944. PMID: 25914908
2. Cardoso R, Coburn N, Seevaratnam R, et al. A systematic review and meta-analysis of the utility of EUS for preoperative staging for gastric cancer. Gastric Cancer. 2012;15 Suppl 1:S19-26. PMID: 22237654
3. Kwee RM, Kwee TC. Imaging in local staging of gastric cancer: a systematic review. J Clin Oncol. 2007;25(15):2107-16. PMID: 17513817
4. Dux M, Richter GM, Hansmann J, et al. Helical hydro-CT for diagnosis and staging of gastric carcinoma. J Comput Assist Tomogr. 1999;23(6):913-22. PMID: 10589566
5. Rossi M, Broglia L, Maccioni F, et al. Hydro-CT in patients with gastric cancer: preoperative radiologic staging. Eur Radiol. 1997;7(5):659-64. PMID: 9166562
6. Lee IJ, Lee JM, Kim SH, et al. Diagnostic performance of 64-channel multidetector CT in the evaluation of gastric cancer: differentiation of mucosal cancer (T1a) from submucosal involvement (T1b and T2). Radiology. 2010;255(3):805-14. PMID: 20501718

~~7. Chen J, Cheong JH, Yun MJ, et al. Improvement in preoperative staging of gastric adenocarcinoma with positron emission tomography. Cancer. 2005;103(11):2383-90. PMID: 15856477~~

~~8~~7. Stahl A, Ott K, Weber WA, et al. FDG PET imaging of locally advanced gastric carcinomas: correlation with endoscopic and histopathological findings. Eur J Nucl Med Mol Imaging. 2003;30(2):288-95. PMID: 12552348

8. Wieder HA, Krause BJ, Herrmann K. PET and PET-CT in esophageal and gastric cancer. Methods Mol Biol 2011:727;59-76. PMID: 21331929

9. Blencowe NS, Whistance RN, Strong S, et al. Evaluating the role of fluorodeoxyglucose positron emission tomography-computed tomography in multi-disciplinary team recommendations for oesophago-gastric cancer. Br J Cancer. 2013;109(6):1445-50. PMID: 23963146

10. Smyth E, Schoder H, Strong VE, et al. A prospective evaluation of the utility of 2-deoxy-2-[(18) F]fluoro-D-glucose positron emission tomography and computed tomography in staging locally advanced gastric cancer. Cancer. 2012;118(22):5481-8. PMID: 22549558

11. Vallbohmer D, Holscher AH, Schneider PM, et al. [18F]-fluorodeoxyglucose-positron emission tomography for the assessment of histopathologic response and prognosis after completion of neoadjuvant chemotherapy in gastric cancer. J Surg Oncol. 2010;102(2):135-40. PMID: 20648583

12. Ott K, Herrmann K, Lordick F, et al. Early metabolic response evaluation by fluorine-18 fluorodeoxyglucose positron emission tomography allows in vivo testing of chemosensitivity in gastric cancer: long-term results of a prospective study. Clin Cancer Res. 2008;14(7):2012-8. PMID: 18381939

13. Wu LM, Hu JN, Hua J, et al. 18 F-fluorodeoxyglucose positron emission tomography to evaluate recurrent gastric cancer: a systematic review and meta-analysis. J Gastroenterol Hepatol. 2012;27(3):472-80. PMID: 21916986

14. Baiocchi GL, Marrelli D, Verlato G, et al. Follow-up after gastrectomy for cancer: an appraisal of the Italian research group for gastric cancer. Ann Surg Oncol. 2014;21(6):2005-11. PMID: 24526547

15. Cardoso R, Coburn NG, Seevaratnam R, et al. A systematic review of patient surveillance after curative gastrectomy for gastric cancer: a brief review. Gastric Cancer. 2012;15 Suppl 1:S164-7. PMID: 22382929

16. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Gastric Cancer (Version 2.~~2019~~2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

~~Germ Cell Tumors: Testis and Ovary~~ Testicular Cancer

This section primarily addresses imaging of seminomatous and nonseminomatous germ cell tumors of the testis. Imaging recommendations for ovarian germ cell tumors are based on available society guidelines and extrapolation of testicular germ cell tumor data. Specific imaging considerations are addressed below.

Advanced imaging is medically necessary for the diagnostic workup, management, and surveillance of documented germ cell tumors of the ovary and testis.

~~Germ Cell Tumors:~~ Seminoma

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated (note: chest X-ray usually sufficient but especially useful for positive abdominal CT or abnormal chest radiographs)	~~As clinically indicated~~ Indicated (note: especially useful for IIA, IIB, IIC, III after chemotherapy)	~~As clinically indicated~~ Indicated (note: chest X-ray usually sufficient)
CT abdomen and pelvis	Indicated	~~As clinically indicated~~ Indicated (note: especially useful for IIA, IIB, IIC, III after chemotherapy)	~~As clinically indicated~~ Indicated (note: chest X-ray especially useful in first 5 years)
MRI brain	~~As clinically indicated~~ Indicated (note: especially useful for high risk of metastases (beta-hCG > 5000 IU/L or extensive lung metastases))	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
MRI abdomen and pelvis	Not indicated	Not indicated	Not indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated when standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for metastatic disease	~~As clinically indicated~~ Indicated in EITHER of the following scenarios: • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease • Residual mass greater than 3 cm and with normal tumor markers	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

~~Germ Cell Tumors:~~ Nonseminoma

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated	~~As clinically indicated~~ Indicated (note: especially useful for IIA, IIB, IIC, III after chemotherapy. Chest X-ray is an option)	~~As clinically indicated~~ Indicated (note: chest X-ray usually sufficient)
CT abdomen and pelvis	Indicated	~~As clinically indicated~~ Indicated (note: especially useful for IIA, IIB, IIC, III after chemotherapy)	~~As clinically indicated~~ Indicated (note: especially useful in first 5 years)
MRI brain	~~As clinically indicated~~ Indicated (note: especially useful in patients with high risk for metastases (beta-hCG > 5000 IU/L, AFP > 10000 ng/mL, extensive lung metastases, nonpulmonary visceral metastases, or choriocarcinoma))	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
MRI abdomen and pelvis	Not indicated	Not indicated	Not indicated
~~**FDG-PET/CT**~~	~~As clinically indicated when standard imaging studies are equivocal or nondiagnostic for metastatic disease~~	~~As clinically indicated when standard imaging studies are equivocal or nondiagnostic for recurrent or progressive disease~~	~~Not indicated~~

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

~~Germ Cell Tumors: Malignant ovarian germ cell cancer~~

~~Imaging Study~~	~~Diagnostic Workup~~	~~Management~~	~~Screening & Surveillance~~
~~**CT chest**~~	~~Indicated~~	~~As clinically indicated~~	~~As clinically indicated (note: especially useful in patients without elevated tumor markers at initial presentation)~~
~~**CT abdomen and pelvis**~~	~~Indicated~~	~~As clinically indicated~~	~~As clinically indicated (note: especially useful in patients without elevated tumor markers at initial presentation)~~
~~**MRI brain**~~	~~Not indicated~~	~~Not indicated~~	~~Not indicated~~
~~**MRI abdomen and pelvis**~~	~~As clinically indicated~~	~~As clinically indicated~~	~~Not indicated~~

~~Imaging Study~~	~~Diagnostic Workup~~	~~Management~~	~~Screening & Surveillance~~
~~FDG-PET/CT~~	~~As clinically indicated when standard imaging studies are equivocal or nondiagnostic for metastatic disease~~	~~As clinically indicated when standard imaging studies are equivocal or nondiagnostic for recurrent or progressive disease~~	~~Not indicated~~

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Testicular cancer is the most common cancer in men between ages 15 and 35.[1] Germ cell tumors (GCTs) are the most common type of testicular cancer and are broadly divided into seminomatous and nonseminomatous. Risk factors include cryptorchidism, family history, and ethnicity. The most common presentation is testicular pain or a palpable mass.

~~Limited data is available for the initial work up of patients with ovarian germ cell tumors, but due to their histologic similarity, recommendations are extrapolated from testicular germ cell tumor data.~~

DIAGNOSTIC WORKUP

~~Germ cell tumors~~GCTs are staged using the American Joint Committee on Cancer TNM system. CT abdomen and pelvis with contrast is primarily used to evaluate the retroperitoneal lymph nodes.[2] A CT Chest with contrast is indicated if the abdominal/pelvic CT or chest x-ray shows evidence of metastatic disease.

In direct comparisons, MRI has not shown an advantage over CT for accuracy of staging.[3,4] Per NCCN, PET scans should not be used routinely to stage testicular GCTs. In a prospective study, ~~the accuracy of PET for stage I and II non-seminomatous germ cell tumors (NSGCT) was 83%, compared to 71% accuracy of CT.~~ CT imaging showed sensitivity, specificity, positive predictive value, and negative predictive value of 41%, 95%, 87%, and 67% compared with PET/CT 66%, 98%, 95%, and 78%, respectively. The poor negative predictive value of PET limits its usefulness in initial staging ~~of testicular cancer~~.[5] In another prospective trial in which high risk stage I NSGCT was imaged with PET, only 23 of 110 patients were found to have PET avid disease, and 33 of 88 PET-negative patients had disease relapse.[6]

MANAGEMENT

PET/CT has higher positive and negative predictive values for identifying residual viable seminomatous tumors compared to CT, especially in the setting of a radiographically persistent mass and normal tumor markers. In the prospective multicenter SEMPET trial, patients with seminoma, negative tumor markers, and at least a 1 cm residual mass following completion of chemotherapy were imaged with PET and CT of the abdomen and pelvis. When compared to CT, PET had superior sensitivity and specificity (80% and 100% vs 74% and 70%) as well as positive predictive value and negative predictive value (100% and 96% vs 37% and 92%).[7] Accuracy is improved and false-negative results decreased when PET/CT is used to evaluate residual masses at least 3 cm in size.[8]

In patients with NSGCT and residual mass > 1 cm after primary chemotherapy, retroperitoneal lymph node dissection or surgical resection of the residual mass should be strongly considered as opposed to continued radiographic surveillance. PET has limited ability to differentiate residual non-seminomatous tumor from radiation necrosis and fibrosis. In a prospective German multicenter trial, PET used for detection of residual NSGCT after chemotherapy only had an accuracy of 56% (compared to CT scan 55% and serum tumor markers 56%).[~~8~~9]

AIM guidelines are in accordance with the National Comprehensive Cancer Network (NCCN) Guidelines for Testicular Cancer.[~~9~~10]

SCREENING AND SURVEILLANCE

Seminomas tend to recur within the first 14 months and nonseminomas within the first 2 years.[1110] AIM guidelines are in accordance with the NCCN Guidelines for Testicular ~~Cancer, NCCN Guidelines for Ovarian Cancer Including Fallopian Tube Cancer and Primary Peritoneal Cancer, and~~Cancer and European Society for Medical Oncology guidelines.[~~9,11,12~~10, 11, 12]

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2018. CA Cancer J Clin. 2018;68(1):7-30. PMID: 29313949
2. Leibovitch L, Foster RS, Kopecky KK, et al. Improved accuracy of computerized tomography based clinical staging in low stage nonseminomatous germ cell cancer using size criteria of retroperitoneal lymph nodes. J Urol. 1995;154(5):1759-63. PMID: 7563341

3. Ellis JH, Bies JR, Kopecky KK, et al. Comparison of NMR and CT imaging in the evaluation of metastatic retroperitoneal lymphadenopathy from testicular carcinoma. J Comput Assist Tomogr. 1984;8(4):709-19. PMID: 6539790

4. Hogeboom WR, Hoekstra HJ, Mooyaart EL, et al. The role of magnetic resonance imaging and computed tomography in the treatment evaluation of retroperitoneal lymph-node metastases of non-seminomatous testicular tumors. Eur J Radiol. 1991;13(1):31-6. PMID: 1716204

5. de Wit M, Brenner W, Hartmann M, et al. [18F]-FDG-PET in clinical stage I/II non-seminomatous germ cell tumours: results of the German multicentre trial. Ann Oncol. 2008;19(9):1619-23. PMID: 18453520

6. Huddart RA, O'Doherty MJ, Padhani A, et al. 18fluorodeoxyglucose positron emission tomography in the prediction of relapse in patients with high-risk, clinical stage I nonseminomatous germ cell tumors: preliminary report of MRC Trial TE22--the NCRI Testis Tumour Clinical Study Group. J Clin Oncol. 2007;25(21):3090-5. PMID: 17634488

7. De Santis M, Becherer A, Bokemeyer C, et al. 2-18fluoro-deoxy-D-glucose positron emission tomography is a reliable predictor for viable tumor in postchemotherapy seminoma: an update of the prospective multicentric SEMPET trial. J Clin Oncol. 2004;22(6):1034-9. PMID: 15020605

8. Treglia G, Sadeghi R, Annunziata S, et al. Diagnostic performance of fluorine-18-fluorodeoxyglucose positron emission tomography in the postchemotherapy management of patients with seminoma: a systematic review and meta-analysis. Biomed Res Int 2014. PMID: 24963486

9. Oechsle K, Hartmann M, Brenner W, et al. [18F]fluorodeoxyglucose positron emission tomography in nonseminomatous germ cell tumors after chemotherapy: the German multicenter positron emission tomography study group. J Clin Oncol. 2008;26(36):5930-5. PMID: 19018083

~~9~~10. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Testicular Cancer (Version ~~1.2019~~3.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

~~10~~11. Kollmannsberger C, Tandstad T, Bedard PL, et al. Patterns of relapse in patients with clinical stage I testicular cancer managed with active surveillance. J Clin Oncol. 2015;33(1):51-7. PMID: 25135991

~~11~~12. Oldenburg J, Fossa SD, Nuver J, et al. Testicular seminoma and non-seminoma: ESMO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2013;24 Suppl 6:vi125-32. PMID: 24078656

~~12. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Ovarian Cancer Including Fallopian Tube Cancer and Primary Peritoneal Cancer (Version 1.2019). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.~~

Head and Neck Cancer

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented head and neck cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT primary site and neck	Indicated	Indicated to assess response to neoadjuvant treatment or after concurrent chemoradiotherapy	~~As clinically indicated~~Indicated (note: especially useful within 6 months of completed treatment for baseline imaging)
CT chest	~~As clinically indicated~~ Indicated (note: especially useful for advanced disease or lung cancer screening in smokers)	~~As clinically indicated~~Indicated (note: not routinely used in subsequent management strategy)	~~As clinically indicated~~ Indicated (note: not routinely used in surveillance but especially useful for patients with smoking history (See Lung Cancer Screening Guideline))
CT abdomen and pelvis	~~As clinically indicated~~Indicated (note: especially useful for occult primary with Level IV or lower V lymph nodes if PET not performed)	~~As clinically indicated~~Indicated (note: not routinely used in subsequent management strategy)	~~As clinically indicated~~ Indicated (note: not routinely used in surveillance)
MRI primary site and neck	Indicated (note: especially useful for nasopharyngeal carcinoma)	Indicated to assess response to neoadjuvant treatment or after concurrent chemoradiotherapy	~~As clinically indicated~~ Indicated (note: especially useful within 6 months of completed treatment for baseline imaging)
FDG-PET/CT	~~As clinically indicated~~Indicated in EITHER of the following scenarios: • Evaluation of stage III and IV cancers (tumors greater than 4 cm in size, or any evidence of regional node involvement) of the oral cavity, oropharynx, hypopharynx, nasopharynx, larynx, and sinus • Following biopsy suggestive of a head and neck primary tumor (squamous cell cancer, adenocarcinoma, or anaplastic undifferentiated epithelial tumor) when CT or MRI evaluation of the neck	~~As clinically indicated~~Indicated in ANY of the following scenarios: • Radiation planning for preoperative or definitive treatment only • Evaluation of disease following clinical response to treatment, no sooner than 12 weeks after completion of radiation therapy or concurrent chemoradiation therapy • Evaluation of suspected recurrence based on signs or symptoms, when CT or MRI ~~is equivocal or~~ cannot be performed or	Not indicated

	has not detected a primary site of tumor	is non-diagnostic for recurrent disease • Follow up of an equivocal post-treatment PET scan, no sooner than 4 weeks after the study, to determine need for further intervention such as neck dissection	

Note: PET is not generally indicated for initial evaluation of lip and salivary gland cancers, regardless of stage.

Note: PET imaging is not indicated for adjuvant radiation therapy planning when all known disease has been removed.

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Head and neck cancers comprise 3% of all cancers in the U.S. Squamous cell carcinoma accounts for more than 90% of these tumors. Tobacco and alcohol use in addition to human papillomavirus infection are primary risk factors. The most common presenting symptoms are pain, dysphagia, or neck mass. Early mucosal lesions may be found incidentally on oral examination.

DIAGNOSTIC WORKUP

Head and neck cancers are staged using the American Joint Committee on Cancer TNM system. When compared to physical exam alone, CT results in a change of stage in 54% of patients.[1] However, CT is relatively poor at identifying invasion of non-osseous cartilage. Newer techniques have improved sensitivity and specificity of CT to almost 90% and 96%, respectively,[2] but up to 67% of pathologic lymph nodes may still be missed.[3] MRI may be indicated as an adjunct to CT, particularly in the management of nasopharyngeal cancers. ~~In general, MRI is not as sensitive as CT for evaluation of nodal metastases although advanced techniques are improving the ability to differentiate benign from malignant adenopathy.~~ In a meta-analysis of 10 studies, diffusion-weighted MRI for evaluation of head and neck squamous cell carcinomas improved overall accuracy from 66% to 86%.[4]

~~The NCCN recommends SLND in patients with T1-2 tumors and clinically lymph node-negative oral cavity squamous cell carcinoma(#34) The use of sentinel lymph node detection has been shown to decrease extent and morbidity of surgery without compromise to outcome. Patients with higher stage disease may require full lymph node dissections.[5, 6]~~

In a retrospective study conducted by Fleming et al., PET/CT had an accuracy of 90%, true positive rate of 82.9%, and false positive rate of 12.2%. In patients with unknown primary, PET/CT was able to identify the primary site in 72.7% of patients. Distant metastases were detected in 15.4% of patients, and overall treatment was altered in 30.9% of patients.[7-5] In a meta-analysis of 8 studies, sensitivity and specificity of PET/PET-CT for detecting distant metastatic disease were 83% and 96% compared with conventional anatomic imaging, 44% and 96%, respectively.[8-6] The accuracy of PET for evaluation of patients with early stage head and neck cancers without lymph node involvement is less clear. Multiple small studies have shown relatively poor sensitivity ranging from 25% to 63% for detecting occult lymph node metastases.[9, 107,8]

MANAGEMENT

A prospective randomized trial by Mehanna et al. found that PET/CT performed 12 weeks after chemoradiation therapy for assessment of treatment response for patients with N2/3 disease resulted in substantially fewer neck dissections with no adverse impact on survival.[11-9] A meta-analysis of 23 studies looking at accuracy of PET/CT found a pooled sensitivity and specificity of 92% and 87%, respectively, for detection of recurrence. A second meta-analysis of 27 studies confirmed these results, with pooled sensitivity and specificity of PET for detecting residual or recurrent head and neck squamous cell carcinoma reported to be 94% and 82%, respectively. However, sensitivity was adversely affected when PET/CT imaging was done within 10 weeks of completion of treatment.[12,10] A negative PET/CT corresponds with a 90% chance of disease eradication.[13-11] These findings were corroborated by 2 additional retrospective studies.[14, 1512,13]

SCREENING AND SURVEILLANCE

Most recurrences are discovered by patients and not by serial imaging or physical exam. AIM guidelines are in accordance with NCCN Guidelines for Head and Neck Cancers.[1614]

References

1. Prehn RB, Pasic TR, Harari PM, et al. Influence of computed tomography on pretherapeutic tumor staging in head and neck cancer patients. Otolaryngol Head Neck Surg. 1998;119(6):628-33. PMID: 9852538

2. Kuno H, Onaya H, Iwata R, et al. Evaluation of cartilage invasion by laryngeal and hypopharyngeal squamous cell carcinoma with dual-energy CT. Radiology. 2012;265(2):488-96. PMID: 22984188

3. Don DM, Anzai Y, Lufkin RB, et al. Evaluation of cervical lymph node metastases in squamous cell carcinoma of the head and neck. Laryngoscope. 1995;105(7 Pt 1):669-74. PMID: 7603268

4. Driessen JPvK, P. M.;van der Heijden, G. J.;Philippens, M. E.;Pameijer, F. A.;Stegeman, I.;Terhaard, C. H.;Janssen, L. M.;Grolman, W. Diffusion-weighted imaging in head and neck squamous cell carcinomas: a systematic review. Head Neck. 2015;37(3):440-8. PMID: 24347513

~~5. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Head and Neck Cancers (Version 2.2018). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.~~

~~6. Food and Drug Administration (FDA). Lymphoseek (technetium Tc 99m tilmanocept) injection, for subcutaneous, intradermal, subareolar, or peritumoral use, (2016). Available from: https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/202207s005lbl.pdf.~~

~~7~~5. Fleming AJ, Jr., Smith SP, Jr., Paul CM, et al. Impact of [18F]-2-fluorodeoxyglucose-positron emission tomography/computed tomography on previously untreated head and neck cancer patients. Laryngoscope. 2007;117(7):1173-9. PMID: 17603315

~~8~~6. Xu G, Li J, Zuo X, et al. Comparison of whole body positron emission tomography (PET)/PET-computed tomography and conventional anatomic imaging for detecting distant malignancies in patients with head and neck cancer: a meta-analysis. Laryngoscope. 2012;122(9):1974-8. PMID: 22753007

~~9~~7. Stoeckli SJ, Steinert H, Pfaltz M, et al. Is there a role for positron emission tomography with 18F-fluorodeoxyglucose in the initial staging of nodal negative oral and oropharyngeal squamous cell carcinoma. Head Neck. 2002;24(4):345-9. PMID: 11933176

~~10~~8. Liao LJ, Hsu WL, Wang CT, et al. Analysis of sentinel node biopsy combined with other diagnostic tools in staging cN0 head and neck cancer: A diagnostic meta-analysis. Head Neck. 2016;38(4):628-34. PMID: 25524256

~~11~~9. Mehanna H, Wong WL, McConkey CC, et al. PET-CT surveillance versus neck dissection in advanced head and neck cancer. N Engl J Med. 2016;374(15):1444-54. PMID: 27007578

~~12~~10. Isles MG, McConkey C, Mehanna HM. A systematic review and meta-analysis of the role of positron emission tomography in the follow up of head and neck squamous cell carcinoma following radiotherapy or chemoradiotherapy. Clin Otolaryngol. 2008;33(3):210-22. PMID: 18559026

~~13~~11. Abgral R, Querellou S, Potard G, et al. Does 18F-FDG PET/CT improve the detection of posttreatment recurrence of head and neck squamous cell carcinoma in patients negative for disease on clinical follow-up? J Nucl Med. 2009;50(1):24-9. PMID: 19091901

~~14~~12. Nayak JV, Walvekar RR, Andrade RS, et al. Deferring planned neck dissection following chemoradiation for stage IV head and neck cancer: the utility of PET-CT. Laryngoscope. 2007;117(12):2129-34. PMID: 17921898

~~15~~13. Ong SC, Schoder H, Lee NY, et al. Clinical utility of 18F-FDG PET/CT in assessing the neck after concurrent chemoradiotherapy for locoregional advanced head and neck cancer. J Nucl Med. 2008;49(4):532-40. PMID: 18344440

~~16. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Cutaneous Melanoma (Version 1.2019). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.~~

14. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Head and Neck Cancers (Version 1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2020.

Hepatobiliary Cancer

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented hepatobiliary cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
CT abdomen and pelvis	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
MRI abdomen with or without MRCP	Indicated	~~Not indicated~~ Indicated	~~Not indicated~~ Indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated in EITHER of the following scenarios: • When standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic regarding the extent of disease • When standard imaging prior to planned curative surgery for gallbladder cancer and cholangiocarcinoma has been performed and has not demonstrated metastatic disease	Not indicated	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

DIAGNOSTIC WORKUP

~~Hepatocellular Carcinoma~~

Hepatobiliary cancer (including gallbladder cancer, cholangiocarcinoma and hepatocellular carcinoma) is staged using the American Joint Committee on Cancer TNM system.

Hepatocellular Carcinoma (HCC)

The initial staging evaluation of suspected ~~hepatocellular carcinoma~~HCC should include either a multiphasic abdominal CT or MRI to establish the diagnosis and assess the burden of disease. A diagnosis of ~~hepatocellular carcinoma~~HCC can be made based on imaging criteria in patients at high risk for developing ~~hepatocellular carcinoma~~HCC; the~~. The~~ most commonly used guidelines are published by the American Association for the Study of Liver Disease (AASLD), which incorporates the American College of Radiology (ACR) Liver Imaging Reporting and Data System (LI-RADS).[1] ~~Two systematic reviews and a meta-analysis have shown that CT and MRI imaging are superior to ultrasound without contrast for detection of hepatocellular carcinoma.[2, 3]~~ In a systematic review and meta-analysis evaluating the diagnostic performance of multidetector CT and MRI, the overall per-patient sensitivity of MR imaging was 88% (95% CI, 83%-92%) and per-patient specificity was 94% (95% CI, 85%-98%). An insufficient number of studies disallowed pooled analysis of CT for diagnostic accuracy and comparison to MRI~~. The sensitivity ranged from 74% to 100%, while specificity ranged from 81% to 100% in the 3 studies identified in the systematic review. The~~, but the overall per-lesion sensitivity of MR imaging was higher than that of multidetector CT when the paired data of the 11 available studies were pooled (80% vs 68%, P = .0023). In addition, MRI sensitivity was further improved when gadoxetic acid-enhanced MR imaging was used. Sensitivity tends to be worse in both modalities for lesions < 1cm.[~~4~~2]

Extrahepatic imaging should include CT of the chest and pelvis if not already done. Bone scan may be useful when clinical suspicion of bone metastases is high. In a retrospective study comparing PET and conventional imaging for

initial diagnosis of HCC, PET identified additional metastases in 2.7% of patients with T2, 5.3% of patients with T3a (5.3%), and 4.8% of patients with T3b tumor classifications.[5,3] In a systematic review and meta-analysis, the pooled estimates of sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of FDG PET for the detection of metastatic hepatocellular carcinoma were 76.6%, 98.0%, 14.68, and 0.28, respectively.[6,4] Although PET imaging may provide prognostic information on the biological aggressiveness of the cancer, the low sensitivity restricts its usefulness.[7,5]

Cholangiocarcinoma and Gallbladder Cancer

In patients with suspected cholangiocarcinoma/gallbladder cancer, CT chest and multi-detector, multiphasic CT of the abdomen and pelvis should be performed to assess local disease, lymph nodes, and sites of distant metastases. If an intervention is not required and accurate imaging of the pancreatobiliary tract is needed to assess surgical resectability, an MRI abdomen with magnetic resonance cholangiopancreatography (MRCP) should be considered. MRCP has largely replaced endoscopic retrograde cholangiopancreatography (ERCP) as it provides better anatomical imaging, a non-invasive alternative with lower risk of complications, and at least equivalent accuracy.[8,12,6,10] In a systematic review and meta-analysis comparing CT, MRI, and PET to assess for resectability of hilar cholangiocarcinoma, CT had the highest pooled sensitivity at 95% (95% CI, 91%-97%) and a pooled specificity of 69% (63%-75%). MRI had a pooled sensitivity of 94% (90%-97%) and a pooled specificity of 71% (60%-81%), whereas PET/CT had a pooled sensitivity of 91% (84%-96%), and the highest pooled specificity at 81% (95% CI, 69%-90%). The area under the curves (AUC) of CT, MRI, and PET/CT were 0.9269, 0.9194, and 0.9218, respectively. Overall, CT and MRI are comparable imaging modalities to assess resectability.[13,11] The data to support use of PET/CT for initial staging of cholangiocarcinoma is mixed, although some studies show a change in management of 17%-25%.[14,16,12,14] Overall, PET imaging has limited sensitivity for local evaluation of cholangiocarcinoma, although high specificity for detection of nodal and distant metastatic disease. Per NCCN recommendations, PET/CT may be considered when equivocal findings are seen by CT or MRI imaging and prior to planned resection.

MANAGEMENT

Response to treatment can be assessed with multiphasic CT or MRI of the abdomen ~~and pelvis~~, as ~~it reliably assesses~~both can assess intra-nodular arterial vascularity, a key feature of residual or recurrent tumor. Overall nodule size does not reliably indicate treatment response since a variety of factors may cause a successfully treated lesion to appear stable in size or even larger after treatment. ~~PET imaging should be reserved for detection of recurrent or progressive disease when standard imaging is equivocal or non-diagnostic.~~

SCREENING AND SURVEILLANCE

In patients treated with curative intent, follow-up for HCC includes CT or MRI imaging of the liver, and consideration for CT chest imaging. Monitoring of AFP is appropriate for HCC. ~~Patients with cholangiocarcinoma can be followed with surveillance contrast enhanced CT of the abdomen and pelvis as well as considered for CT imaging of the chest.~~ AIM Oncologic Imaging guidelines are in concordance with the National Comprehensive Cancer Network (NCCN) Guidelines for Hepatobiliary Cancer.[15]

References

1. Marrero JA, Kulik LM, Sirlin CB, et al. Diagnosis, staging, and management of hepatocellular carcinoma: 2018 practice guidance by the American Association for the Study of Liver Diseases. Hepatology. 2018;68(2):723-50. PMID: 29624699

~~2. Chou R, Cuevas C, Fu R, et al. Imaging techniques for the diagnosis of hepatocellular carcinoma: a systematic review and meta-analysis. Ann Intern Med. 2015;162(10):697-711. PMID: 25984845~~

~~3. Colli A, Fraquelli M, Casazza G, et al. Accuracy of ultrasonography, spiral CT, magnetic resonance, and alpha-fetoprotein in diagnosing hepatocellular carcinoma: a systematic review. Am J Gastroenterol. 2006;101(3):513-23. PMID: 16542288~~

~~4~~2. Lee YJ, Lee JM, Lee JS, et al. Hepatocellular carcinoma: diagnostic performance of multidetector CT and MR imaging-a systematic review and meta-analysis. Radiology. 2015;275(1):97-109. PMID: 25559230

~~5~~3. Cho Y, Lee DH, Lee YB, et al. Does 18F-FDG positron emission tomography-computed tomography have a role in initial staging of hepatocellular carcinoma? PLoS ONE. 2014;9(8):e105679. PMID: 25153834

~~6~~4. Lin CY, Chen JH, Liang JA, et al. 18F-FDG PET or PET/CT for detecting extrahepatic metastases or recurrent hepatocellular carcinoma: a systematic review and meta-analysis. Eur J Radiol. 2012;81(9):2417-22. PMID: 21899970

~~7~~5. Sun DW, An L, Wei F, et al. Prognostic significance of parameters from pretreatment (18)F-FDG PET in hepatocellular carcinoma: a meta-analysis. Abdom Radiol. 2016;41(1):33-41. PMID: 26830609

~~8~~6. Hyodo T, Kumano S, Kushihata F, et al. CT and MR cholangiography: advantages and pitfalls in perioperative evaluation of biliary tree. Br J Radiol. 2012;85(1015):887-96. PMID: 22422383

~~9~~7. Szklaruk J, Tamm E, Charnsangavej C. Preoperative imaging of biliary tract cancers. Surg Oncol Clin N Am. 2002;11(4):865-76. PMID: 12607576

~~10~~8. Vogl TJ, Schwarz WO, Heller M, et al. Staging of Klatskin tumours (hilar cholangiocarcinomas): comparison of MR cholangiography, MR imaging, and endoscopic retrograde cholangiography. Eur Radiol. 2006;16(10):2317-25. PMID: 16622690

~~11~~9. Yeh TS, Jan YY, Tseng JH, et al. Malignant perihilar biliary obstruction: magnetic resonance cholangiopancreatographic findings. Am J Gastroenterol. 2000;95(2):432-40. PMID: 10685746

~~12~~10. Zidi SH, Prat F, Le Guen O, et al. Performance characteristics of magnetic resonance cholangiography in the staging of malignant hilar strictures. Gut. 2000;46(1):103-6. PMID: 10601064

~~13~~11. Zhang H, Zhu J, Ke F, et al. Radiological imaging for assessing the respectability of hilar cholangiocarcinoma: a systematic review and meta-analysis. Biomed Res Int. 2015;2015:497942. PMID: 26448940

~~14~~12. Corvera CU, Blumgart LH, Akhurst T, et al. 18F-fluorodeoxyglucose positron emission tomography influences management decisions in patients with biliary cancer. J Am Coll Surg. 2008;206(1):57-65. PMID: 18155569

~~15~~13. Petrowsky H, Wildbrett P, Husarik DB, et al. Impact of integrated positron emission tomography and computed tomography on staging and management of gallbladder cancer and cholangiocarcinoma. J Hepatol. 2006;45(1):43-50. PMID: 16690156

~~16~~14. Ruys AT, Bennink RJ, van Westreenen HL, et al. FDG-positron emission tomography/computed tomography and standardized uptake value in the primary diagnosis and staging of hilar cholangiocarcinoma. HPB. 2011;13(4):256-62. PMID: 21418131

15. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Hepatobiliary Cancers (Version 3.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2020

Kidney Cancer/Renal Cell Carcinoma

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented kidney cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated (note: chest X-ray usually sufficient)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
CT abdomen and pelvis	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: especially useful in first 3-5 years)
MRI abdomen	Indicated for renal mass suspicious for renal cell cancer (*see Abdomen and Pelvis imaging, Renal mass*)	Indicated for baseline imaging after ablation, partial or total nephrectomy	Indicated for EITHER of the following: • Active surveillance of stage I renal cancer • Annual surveillance after ablation, partial or total nephrectomy
MRI brain	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
FDG PET/CT	Not indicated	Not indicated	Not indicated

Note: PET/CT does not replace a diagnostic CT scan.

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Kidney cancer is the sixth most common cancer in men and the tenth most common cancer in women. The most common tumor type is renal cell carcinoma, which arises from the renal parenchyma. Primary nephrectomy is indicated in most forms of kidney cancer. Until recently, fully resected renal cell carcinoma has been managed with surveillance only. Treatment options for metastatic renal cell carcinoma have greatly expanded in the last decade with immunosuppressive therapies such as cell cycle checkpoint inhibitors (PD-1 agents), mechanistic target of rapamycin (mTOR) inhibitors, and tyrosine kinase inhibitors (TKI).

DIAGNOSTIC WORKUP

Kidney cancer is staged using the American Joint Committee on Cancer TNM system. In a study comparing triphasic helical CT and fast MRI, renal cell carcinoma was correctly staged 67% of the time.[1] In another prospective study, accuracy of MRI was 78%-87%, and the accuracy of CT was 80%-83%.[2] Both modalities, however, are poor at detecting invasion of perinephric fat and assessing tumor extension into the renal veins or inferior vena cava. For the evaluation of renal vein involvement, MRI and CT appear to have approximately the same accuracy of 72%-76% and 78%-88%, respectively.[3]

In the evaluation of primary renal cell carcinoma, PET accuracy was only 50%. The utility of PET/CT is adversely affected by poor FDG avidity and background uptake from the kidney. Although a poor staging modality, specificity of PET was found to approach 100% in 2 separate studies.[4, 5] The NCCN and ACR notes that the value of PET in renal cell carcinoma remains to be determined.[6, 7] Current evidence suggests that imaging of the pelvis is of low yield and does not affect overall management.[8, 9] For chest imaging, radiography is preferred, although CT is more sensitive in patients with symptoms, advanced-stage disease, anemia, or thrombocytopenia.[10, 11]

AIM guidelines are in accordance with recommendations from the National Comprehensive Cancer Network Guidelines for Kidney Cancer, American College of Radiology ACR Appropriateness Criteria® for Renal Cell Carcinoma Staging, and European Association of Urology.[6,7]

MANAGEMENT

Imaging (CT or MRI) with contrast can be done when clinically indicated following ablative techniques, and as baseline imaging after partial or radical nephrectomy (NCCN level of evidence category 2B).[6,12] ~~A pooled analysis of 15 studies found PET/CT to have combined sensitivity of 86% and specificity of 88%. Comparison across studies found similar sensitivity but markedly higher specificity with PET imaging.[12]~~

SCREENING AND SURVEILLANCE

Active surveillance can be considered in select T1b patients. Imaging (CT or MRI) should be done with contrast when clinically indicated if no contraindication. Active surveillance entails serial abdominal imaging with timely intervention should the mass demonstrate growth (e.g. tumor size, growth rate, infiltrative pattern) indicative of increasing metastatic potential. ~~Surveillance of asymptomatic renal cell cancer generally should not go beyond 5 years.~~ No single follow-up plan is appropriate for all patients. Follow-up frequency and duration should be individualized based on patient requirements, and may be extended beyond 5 years at the discretion of the physician. ~~All recommendations are~~The choice to perform imaging follow-up is level of evidence category 2B as designated by the National Comprehensive Cancer Network.[6,12]

References

1. Walter C, Kruessell M, Gindele A, et al. Imaging of renal lesions: evaluation of fast MRI and helical CT. Br J Radiol. 2003;76(910):696-703. PMID: 14512329
2. Hallscheidt PJ, Bock M, Riedasch G, et al. Diagnostic accuracy of staging renal cell carcinomas using multidetector-row computed tomography and magnetic resonance imaging: a prospective study with histopathologic correlation. J Comput Assist Tomogr. 2004;28(3):333-9. PMID: 15100536
3. Hallscheidt PJ, Fink C, Haferkamp A, et al. Preoperative staging of renal cell carcinoma with inferior vena cava thrombus using multidetector CT and MRI: prospective study with histopathological correlation. J Comput Assist Tomogr. 2005;29(1):64-8. PMID: 15665685
4. Kang DE, White RL, Jr., Zuger JH, et al. Clinical use of fluorodeoxyglucose F 18 positron emission tomography for detection of renal cell carcinoma. J Urol. 2004;171(5):1806-9. PMID: 15076281
5. Majhail NS, Urbain JL, Albani JM, et al. F-18 fluorodeoxyglucose positron emission tomography in the evaluation of distant metastases from renal cell carcinoma. J Clin Oncol. 2003;21(21):3995-4000. PMID: 14581422
6. ~~-~~NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Kidney Cancer (Version ~~4.2019~~2.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.
7. Vikram R, Beland MD, Blaufox MD, et al. ACR Appropriateness Criteria® renal cell carcinoma staging. J Am Coll Radiol. 2016;13(5):518-25. PMID: 27016804
8. Fielding JR, Aliabadi N, Renshaw AA, et al. Staging of 119 patients with renal cell carcinoma: the yield and cost-effectiveness of pelvic CT. AJR Am J Roentgenol. 1999;172(1):23-5. PMID: 9888732
9. Khaitan A, Gupta NP, Hemal AK, et al. Is there a need for pelvic CT scan in cases of renal cell carcinoma? Int Urol Nephrol. 2002;33(1):13-5. PMID: 12090319
10. Lim DJ, Carter MF. Computerized tomography in the preoperative staging for pulmonary metastases in patients with renal cell carcinoma. J Urol. 1993;150(4):1112-4. PMID: 8371366
11. Larcher A, Dell'Oglio P, Fossati N, et al. When to perform preoperative chest computed tomography for renal cancer staging. BJU Int. 2017;120(4):490-6. PMID: 27684653

~~12. Kim JH, Sun HY, Hwang J, et al. Diagnostic accuracy of contrast-enhanced computed tomography and contrast-enhanced magnetic resonance imaging of small renal masses in real practice: sensitivity and specificity according to subjective radiologic interpretation. World J Surg Oncol. 2016;14(1):260. PMID: 27729042~~

12. Donat SM, Diaz M, Bishoff JT, et al. Follow-up for clinically localized renal neoplasms: AUA Guideline. J urol 2013;190:407-416.

Lung Cancer – Non-Small Cell

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented non-small cell lung cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: usually only CT chest needed with contrast for 1st 2 years followed with non-contrast thereafter)
CT abdomen	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: generally CT chest is sufficient)
CT pelvis	~~As clinically indicated~~ Indicated (note: generally CT of chest and abdomen is sufficient)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: generally CT chest is sufficient)
MRI brain	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
MRI spine	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated for evaluation of suspected or known spinal metastases	Not indicated
MRI chest	For Pancoast tumors when CT is nondiagnostic	~~For Pancoast tumors when CT non-diagnostic~~ Not indicated	Not indicated
FDG-PET/CT	Indicated in EITHER of the following scenarios: • ~~Diagnosis in patients with a strong clinical or radiographic suspicion of non-small cell lung cancer~~ • Further characterizion of a solid or part solid pulmonary nodule or mass greater than 8 mm • Evaluation of the extent of disease following biopsy confirmation of non-small cell lung cancer if not previously performed	Indicated in ANY of the following scenarios: • Radiation planning for preoperative or definitive treatment • Evaluation following induction or neoadjuvant therapy, to determine eligibility for resection • Assessment of response to definitive chemoradiation when performed at least 12 weeks following therapy • Evaluation of signs or symptoms of disease when CT or MRI ~~has not clearly demonstrated recurrence or~~	Not indicated

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
		~~progression~~ cannot be performed or is nondiagnostic • Differentiation of tumor from benign conditions (atelectasis, consolidation, or radiation fibrosis) when CT clearly delineates the abnormal findings	

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Lung cancer is the second most common cancer in both men and women but accounts for the largest number of cancer deaths. The two most common types of lung cancer are non-small cell lung cancer and small cell lung cancer. Non-small cell lung cancer accounts for 85%-90% of lung cancers and is further subdivided into adenocarcinoma, squamous cell carcinoma, and other large cell carcinomas. Risk factors for developing non-small cell lung cancer include tobacco use, radon exposure, asbestos exposure, and other environmental factors. Adenocarcinoma is unique as this lung cancer is most often seen in nonsmokers and light smokers. Presenting symptoms may include cough, hemoptysis, dyspnea, and chest pain.

DIAGNOSTIC WORKUP

Non-small cell lung cancer is staged using the American Joint Committee on Cancer TNM system.

PET/CT for evaluation of pulmonary nodules suspected to be malignant should be limited those greater than 8 mm and of solid or part-solid composition to limit false-negative results commonly seen in nodules small in size and of low cellular density/low tumor avidity for FDG. CT can accurately evaluate~~s~~ the primary tumor and detect~~s~~ metastatic disease, but is less accurate than PET/CT in identifying mediastinal lymphadenopathy.[1, 2] Studies comparing CT and PET/CT for staging of mediastinal nodes have found accuracy rates of 80%-84% for PET/CT versus 76%-77% for CT alone.[3, 4] In one prospective trial, PET/CT prevented unnecessary surgery in 17% of patients.[5]

~~An added benefit of PET/CT is detection of distant metastases, although its superiority over conventional CT has not been definitively shown. In a retrospective analysis of 217 patients, PET/CT showed a sensitivity and specificity of 92% and 98%, respectively, for the detection of malignant extrapulmonary lesions.[6]~~

PET/CT can be used for planning treatment volumes as well as determination of the need for extranodal irradiation. The Radiation Therapy Oncology Group 0151 showed that PET/CT-derived tumor volumes were smaller than those derived by CT alone with only a small number of patients developing nodal failures.[~~7~~6] Involved field irradiation has been shown to improve overall survival in patients over extranodal irradiation in a prospective study by Yuan et al. In this prospective study, the involved field irradiation arm achieved better overall response and local control than the extranodal irradiation arm, and it allowed a dose increase from 68 to 74 Gy to be safely administered.[~~8~~–7]

Asymptomatic metastatic central nervous system disease is seen in as many as 12% of patients, and brain imaging should always be performed for stage II or higher.[~~9~~8] MRI chest with contrast should be considered to assess the spine/thoracic inlet for superior sulcus lesions abutting the spine and/or subclavian vessels in patients with stage IIB (T3 invasion N0) and stage IIIA (T4 extension N0-1; T3 N1, T4N0-1).

MANAGEMENT

Following treatment with concurrent chemoradiation therapy for superior sulcus non-small cell lung cancer, restaging with either CT or PET/CT is appropriate for detection of metastatic disease. For definitive treatment with chemoradiation therapy, the most appropriate follow-up imaging modality is not clear. A prospective study looking at PET/CT versus CT for the restaging of stage IIIA non-small cell lung cancer after neoadjuvant chemoradiation therapy showed PET/CT scan was more accurate than CT alone for restaging at all pathologic stages (stage 0, 92% vs 39%, P = .03; stage I, 89% vs 36%, P = .04). The authors, however, concluded that nodal biopsies are required since a persistently high maximum standardized uptake value does not equate to residual cancer.[~~10~~9] Two other studies which evaluated post-treatment PET for locally advanced non-small cell lung cancer after treatment with concurrent chemoradiation therapy found PET was able to accurately predict local control and tumor response.[10,11,~~12~~] Pan et al. compared conventional CT to PET/CT for locally advanced non-small cell lung cancer performed at 9 months after completion of therapy. Although PET/CT was able to identify progression of disease and recurrence in 48% of patients, no difference in survival could be demonstrated (21.6 months in CT group vs.

23.5 months in PET/CT, P = .89).[13,12] PET/CT may remain FDG-avid up until 2 years after treatmentradiation therapy.[14,13] Any suspected recurrence should be biopsied for pathologic confirmation.

SCREENING AND SURVEILLANCE

NCCN recommends surveillance Surveillance imaging should include CTwith CT chest every 6 months for 2 to 3 years followed by annual low-dose technique CT chest for stage I/II treated with surgery. All others should undergo CT chest every 3 to 6 months for 3 years, then every 6 months for 2 years. Timing of CT scans within Guideline parameters is a clinical decision.[15,14]

References

1. McLoud TC, Bourgouin PM, Greenberg RW, et al. Bronchogenic carcinoma: analysis of staging in the mediastinum with CT by correlative lymph node mapping and sampling. Radiology. 1992;182(2):319-23. PMID: 1732943
2. Seely JM, Mayo JR, Miller RR, et al. T1 lung cancer: prevalence of mediastinal nodal metastases and diagnostic accuracy of CT. Radiology. 1993;186(1):129-32. PMID: 8416552
3. Chin R, Jr., Ward R, Keyes JW, et al. Mediastinal staging of non-small-cell lung cancer with positron emission tomography. Am J Respir Crit Care Med. 1995;152(6 Pt 1):2090-6. PMID: 8520780
4. Kernstine KH, Stanford W, Mullan BF, et al. PET, CT, and MRI with Combidex for mediastinal staging in non-small cell lung carcinoma. Ann Thorac Surg. 1999;68(3):1022-8. PMID: 10510001
5. Fischer B, Lassen U, Mortensen J, et al. Preoperative staging of lung cancer with combined PET-CT.[Erratum appears in N Engl J Med. 2011 Mar 10;364(10):982]. N Engl J Med. 2009;361(1):32-9. PMID: 19571281
6. De Wever W, Vankan Y, Stroobants S, et al. Detection of extrapulmonary lesions with integrated PET/CT in the staging of lung cancer. Eur Respir J. 2007;29(5):995-1002. PMID: 17331966
7. 6. Bradley J, Bae K, Choi N, et al. A phase II comparative study of gross tumor volume definition with or without PET/CT fusion in dosimetric planning for non-small-cell lung cancer (NSCLC): primary analysis of Radiation Therapy Oncology Group (RTOG) 0515. Int J Radiat Oncol Biol Phys. 2012;82(1):435-41.e1. PMID: 21075551
8. 7. Yuan S, Sun X, Li M, et al. A randomized study of involved-field irradiation versus elective nodal irradiation in combination with concurrent chemotherapy for inoperable stage III nonsmall cell lung cancer. Am J Clin Oncol. 2007;30(3):239-44. PMID: 17551299
9. 8. Mintz BJ, Tuhrim S, Alexander S, et al. Intracranial metastases in the initial staging of bronchogenic carcinoma. Chest. 1984;86(6):850-3. PMID: 6094117
10. 9. Cerfolio RJ, Bryant AS, Ojha B. Restaging patients with N2 (stage IIIa) non-small cell lung cancer after neoadjuvant chemoradiotherapy: a prospective study.[Erratum appears in J Thorac Cardiovasc Surg. 2006 Sep;132(3):565-7]. J Thorac Cardiovasc Surg. 2006;131(6):1229-35. PMID: 16733150
11. 10. Ohri N, Bodner WR, Halmos B, et al. 18F-fluorodeoxyglucose/positron emission tomography predicts patterns of failure after definitive chemoradiation therapy for locally advanced non-small cell lung cancer. Int J Radiat Oncol Biol Phys. 2017;97(2):372-80. PMID: 28068244
12. 11. Roy S, Pathy S, Kumar R, et al. Efficacy of 18F-fluorodeoxyglucose positron emission tomography/computed tomography as a predictor of response in locally advanced non-small-cell carcinoma of the lung. Nucl Med Commun. 2016;37(2):129-38. PMID: 26544097
13. 12. Pan Y, Brink C, Schytte T, et al. Planned FDG PET-CT Scan in Follow-Up Detects Disease Progression in Patients With Locally Advanced NSCLC Receiving Curative Chemoradiotherapy Earlier Than Standard CT. Medicine (Baltimore). 2015;94(43):e1863. PMID: 26512597
14. 13. Ulaner GA, Lyall A. Identifying and distinguishing treatment effects and complications from malignancy at FDG PET/CT. Radiographics. 2013;33(6):1817-34. PMID: 24108564
15. 14. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Non-Small Cell Lung Cancer (Version 5.20195.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 20192020.

Lung Cancer – Small Cell

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented small cell lung cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
CT abdomen	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
CT pelvis	~~As clinically indicated~~ Indicated (note: generally CT of chest and abdomen is sufficient)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: generally CT chest and abdomen are sufficient)
MRI brain	Indicated	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases or prior to prophylactic cranial irradiation	~~As clinically indicated~~ Indicated ~~or every 3 to 4 months for 1 to 2 years when prophylactic cranial irradiation not given~~
FDG-PET/CT	Indicated prior to definitive therapy when standard imaging suggests limited stage disease	~~As clinically indicated~~ Indicated prior to initiation of radiation therapy	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Lung cancer is the second most common cancer in both men and women but accounts for the largest number of cancer deaths. The two most common types of lung cancer are small cell lung cancer and non-small cell lung cancer. Small cell lung cancer is classified as limited stage small cell lung cancer or extensive stage small cell lung cancer. Small cell lung cancer accounts for 10% to 15% of lung cancers and is most commonly found in smokers. Presenting symptoms may include cough, hemoptysis, dyspnea, and chest pain.

DIAGNOSTIC WORKUP

Asymptomatic metastatic central nervous system disease is seen in up to 15% of patients and MRI brain with contrast is indicated regardless of stage.[1, 2] ~~If CT and MRI are negative for metastatic disease then a PET/CT is also indicated.~~ Most of the available data regarding PET in lung cancer is for non-small cell lung cancer, but limited data does suggest that PET/CT ~~has a high sensitivity for detecting lymph node involvement and distant metastases~~can increase staging accuracy in small cell lung cancer. In a small prospective trial (N = 24) evaluating PET versus CT in limited stage small cell lung cancer, FDG-PET had a lesion-based sensitivity relative to CT of 100% and upstaged 2/24 (8.3%) patients. In addition, 25% of patients (6/24) were discovered to have unsuspected regional nodal metastasis.[3] Survival benefit was seen in a retrospective study using pre-treatment PET in patients with limited stage small cell lung cancer. Three-year overall survival was 47% for PET versus 19% for CT (P = .03). The authors attributed the difference in survival to improved radiation field planning and disease upstaging ~~to extensive stage small cell lung cancer with PET staging~~.[4] Another review found an 84% concordance between PET and CT for staging; however, 19% were upstaged to extensive stage small cell lung cancer and ~~11~~8% were downstaged to limited stage small cell lung cancer when PET was performed.[1] ~~Ruben et al. published data from a second review of 22 studies showing PET sensitivity approaching 100% and specificity exceeding 90%. PET altered the treatment plan in at least 28% of cases, with 6% deemed appropriate for curative treatment and 9% in which radiation was deemed no longer appropriate.~~[5] In studies where PET/CT was used for staging and targeting of lymph nodes for radiation, the local recurrence rates have been reported to be less than 3%.[6,7~~5~~,6] Pathologic staging is still required for PET/CT-detected lesions that would result in upstaging.[7]

MANAGEMENT

The NCCN recommends assessment of treatment response following systemic therapy with or without subsequent radiation therapy using chest/abdomen/pelvis CT (level of evidence category 2A); NCCN does not recommend PET/CT for routine follow-up.[7] Three small prospective trials (N = 36) evaluated the use of PET for response

assessment in small cell lung cancer. Although metabolic response was associated with better prognosis, no patient benefit was observed.[2]

SCREENING AND SURVEILLANCE

National Comprehensive Cancer Network Guidelines for Small Cell Lung Cancer recommend imaging surveillance with a CT of the chest and abdomen every 3 to 4 months as clinically indicated. There is no role for PET/CT in surveillance of treated small cell lung cancer.[8-7]

References

1. Kalemkerian GP. Staging and imaging of small cell lung cancer. Cancer Imaging. 2012;11:253-8. PMID: 22245990
2. Jett JR, Schild SE, Kesler KA, et al. Treatment of small cell lung cancer: Diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest. 2013;143(5 Suppl):e400S-e19S. Epub 2013/05/10. PMID: 23649448
3. Bradley JD, Dehdashti F, Mintun MA, et al. Positron emission tomography in limited-stage small-cell lung cancer: a prospective study. J Clin Oncol. 2004;22(16):3248-54. PMID: 15310768
4. Xanthopoulos EP, Corradetti MN, Mitra N, et al. Impact of PET staging in limited-stage small-cell lung cancer.[Erratum appears in J Thorac Oncol. 2013 Aug;8(8):1106]. J Thorac Oncol. 2013;8(7):899-905. PMID: 23608814

~~5. Ruben JD, Ball DL. The efficacy of PET staging for small-cell lung cancer: a systematic review and cost analysis in the Australian setting. J Thorac Oncol. 2012;7(6):1015-20. PMID: 22534816~~

~~6~~5. Shirvani SM, Komaki R, Heymach JV, et al. Positron emission tomography/computed tomography-guided intensity-modulated radiotherapy for limited-stage small-cell lung cancer. Int J Radiat Oncol Biol Phys. 2012;82(1):e91-7. PMID: 21489716

~~7~~6. van Loon J, De Ruysscher D, Wanders R, et al. Selective nodal irradiation on basis of (18)FDG-PET scans in limited-disease small-cell lung cancer: a prospective study. Int J Radiat Oncol Biol Phys. 2010;77(2):329-36. PMID: 19782478

~~8~~7. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Small Cell Lung Cancer (Version ~~2.2018~~3.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2018~~2020.

Lymphoma – Hodgkin

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented Hodgkin lymphoma.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT neck	~~As clinically indicated~~ Indicated (note: especially useful for when radiation of neck planned or PET positive disease)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: especially useful in first 2 years)
CT chest	~~As clinically indicated~~ Indicated (note: may consider omitting if PET/CT has been completed)	~~As clinically indicated~~ Indicated (note: may consider omitting if PET/CT done to assess disease response to chemotherapy)	~~As clinically indicated~~ Indicated (note: especially useful in first 2 years)
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: may consider omitting if PET/CT has been completed)	~~As clinically indicated~~ Indicated (note: may consider omitting if PET/CT done to assess disease response to chemotherapy)	~~As clinically indicated~~ Indicated (note: especially useful in first 2 years)
FDG-PET/CT	Indicated (note: especially useful as an adjunct to CT imaging)	Indicated in ANY of the following scenarios: • Radiation planning for definitive or consolidative treatment • Evaluation of response following 2-4 cycles of treatment • ~~Post-treatment~~ Baseline post-treatment evaluation at least 3 weeks following completion of all cycles of chemotherapy or 12 weeks following completion of radiation therapy • Post-treatment follow up when post-treatment baseline was Deauville 4 or 5 • ~~Evaluation of suspected~~ Clinical suspicion for recurrence or progression of disease based on standard imaging or objective signs/symptoms	Not indicated

Rationale

Hodgkin lymphoma accounts for about 10% of all lymphomas. Risk factors include Epstein-Barr viral infection, immunosuppression, autoimmune disorders, and genetic predisposition. The most common presentation is painless lymphadenopathy, although many patients also present with B (systemic) symptoms (fevers, chills, night sweats, and weight loss). In more advanced disease, symptoms result from local tumor growth affecting organ function or causing systemic metabolic derangements.

DIAGNOSTIC WORKUP

Hodgkin lymphoma is staged using the Lugano classification system. ~~Response to treatment uses the 5-point Deauville criteria for assessment of metabolic response.~~ PET/CT can result in changing of clinical stage in 20% of patients.[1] In ~~the RATHL~~the RATHL (Response-Adapted Therapy in Advanced Hodgkin Lymphoma) study, PET/CT resulted in upstaging 14% and downstaging 6%.[2] In a meta-analysis of 20 studies, the pooled sensitivity for PET/CT was 90.9% (95% CI, 88.0-93.4), and the pooled false positive rate was 10.3% (95% CI, 7.4-13.8) for staging and restaging.

MANAGEMENT

Response to treatment uses the 5-point Deauville criteria for assessment of metabolic response. For early stage favorable Hodgkin lymphoma, the value of interim PET/CT has been mixed although more recent data supports the use of interim PET for response-adapted treatment.[3,4] For early stage unfavorable Hodgkin lymphoma or stage III and IV Hodgkin lymphoma, Gallamini et al. found that following a negative interim PET scan, the 2-year progression-free survival was 12.8% for PET positive and 95.0% for PET negative ($P < .0001$).[5] Cercil et al. found 3-year event-free survival was 53.4% for PET positive and 90.5% for PET negative ($P < 0.001$).[6] Three large randomized trials have confirmed that a risk-adapted approach to chemotherapy after negative interim PET is safe and did not result in poorer outcomes.[7,8]

SCREENING AND SURVEILLANCE

There is limited data to support routine surveillance imaging in Hodgkin lymphoma. A randomized study comparing PET/CT to ultrasound and chest radiography for routine surveillance of patients with advanced Hodgkin lymphoma showed that sensitivity was equal in both groups. The conventional imaging arm had a higher specificity (96% vs 86%; $P = .02$) and positive predictive value (91% vs 73%; $P = .01$).[9] Although PET/CT negative patients had a high likelihood of being disease free, PET/CT also produced false positive rates as high as 20%.[10-12] A systematic review found no retrospective or prospective data demonstrating a survival advantage associated with the use of surveillance imaging for patients with Hodgkin lymphoma who achieved remission after first-line therapy.[13]

References

1. Naumann R, Beuthien-Baumann B, Reiss A, et al. Substantial impact of FDG PET imaging on the therapy decision in patients with early-stage Hodgkin's lymphoma. British Journal of Cancer. 2004;90(3):620-5. PMID: 14760374
2. Barrington SF, Kirkwood AA, Franceschetto A, et al. PET-CT for staging and early response: results from the Response-Adapted Therapy in Advanced Hodgkin Lymphoma study. Blood. 2016;127(12):1531-8. PMID: 26747247
3. Andre MPE, Girinsky T, Federico M, et al. Early positron emission tomography response-adapted treatment in stage I and II Hodgkin lymphoma: final results of the randomized EORTC/LYSA/FIL H10 trial. J Clin Oncol. 2017;35(16):1786-94. PMID: 28291393
4. Radford J, Illidge T, Counsell N, et al. Results of a trial of PET-directed therapy for early-stage Hodgkin's lymphoma. N Engl J Med. 2015;372(17):1598-607. PMID: 25901426
5. Gallamini A, Hutchings M, Rigacci L, et al. Early interim 2-[18F]fluoro-2-deoxy-D-glucose positron emission tomography is prognostically superior to international prognostic score in advanced-stage Hodgkin's lymphoma: a report from a joint Italian-Danish study. J Clin Oncol. 2007;25(24):3746-52. PMID: 17646666
6. Cerci JJ, Pracchia LF, Linardi CC, et al. 18F-FDG PET after 2 cycles of ABVD predicts event-free survival in early and advanced Hodgkin lymphoma.[Erratum appears in J Nucl Med. 2010 Oct;51(10):1658]. J Nucl Med. 2010;51(9):1337-43. PMID: 20720036
7. Bartlett NL. Fine-tuning the treatment of Hodgkin's lymphoma. N Engl J Med. 2016;374(25):2490-2. PMID: 27332908
8. Johnson P, Federico M, Kirkwood A, et al. Adapted treatment guided by interim PET-CT scan in advanced Hodgkin's lymphoma. N Engl J Med. 2016;374(25):2419-29. PMID: 27332902
9. Picardi M, Pugliese N, Cirillo M, et al. Advanced-stage Hodgkin lymphoma: US/chest radiography for detection of relapse in patients in first complete remission--a randomized trial of routine surveillance imaging procedures. Radiology. 2014;272(1):262-74. PMID: 24708193
10. Cheson BD, Fisher RI, Barrington SF, et al. Recommendations for initial evaluation, staging, and response assessment of Hodgkin and non-Hodgkin lymphoma: the Lugano classification. J Clin Oncol. 2014;32(27):3059-68. PMID: 25113753
11. El-Galaly TC, Mylam KJ, Brown P, et al. Positron emission tomography/computed tomography surveillance in patients with Hodgkin lymphoma in first remission has a low positive predictive value and high costs. Haematologica. 2012;97(6):931-6. PMID: 22207683

12. Mocikova H, Obrtlikova P, Vackova B, et al. Positron emission tomography at the end of first-line therapy and during follow-up in patients with Hodgkin lymphoma: a retrospective study. Ann Oncol. 2010;21(6):1222-7. PMID: 19901011
13. Cohen JB, Behera M, Thompson CA, et al. Evaluating surveillance imaging for diffuse large B-cell lymphoma and Hodgkin lymphoma. Blood. 2017;129(5):561-4. PMID: 27956385

Lymphoma – Non-Hodgkin and Leukemia

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented chronic lymphocytic leukemia/small lymphocytic lymphoma and non-Hodgkin lymphomas.

Acute Leukemia

Advanced imaging is considered medically necessary for diagnostic workup and management of documented acute leukemias.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT or MRI brain	Indicated for clinical suspicion	Indicated for clinical suspicion or treatment response to extramedullary disease (chloromas)	Not indicated
CT neck	Indicated for clinical suspicion	Indicated for clinical suspicion or treatment response to extramedullary disease (chloromas)	Not indicated
CT chest	Indicated for clinical suspicion	Indicated for clinical suspicion or treatment response to extramedullary disease (chloromas)	Not indicated
CT abdomen and pelvis	Indicated for clinical suspicion	Indicated for clinical suspicion or treatment response to extramedullary disease (chloromas)	Not indicated
PET/CT	Indication for acute leukemia in EITHER of the following scenarios: • Clinical suspicion for extramedullary disease or lymphadenopathy • When standard imaging cannot be performed or is nondiagnostic	Indication for acute leukemia in EITHER of the following scenarios: • Relapsed or refractory extramedullary disease • When standard imaging cannot be performed or is nondiagnostic	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Chronic lymphocytic leukemia or small lymphocytic lymphoma ~~Lymphoma and leukemia not otherwise specified – Non-Hodgkin: Chronic lymphocytic leukemia or small lymphocytic lymphoma~~

Note: includes chronic lymphocutic leukemia, small lymphocytic lymphoma, Waldenstrom macroglobulinemia, and lymphoplasmacytic lymphoma

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated based on symptoms or to evaluate bulky disease	~~As clinically indicated~~ Indicated based on symptoms or to evaluate bulky disease
CT abdomen and pelvis	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated based on symptoms or to evaluate bulky disease	~~As clinically indicated~~ Indicated based on symptoms or to evaluate bulky disease
FDG-PET/CT	~~As clinically indicated~~ Indicated for suspicion of Richter's transformation when PET is utilized to direct biopsy	~~As clinically indicated~~ Indicated for suspicion of Richter's transformation when PET is utilized to direct biopsy	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Lymphoma – Non-Hodgkin: Indolent non-Hodgkin lymphoma

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT neck	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated, not to exceed 2 years following completion of treatment and no evidence of disease
CT chest	Indicated (note: may consider omitting if PET/CT has been completed)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated, not to exceed 2 years following completion of treatment and no evidence of disease
CT abdomen, and pelvis	Indicated (note: may consider omitting if PET/CT has been completed)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated, not to exceed 2 years following completion of treatment and no evidence of disease
FDG-PET/CT	Indicated in ANY of the following scenarios: • Initial evaluation of suspected lymphoma when lymph nodes are not amenable to biopsy • Evaluation of suspected	~~As clinically indicated~~ Indicated in ANY of the following scenarios: • Radiation planning prior to definitive or consolidative treatment for indolent, aggressive, and highly-aggressive non-Hodgkin's lymphoma	Not indicated

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
	transformation to a more aggressive lymphoma based on clinical signs or symptoms • Prior to initiation of therapy	• Post-treatment response evaluation, when initial PET scan has demonstrated FDG uptake • Evaluation of suspected recurrence or progression of disease based on standard imaging when there is an indication to resume systemic treatment • Evaluation of suspected transformation to a more aggressive lymphoma based on clinical signs or symptoms	

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Lymphoma – Non-Hodgkin: Intermediate and high grade non-Hodgkin lymphoma

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated (note: may consider omitting if PET/CT has been completed)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated not to exceed 2 years following completion of treatment
CT abdomen, and pelvis	Indicated (note: may consider omitting if PET/CT has been completed)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated not to exceed 2 years following completion of treatment
FDG-PET/CT	Indicated in EITHER of the following scenarios: • Initial evaluation of suspected lymphoma when lymph nodes are not amenable to biopsy • Initial staging (often used as an adjunct to CT chest/abdomen/pelvis)	Indicated in ANY of the following scenarios: • Radiation planning prior to definitive or consolidative treatment for indolent, aggressive, and highly-aggressive non-Hodgkin's lymphoma • Evaluation of response following 2 to 4 cycles of treatment for stage III and IV disease • Post-treatment evaluation • Evaluation of suspected recurrence or progression of disease based on standard imaging or objective signs/symptoms	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Lymphomas are divided into Hodgkin and non-Hodgkin lymphomas. Non-Hodgkin lymphoma (NHL) is the seventh most common cancer in both men and women. ~~Lymphomas are divided into Hodgkin and non-Hodgkin lymphomas.~~ Non-Hodgkin lymphoma is further subdivided into indolent, aggressive, and highly aggressive. Aggressive and highly aggressive lymphomas generally present over weeks to months, while indolent lymphomas may be undiagnosed for years due to their slow rate of growth. Common presenting symptoms include enlarged lymph nodes, B symptoms (fevers, chills, night sweats, weight loss), or in the case of more aggressive ~~non-Hodgkin lymphomas~~NHL, symptoms resulting from local tumor growth or systemic metabolic derangements.

Acute leukemias include acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), and acute promyelocytic leukemia (APL). Risk factors for developing ALL include older age (>70 years), exposure to chemotherapy or radiation therapy, and certain genetic disorders. The clinical presentation of ALL is typically nonspecific, and may include fatigue, B symptoms, dyspnea, and easy bruising or bleeding. Approx. 20% of patient have lymphadenopathy, splenomegaly and/or hepatomegaly.[1] Extramedullary disease (including CNS involvement) is uncommon in AML; presentation of solitary extramedullary disease is currently referred to as myeloid sarcoma (historically as chloroma).[2]

DIAGNOSTIC WORKUP

Lymphoma is staged using the Lugano classification system. ~~The 5-point Deauville criteria are used for assessment of treatment response.~~ For chronic lymphocytic leukemia/small lymphocytic lymphoma (CLL/SLL), CT chest, abdomen, and pelvis is not routinely indicated unless clinically indicated. PET/CT is most accurate for staging and interim assessment of lymphomas with high FDG avidity like diffuse large B-cell lymphoma, follicular ~~non-Hodgkin lymphoma~~NHL, and nodal marginal zone lymphoma, but may be less accurate for CLL/SLL, marginal zone lymphoma, and hairy cell leukemia.[~~1~~3]

For staging of indolent ~~non-Hodgkin lymphomas~~NHL, the evidence comparing the accuracy of PET/CT to CT alone is mixed. In a recent prospective trial, both modalities performed equally well at initial staging for both indolent and intermediate grade lymphomas.[2-4] However, multiple retrospective trials have found significantly higher sensitivity for PET/CT (94%-98%) and a resultant change of management based on PET findings in 34% of patients.[~~3~~,4,5,6]

For aggressive and highly aggressive ~~non-Hodgkin lymphomas~~NHL, a PET/CT with or without CT chest, abdomen and pelvis with contrast is indicated. In a retrospective study comparing CT to PET for Hodgkin lymphoma and high-grade ~~non-Hodgkin lymphoma~~NHL, the sensitivity of PET/CT versus contrast-enhanced CT was 94% vs. 88% respectively. For evaluation of organ involvement, sensitivity of PET/CT versus contrast-enhanced CT was 88% vs. 50%, respectively. Statistically, PET/CT and CT were equivalent for nodal disease, but PET/CT was more accurate for extranodal disease.[5-7] In a meta-analysis of 20 studies, PET/CT had a pooled sensitivity of 90.9% (95% CI, 88.0-93.4) and the pooled false-positive rate was 10.3% (95% CI, 7.4-13.8).[6-8] Change in treatment has been reported in as many as 9% of cases with the addition of PET/CT scan.[~~7~~9]

For acute leukemia, CT scans of the neck, chest, and abdomen/pelvis with IV contrast and CT or MRI head are recommended as indicated by signs/symptoms at diagnosis; PET/CT may be considered if any extramedullary involvement is suspected.[1,2]

MANAGEMENT

In general, advanced imaging is not necessary for routine monitoring of treatment response or progression of ~~chronic lymphocytic leukemia or small lymphocytic lymphoma~~CLL/SLL. A meta-analysis of the German CLL study group phase 3 trials (CLL4, CLL5, and CLL8) found that 77% of recurrent/progressive disease were detected by clinical symptoms or laboratory testing; CT detected an additional 9% with only a 1% effect on management decisions.[~~8~~10]

The 5-point Deauville criteria are used for assessment of treatment response. ~~For indolent non-Hodgkin lymphomas, CT or PET/CT is indicated; i~~In a retrospective study, PET/CT outperformed CT for response assessment for follicular non-Hodgkin lymphoma. The accuracy of PET/CT for response assessment was superior to CT (0.97 vs 0.64) and also predicted improvement in progression-free survival (48 months vs 17 months, P < .01).[~~9~~-11] ~~In the analysis of the PRIMA trial, patients with remaining PET-positive disease had a significantly inferior progression-free survival at 42 months compared with to patients who became PET negative (33% vs 71%, P < .001).[10]~~

Multiple studies have confirmed that PET positivity correlates with active tumor for both NHL and lymphomatous extramedullary disease in ALL. ~~However, there is insufficient evidence that post-treatment PET/CT improves outcomes to recommend its routine use.[11]~~ In a representative study, patients who had negative PET imaging after 2 cycles of therapy had a higher rate of complete remission (83% vs 58%) and greater estimated 2 year overall survival (90% vs 61%, P < .001).[12] A more recent prospective study, however, showed that a positive interim PET scan predicted worse event-free survival (48% vs 74%, P =.004), but was unable to predict differences in 2 year overall survival (88% vs 91%, P < .001).[13]

SCREENING AND SURVEILLANCE

For CLL/SLL, routine use of CT is not indicated. Management changes resulting from CT imaging only occurred in 1% of patients.[8] There is limited data to support routine surveillance imaging in indolent ~~non-Hodgkin lymphoma~~NHL. A retrospective study assessing CT for patients who had achieved complete remission found that only 4% of relapses were detected on surveillance imaging.[14] In a study looking at the use of PET/CT surveillance,

relapse was found in 30% of asymptomatic patients. Sixteen percent of patients had no evidence of relapse by CT imaging. The value of PET for early detection of relapse is still under active investigation.[15]

There is limited data to support routine surveillance imaging in aggressive or highly aggressive ~~non-Hodgkin lymphoma~~NHL. A retrospective study assessing CT in patients who had achieved complete remission found that only 6% of relapses were detected on surveillance imaging.[16] In a prospective trial including patients with indolent, intermediate, and aggressive ~~non-Hodgkin lymphoma~~NHL, PET/CT surveillance detected relapses in 27% of patients.[15] In a recent population-based study, PET/CT only detected 2% of asymptomatic relapse.[17] Cohen et al. found that surveillance imaging did not detect most relapses prior to clinical signs and symptoms, and the imaging findings did not result in improved survival.[18]

References

1. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Acute Lymphoblastic Leukemia (Version 1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2020
2. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Acute Myeloid Leukemia (Version 3.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2020
3. Weiler-Sagie M, Bushelev O, Epelbaum R, et al. (18)F-FDG avidity in lymphoma readdressed: a study of 766 patients. J Nucl Med. 2010;51(1):25-30. PMID: 20009002
~~2~~4. Gomez Leon N, Delgado-Bolton RC, Del Campo Del Val L, et al. Multicenter comparison of contrast-enhanced FDG PET/CT and 64-slice multi-detector-row CT for initial staging and response evaluation at the end of treatment in patients with lymphoma. Clin Nucl Med. 2017;42(8):595-602. PMID: 28604477
~~3~~5. Blum RH, Seymour JF, Wirth A, et al. Frequent impact of [18F]fluorodeoxyglucose positron emission tomography on the staging and management of patients with indolent non-Hodgkin's lymphoma. Clin Lymphoma. 2003;4(1):43-9. PMID: 12837154
~~4~~6. Wohrer S, Jaeger U, Kletter K, et al. 18F-fluoro-deoxy-glucose positron emission tomography (18F-FDG-PET) visualizes follicular lymphoma irrespective of grading. Ann Oncol. 2006;17(5):780-4. PMID: 16497824
~~5~~7. Schaefer NG, Hany TF, Taverna C, et al. Non-Hodgkin lymphoma and Hodgkin disease: coregistered FDG PET and CT at staging and restaging--do we need contrast-enhanced CT? Radiology. 2004;232(3):823-9. PMID: 15273335
~~6~~8. Isasi CR, Lu P, Blaufox MD. A metaanalysis of 18F-2-deoxy-2-fluoro-D-glucose positron emission tomography in the staging and restaging of patients with lymphoma. Cancer. 2005;104(5):1066-74. PMID: 16047335
~~7~~9. Juweid ME. FDG-PET/CT in lymphoma. Methods Mol Biol. 2011;727:1-19. PMID: 21331925
~~8~~10. Eichhorst BF, Fischer K, Fink AM, et al. Limited clinical relevance of imaging techniques in the follow-up of patients with advanced chronic lymphocytic leukemia: results of a meta-analysis. Blood. 2011;117(6):1817-21. PMID: 21139079
~~9~~11. Le Dortz L, De Guibert S, Bayat S, et al. Diagnostic and prognostic impact of 18F-FDG PET/CT in follicular lymphoma. Eur J Nucl Med Mol Imaging. 2010;37(12):2307-14. PMID: 20717826
~~10. Trotman J, Fournier M, Lamy T, et al. Positron emission tomography-computed tomography (PET-CT) after induction therapy is highly predictive of patient outcome in follicular lymphoma: analysis of PET-CT in a subset of PRIMA trial participants. J Clin Oncol. 2011;29(23):3194-200. PMID: 21747087~~
~~11. Huttmann A, Muller S, Jockel KH, et al. Pitfalls of interim positron emission tomography scanning in diffuse large B-cell lymphoma. J Clin Oncol. 2010;28(27):e488-9; author reply e90-1. PMID: 20644097~~
12. Haioun C, Itti E, Rahmouni A, et al. [18F]fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET) in aggressive lymphoma: an early prognostic tool for predicting patient outcome. Blood. 2005;106(4):1376-81. PMID: 15860666
13. Mamot C, Klingbiel D, Hitz F, et al. Final Results of a prospective evaluation of the predictive value of interim positron emission tomography in patients with diffuse large B-cell lymphoma treated with R-CHOP-14 (SAKK 38/07).[Erratum appears in J Clin Oncol. 2015 Sep 20;33(27):3074; PMID: 26381873]. J Clin Oncol. 2015;33(23):2523-9. PMID: 26150440
14. Oh YK, Ha CS, Samuels BI, et al. Stages I-III follicular lymphoma: role of CT of the abdomen and pelvis in follow-up studies. Radiology. 1999;210(2):483-6. PMID: 10207433
15. Zinzani PL, Stefoni V, Tani M, et al. Role of [18F]fluorodeoxyglucose positron emission tomography scan in the follow-up of lymphoma. J Clin Oncol. 2009;27(11):1781-7. PMID: 19273712

16. Guppy AE, Tebbutt NC, Norman A, et al. The role of surveillance CT scans in patients with diffuse large B-cell non-Hodgkin's lymphoma. Leuk Lymphoma. 2003;44(1):123-5. PMID: 12691151

17. El-Galaly TC, Jakobsen LH, Hutchings M, et al. Routine imaging for diffuse large B-cell lymphoma in first complete remission does not improve post-treatment survival: a Danish-Swedish population-based study. J Clin Oncol. 2015;33(34):3993-8. PMID: 26438115

18. Cohen JB, Behera M, Thompson CA, et al. Evaluating surveillance imaging for diffuse large B-cell lymphoma and Hodgkin lymphoma. Blood. 2017;129(5):561-4. PMID: 27956385

Melanoma ~~– Cutaneous~~

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented cutaneous melanoma.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT neck	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated ~~OR for patients not receiving definitive surgical treatment~~	~~As clinically indicated~~ Indicated (note: especially useful for stage IIB or higher)
CT chest	~~As clinically indicated~~ Indicated (note: especially useful for stage III and above)	~~As clinically indicated~~ Indicated ~~OR for patients not receiving definitive surgical treatment~~	~~As clinically indicated~~ Indicated (note: especially useful for stage IIB or higher)
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: especially useful for stage III and above)	~~As clinically indicated~~ Indicated ~~OR for patients not receiving definitive surgical treatment~~	~~As clinically indicated~~ Indicated (note: especially useful for stage IIB or higher)
MRI brain	~~As clinically indicated~~ Indicated OR stage IIIC and above	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated in ANY of the following scenarios: • To determine the extent of involvement in mucosal melanoma or stage III and IV ~~disease~~ cutaneous melanoma, when used in place of CT chest, abdomen, and pelvis • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for metastatic disease • When the primary site is unknown and standard imaging is negative	~~As clinically indicated~~ Indicated in ANY of the following scenarios: • Radiation planning for definitive treatment • Evaluation of objective signs or symptoms of metastatic disease when CT or MRI ~~has not clearly demonstrated recurrence or progression~~ cannot be performed or is nondiagnostic • To assess treatment response in mucosal melanoma or unresectable stage III and IV ~~disease~~ cutaneous melanoma, when used in place of CT chest, abdomen, and pelvis	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Melanoma, which arises from the pigment-producing cells of the epidermis, is the sixth most common cancer in men and women. Incidence increases with age and is higher in Caucasians. Risk factors include excessive sun exposure, family history, and immunosuppression. The most common initial manifestation of melanoma is a darkly pigmented lesion that changes in size, shape, or color.

Mucosal melanoma is an aggressive type of noncutaneous melanoma arising from melanocytes in mucosal cells, and includes uveal or choroidal melanomas of the eye. The most common site is the head and neck. The incidence of mucosal melanoma is higher in females and persons of African descent, and increases with age. Lesions are most often found incidentally on exam, although they can present with local symptoms such as vision loss/changes, epistaxis, loss of smell, bleeding, or ulceration. Unlike other solid cancers, all mucosal melanomas are considered stage III at a minimum. Resectable disease is treated with surgery and neck dissection followed by adjuvant radiation. For advanced stage (IVB/C) disease, treatment may include radiation and/or systemic treatment.

DIAGNOSTIC WORKUP

Cutaneous melanoma

Melanoma is staged using the American Joint Committee on Cancer TNM system. Imaging for patients with stage I/II disease is insensitive and has a high rate of false positive findings. In a study of 344 patients with T1b-T3b melanoma who had preoperative imaging, the false positive rates were 88% for CT chest, 91% for CT abdomen and pelvis, and 60% for PET/CT.[1] Among patients with positive sentinel lymph nodes, routine imaging resulted in 48% of patients having indeterminate findings, of these less than 4% had confirmed systemic metastases. All patients with true positive metastatic disease had thick melanomas and/or lymph node macrometastases.[2] Older studies evaluating the accuracy of CT for detection of metastases in stage III disease have found rates approaching 4%, with false positives ranging from 3%-8%.[3, 4]

The NCCN recommends SLND in patients with Stage IA with adverse features, IB, II, in-transit, and local recurrence and clinically negative lymph node cutaneous melanoma. The use of sentinel lymph node detection has been shown to decrease extent and morbidity of surgery without compromise to outcome.[5-7]

In a systematic review evaluating PET/CT imaging, sensitivity ranged from 68% to 87% and specificity from 92% to 98% for stage III/IV melanomas. These results were similar to another meta-analysis showing an overall sensitivity of 89.4% and specificity of 88.8%. Management changed in 22% of patients when PET imaging was utilized. Comparing across modalities, a meta-analysis of 74 studies showed that the sensitivity, specificity, and odds ratio of CT were 51%, 69%, and 2.29, respectively, for detection of distant metastases compared to PET/CT which were 80%, 87%, and 25.23, respectively.[8]

Mucosal melanoma

Staging studies for tumors arising in the head and neck should include CT/MRI to determine extent of the primary tumor, resectability, and lymph node involvement. Despite the lack of treatment options for patients with uveal melanoma and distant metastatic disease, NCCN favors staging before primary treatment.[14] The most frequent sites of uveal melanoma metastasis are liver, lungs, skin/soft tissue and bones. As such, NCCN recommends at minimum that these patients have contrast MRI or ultrasound of the liver, with modality preference determined by expertise at the treating institution.[14] Bone scintigraphy is generally not required, especially if a FDG-PET/CT is planned. Evidence to support the use of PET is limited, but given the behavior of these tumors, AIM's panel of external experts has recommended in favor of its use.

MANAGEMENT

In most cases, conventional imaging with CT is adequate for assessment of treatment response. If radiation is planned either for definitive therapy or consolidative therapy, PET imaging may be used to assess for metastatic ~~disease. After~~disease. After complete surgical resection, additional imaging should follow guidelines for surveillance.

SCREENING AND SURVEILLANCE

The majority of cutaneous melanoma recurrences are either detected by the patient or on physical examination. Surveillance imaging is of low yield and not indicated for early stage disease. In surveillance imaging for stage III melanoma, studies have found detection rates were widely variable, ranging between 7%-56%.[9-12] The National Comprehensive Cancer Network considers imaging for stage IIB-IV (no evidence of disease) melanoma a level 2B recommendation.[5] Surveillance imaging of asymptomatic patients should not continue beyond 3 to 5 years due to the risk of radiation exposure and based on expected patterns of recurrence.[13] For patients with uveal melanoma who elect surveillance imaging, options include contrast MRI or ultrasound of the liver, with modality preference determined by expertise at the treating institution.[14]

References

1. Yancovitz M, Finelt N, Warycha MA, et al. Role of radiologic imaging at the time of initial diagnosis of stage T1b-T3b melanoma. Cancer. 2007;110(5):1107-14. PMID: 17620286
2. Gold JS, Jaques DP, Busam KJ, et al. Yield and predictors of radiologic studies for identifying distant metastases in melanoma patients with a positive sentinel lymph node biopsy. Ann Surg Oncol. 2007;14(7):2133-40. PMID: 17453294
3. Johnson TM, Fader DJ, Chang AE, et al. Computed tomography in staging of patients with melanoma metastatic to the regional nodes. Ann Surg Oncol. 1997;4(5):396-402. PMID: 9259966

4. Kuvshinoff BW, Kurtz C, Coit DG. Computed tomography in evaluation of patients with stage III melanoma. Ann Surg Oncol. 1997;4(3):252-8. PMID: 9142387

5. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Cutaneous Melanoma (Version ~~1.2019~~3.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

6. Food and Drug Administration (FDA). Lymphoseek (technetium Tc 99m tilmanocept) injection, for subcutaneous, intradermal, subareolar, or peritumoral use, (2016) Available from: https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/202207s005lbl.pdf.

7. Pharmalucence Inc., Kit for the preparation of technetium tc 99m sulfur colloid injection for subcutaneous, intraperitoneal, intravenous, and oral use, (1978) Billerica, MA 01821, Available from: https://dailymed.nlm.nih.gov/dailymed/fda/fdaDrugXsl.cfm?setid=eeaf70fd-46bd-4fec-ba9d-2366fdf07888&type=display.

8. Xing Y, Bronstein Y, Ross MI, et al. Contemporary diagnostic imaging modalities for the staging and surveillance of melanoma patients: a meta-analysis. J Natl Cancer Inst. 2011;103(2):129-42. PMID: 21081714

9. Podlipnik S, Carrera C, Sanchez M, et al. Performance of diagnostic tests in an intensive follow-up protocol for patients with American Joint Committee on Cancer (AJCC) stage IIB, IIC, and III localized primary melanoma: A prospective cohort study. J Am Acad Dermatol. 2016;75(3):516-24. PMID: 27183845

10. Meyers MO, Yeh JJ, Frank J, et al. Method of detection of initial recurrence of stage II/III cutaneous melanoma: analysis of the utility of follow-up staging. Ann Surg Oncol. 2009;16(4):941-7. PMID: 19101766

11. Moore Dalal K, Zhou Q, Panageas KS, et al. Methods of detection of first recurrence in patients with stage I/II primary cutaneous melanoma after sentinel lymph node biopsy. Ann Surg Oncol. 2008;15(8):2206-14. PMID: 18512102

12. Romano E, Scordo M, Dusza SW, et al. Site and timing of first relapse in stage III melanoma patients: implications for follow-up guidelines. J Clin Oncol. 2010;28(18):3042-7. PMID: 20479405

13. Mathews JD, Forsythe AV, Brady Z, et al. Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. BMJ. 2013;346:f2360. PMID: 23694687

14. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Uveal Melanoma (Version 1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2020

Melanoma – Mucosal

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented mucosal melanoma.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT primary site and/or neck	Indicated for mucosal melanoma of the head and neck	As clinically indicated	As clinically indicated (note: especially useful within 6 months of completed treatment for baseline imaging)
CT chest	As clinically indicated	As clinically indicated	As clinically indicated
CT abdomen and pelvis	As clinically indicated	As clinically indicated	As clinically indicated
MRI brain	As clinically indicated (note: should be considered in asymptomatic patients)	As clinically indicated for evaluation of suspected or known brain metastases	Not indicated
MRI primary site and/or neck	Indicated for mucosal melanoma of the head and neck	As clinically indicated	Not indicated
FDG-PET/CT	As clinically indicated	As clinically indicated in ANY of the following scenarios: • Radiation planning for preoperative or definitive treatment • Evaluation of disease following clinical response to treatment, no sooner than 12 weeks after completion of radiation therapy or concurrent chemoradiation therapy • Evaluation of suspected recurrence based on signs or symptoms, when CT or MRI is equivocal or nondiagnostic for recurrent disease	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Mucosal melanoma is an aggressive type of noncutaneous melanoma arising from melanocytes in mucosal cells. The most common site is the head and neck. The incidence of mucosal melanoma is higher in females and persons of African descent, and increases with age. Lesions are most often found incidentally on exam, although they can present

with local symptoms such as epistaxis, loss of smell, bleeding, or ulceration. Unlike other solid cancers, all mucosal melanomas are considered stage III at a minimum. Resectable disease is treated with surgery and neck dissection followed by adjuvant radiation. For advanced stage (IVB/C) disease, treatment may include radiation and/or systemic treatment.

DIAGNOSTIC WORKUP

Mucosal melanoma is staged using the American Joint Committee on Cancer TNM system. Staging studies for tumors arising in the head and neck should include CT or MRI to determine extent of the primary tumor, resectability, and lymph node involvement. Chest and brain imaging should also be considered. Bone scintigraphy is generally not required, especially if a FDG-PET/CT is planned. Evidence to support the use of PET is limited, but given the behavior of these tumors, AIM's panel of external experts has recommended in favor of its use. The NCCN recommends sentinel lymph node detection in patients with Stage IA with adverse features, IB, II, in-transit, and local recurrence and clinically negative lymph node cutaneous melanoma. The use of sentinel lymph node detection has been shown to decrease extent and morbidity of surgery without compromise to outcome.[1]

Mucosal melanomas arising outside of the head and neck region are rare, but recommendations may be extrapolated from those for head and neck tumors and cutaneous melanomas.

MANAGEMENT

In most cases, conventional imaging with CT or MRI is adequate for assessment of treatment response and for subsequent strategy planning. If radiation is planned either for preoperative or definitive therapy, PET may be used for radiation planning. Evaluation of response should be done no sooner than 12 weeks after completion of therapy.

SCREENING AND SURVEILLANCE

The follow-up protocol for mucosal melanoma is based on recommendations for squamous cell carcinoma of the head and neck and cutaneous melanomas. The National Comprehensive Cancer Network (NCCN) Guidelines for Head and Neck Cancer include follow-up imaging of the primary and neck within 6 months of definitive treatment as a category 2B recommendation.[2] The NCCN Guidelines for Cutaneous Melanoma consider surveillance imaging a level 2B recommendation.[1]

References

1. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Head and Neck Cancers (Version 1.2019). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.

2. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Cutaneous Melanoma (Version 2.2019). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.

Merkel Cell Carcinoma

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented Merkel cell carcinoma.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT neck	Indicated (note: may consider omitting if PET imaging done)	Indicated (note: may consider omitting if PET imaging done)	~~As clinically indicated~~ Indicated (note: most useful with high-risk patients)
CT chest	Indicated (note: may consider omitting if PET imaging done)	Indicated (note: may consider omitting if PET imaging done)	~~As clinically indicated~~ Indicated (note: most useful with high-risk patients)
CT abdomen and pelvis	Indicated (note: may consider omitting if PET imaging done)	Indicated (note: may consider omitting if PET imaging done)	~~As clinically indicated~~ Indicated (note: most useful with high-risk patients)
MRI brain	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Merkel cell carcinoma is a very rare and aggressive type of skin cancer arising from cells in the basal layer of the epidermis and hair follicles. Incidence increases with age and is higher in Caucasians; other risk factors include sun exposure, immunosuppression, and Merkel cell polyomavirus.

DIAGNOSTIC WORKUP AND MANAGEMENT

Merkel cell carcinoma is staged using the American Joint Committee on Cancer TNM system. Merkel cell carcinoma is a highly aggressive cancer and up to 8% of patients will present with metastases.[1] Results from a single institution study showed that PET resulted in upstaging in 17% and downstaging in 5% of patients with an overall management change in 37% of patients. A second single institution study also found that PET resulted in upstaging of 16% of patients.[2] A meta-analysis of 6 studies (N = 92 patients) showed PET had a sensitivity of 90% (95% CI, 80%-96%) and specificity of 98%.[3] Asymptomatic brain metastases are fairly rare and routine use of MRI is not recommended.[4]

The NCCN recommends sentinel lymph node detection in patients with clinically lymph node-negative Merkel cell carcinoma. Sentinel lymph node biopsy is an important staging tool. This procedure and subsequent treatment impact for regional control for patients with positive sentinel lymph node, but the impact of sentinel lymph node biopsy on overall survival is unclear. If sentinel lymph node biopsy is not performed concurrently, it is recommended that sentinel lymph node biopsy be performed prior to definitive excision with exhaustive histologic margin assessment (ie, Mohs micrographic surgery).[5]

SCREENING AND SURVEILLANCE

Most recurrences of Merkel cell carcinoma occur within the first 2 years. In high-risk patients, routine surveillance with CT neck, chest, abdomen, and pelvis with contrast can be considered for the first 3 years although there is limited data to support this recommendation.

References

1. Harms KL, Healy MA, Nghiem P, et al. Analysis of prognostic factors from 9387 Merkel cell carcinoma cases forms the basis for the new 8th edition AJCC Staging System. Ann Surg Oncol. 2016;23(11):3564-71. PMID: 27198511

2. Hawryluk EB, O'Regan KN, Sheehy N, et al. Positron emission tomography/computed tomography imaging in Merkel cell carcinoma: a study of 270 scans in 97 patients at the Dana-Farber/Brigham and Women's Cancer Center. J Am Acad Dermatol. 2013;68(4):592-9. PMID: 23127473
3. Treglia G, Kakhki VR, Giovanella L, et al. Diagnostic performance of fluorine-18-fluorodeoxyglucose positron emission tomography in patients with Merkel cell carcinoma: a systematic review and meta-analysis. Am J Clin Dermatol. 2013;14(6):437-47. PMID: 23959776
4. Alexander E, 3rd, Rossitch E, Jr., Small K, et al. Merkel cell carcinoma. Long term survival in a patient with proven brain metastasis and presumed choroid metastasis. Clin Neurol Neurosurg. 1989;91(4):317-20. PMID: 2555091
5. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Merkel Cell Carcinoma (Version ~~2.2019~~1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

Multiple Myeloma

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented solitary plasmacytoma and multiple myeloma.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated for initial staging of myeloma, smoldering myeloma, or solitary plasmacytoma ~~(note: Skeletal survey or whole-body low dose CT scan typically used for initial staging)~~	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ N/A
CT abdomen and pelvis	~~As clinically indicated~~ Indicated for initial staging of myeloma, smoldering myeloma, or solitary plasmacytoma ~~(note: Skeletal survey or whole-body low dose CT scan typically used for initial staging)~~	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ N/A
~~**MRI skeletal**~~ **MRI (bone marrow blood supply)**	~~As clinically indicated~~ Indicated for initial staging of myeloma, smoldering myeloma, or solitary plasmacytoma ~~when no lytic bone lesions are identified on whole body radiography; Skeletal survey or whole-body low dose CT scan typically used for initial staging~~	~~Not indicated~~ Indicated	~~Not indicated~~ N/A
MRI dedicated body part	As clinically indicated for evaluation of focal bone lesions	~~As clinically indicated~~ Indicated for evaluation of focal bone lesions	~~As clinically indicated for evaluation of focal bone lesions~~ N/A
FDG-PET/CT	~~As clinically indicated in EITHER of the following scenarios:~~ ~~•~~ Initial work-up/staging of active myeloma, smoldering myeloma or solitary plasmacytoma ~~when skeletal survey and/or whole body MRI is negative for bone involvement~~ • ~~Differentiate smoldering myeloma from active myeloma when skeletal survey and/or whole body MRI is negative for bone involvement~~	~~As clinically indicated when routine evaluation with laboratory or bone survey suggests recurrence or progression of disease following treatment~~ Indicated for restaging/treatment response of active myeloma, smoldering myeloma, or plasmacytoma	~~Not indicated~~ N/A

Note: A dedicated MRI should be used for characterization of equivocal bone lesions seen on whole body radiography.

Rationale

Multiple myeloma arises from plasma cells in the bone marrow. The disease disseminates widely and often produces antibodies and other proteins that interfere with normal function of bone, kidney, and other organ systems. Incidence increases with age and is higher in males and persons of African descent. The most common presenting symptoms include generalized fatigue, anemia, bone pain, hypercalcemia, and renal dysfunction.

Plasmacytoma is a related tumor which, unlike multiple myeloma, remains localized in bone or soft tissue. Once systemic involvement is excluded (by laboratory testing or bone marrow evaluation), solitary plasmacytoma is typically treated with radiation therapy alone; however, close surveillance is required as these tumors may recur or evolve into multiple myeloma.

DIAGNOSTIC WORKUP

The International Staging System and the Durie-Salmon Staging System are both used in staging. Recent advances in low dose CT technology have improved detection rates of lytic bone lesions with a radiation dose comparable to that of a skeletal survey.[1, 2] In a prospective study comparing whole body low-dose CT (WBCT) and whole body X-ray, WBCT performed markedly better and resulted in a change in management in 18% of patients.[3] In a recent large retrospective study, ~~whole body low-dose~~WB-CT detected 25% more lytic lesions than conventional bone radiography.[4] ~~Currently the National Comprehensive Cancer Network (NCCN) Guidelines for Multiple Myeloma recommend either a skeletal survey or whole body low-dose CT.[5]~~

MRI is the most sensitive modality for detection of bone lesions; when compared head to head, MRI detected lesions in 74% of patients compared to 56% with whole body X-ray. In patients with negative skeletal surveys, MRI detected lesions in 52% of patients, while 20% of patients with a negative MRI were discovered to have focal lesions on skeletal survey.[6] In patients thought to have a solitary plasmacytoma, MRI detected additional disease and led to a change of management in 25% of those studied.[7] In a similar study of indolent myeloma, MRI detected 28% more lesions.[8]

While MRI is superior for detection of bone disease, PET/CT may be more sensitive for extramedullary involvement. The majority of patients with active myeloma will have positive results on PET scan, and PET imaging may detect early bone marrow involvement in patients with solitary plasmacytoma.[9,10] In a prospective study using PET/CT to stage solitary plasmacytoma and multiple myeloma, 14% of patients had a change in management as a result of information gleaned from PET imaging.[9] ~~However, a meta-analysis of 5 studies comparing PET to MRI did not show significant clinical benefit of PET imaging.[10]~~ NCCN recommends either WBCT or FDG PET/CT for initial workup of active myeloma, smoldering myeloma or solitary plasmacytoma (level of evidence category 2A); if negative, whole body MRI with contrast can be considered to discern smoldering from multiple myeloma.[5]

MANAGEMENT

MRI may be able to detect early treatment response based on the pattern of marrow response, but false positive results are common due to persistent nonviable lesions.[11] In one study, the overall accuracy of whole body MRI was 79% with a sensitivity of 64%, specificity of 86%, positive predictive value of 70%, and negative predictive value of 83%. MRI had only moderate agreement with routinely performed laboratory tests for determining remission.[12]

PET imaging, however, does provide early assessment of response as well as prognostic information for lesions smaller than 5 mm.[13] In a head-to-head study comparing MRI and PET/CT for treatment evaluation of multiple myeloma, PET/CT was less accurate but was able to detect treatment responses earlier.[14] In the IMAJEM study, normalization of PET following induction therapy with lenalidomide/bortezomib/dexamethasone (RVD) regimen was associated with improved progression-free survival (30-month progression-free survival, 78.7% vs 56.8%, respectively)[15] whereas normalization of MRI findings was not found to correlate with improved outcome measures. ~~In a study by Zammagni et al., patients post autologous stem cell transplant with FDG-avid disease had a lower 4-year estimated progression-free survival and overall survival when compared to the PET/CT negative cohorts, 47% and 79% (P = .02) versus 32% and 66% (P = .02), respectively.[16]~~ The NCCN panel recommends considering using the same imaging modality used during the initial workup for the follow-up assements.[5]

~~SCREENING AND SURVEILLANCE~~

~~Routine follow-up evaluation includes quantitative immunoglobulins and M protein (serum and urine), complete blood count (CBC), kidney function, calcium levels, and bone survey. MRI and PET/CT are not indicated in the absence of signs or symptoms of progressive disease.~~

AIM guidelines are in accordance with the NCCN Guidelines for Multiple Myeloma.[5]

References

1. Regelink JC, Minnema MC, Terpos E, et al. Comparison of modern and conventional imaging techniques in establishing multiple myeloma-related bone disease: a systematic review. Br J Haematol. 2013;162(1):50-61. PMID: 23617231
2. Pianko MJ, Terpos E, Roodman GD, et al. Whole-body low-dose computed tomography and advanced imaging techniques for multiple myeloma bone disease. Clin Cancer Res. 2014;20(23):5888-97. PMID: 25294899

3. Kropil P, Fenk R, Fritz LB, et al. Comparison of whole-body 64-slice multidetector computed tomography and conventional radiography in staging of multiple myeloma. Eur Radiol. 2008;18(1):51-8. PMID: 17924119

4. Hillengass J, Moulopoulos LA, Delorme S, et al. Whole-body computed tomography versus conventional skeletal survey in patients with multiple myeloma: a study of the International Myeloma Working Group. Blood Cancer J. 2017;7(8):e599. PMID: 28841211

5. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Multiple Myeloma (Version ~~2.2019~~4.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

6. Walker R, Barlogie B, Haessler J, et al. Magnetic resonance imaging in multiple myeloma: diagnostic and clinical implications. J Clin Oncol. 2007;25(9):1121-8. PMID: 17296972

7. Moulopoulos LA, Dimopoulos MA, Weber D, et al. Magnetic resonance imaging in the staging of solitary plasmacytoma of bone. J Clin Oncol. 1993;11(7):1311-5. PMID: 8315427

8. Hillengass J, Fechtner K, Weber MA, et al. Prognostic significance of focal lesions in whole-body magnetic resonance imaging in patients with asymptomatic multiple myeloma. J Clin Oncol. 2010;28(9):1606-10. PMID: 20177023

9. Schirrmeister H, Bommer M, Buck AK, et al. Initial results in the assessment of multiple myeloma using 18F-FDG PET. Eur J Nucl Med Mol Imaging. 2002;29(3):361-6. PMID: 12002711

~~10. van Lammeren-Venema D, Regelink JC, Riphagen, II, et al. 18F-fluoro-deoxyglucose positron emission tomography in assessment of myeloma-related bone disease: a systematic review. Cancer. 2012;118(8):1971-81. PMID: 21887677~~

10. Kato T, Tsukamoto E, Nishioka T, et al. Early detection of bone marrow involvement in extramedullary plasmacytoma by whole-body F-18 FDG positron emission tomography. Clin Nucl Med 2000;25:870-873. PMID: 11079582

11. Hillengass J, Ayyaz S, Kilk K, et al. Changes in magnetic resonance imaging before and after autologous stem cell transplantation correlate with response and survival in multiple myeloma. Haematologica. 2012;97(11):1757-60. PMID: 22689673

12. Bannas P, Hentschel HB, Bley TA, et al. Diagnostic performance of whole-body MRI for the detection of persistent or relapsing disease in multiple myeloma after stem cell transplantation. Eur Radiol. 2012;22(9):2007-12. PMID: 22544292

13. Zamagni E, Nanni C, Mancuso K, et al. PET/CT improves the definition of complete response and allows to detect otherwise unidentifiable skeletal progression in multiple myeloma. Clin Cancer Res. 2015;21(19):4384-90. PMID: 26078390

14. Spinnato P, Bazzocchi A, Brioli A, et al. Contrast enhanced MRI and 18F-FDG PET-CT in the assessment of multiple myeloma: a comparison of results in different phases of the disease. Eur J Radiol. 2012;81(12):4013-8. PMID: 22921683

15. Moreau P, Attal M, Caillot D, et al. Prospective evaluation of magnetic Resonance imaging and 18fluorodeoxyglucose positron emission tomography-computed tomography at diagnosis and before maintenance therapy in symptomatic patients with multiple myeloma included in the IFM/DFCI 2009 trial: results of the IMAJEM study. J Clin Oncol. 2017;35(25):2911-8. PMID: 28686535

~~16. Zamagni E, Patriarca F, Nanni C, et al. Prognostic relevance of 18-F FDG PET/CT in newly diagnosed multiple myeloma patients treated with up-front autologous transplantation.[Erratum appears in Blood. 2012 Sep 13;120(11):2349]. Blood. 2011;118(23):5989-95. PMID: 21900189~~

Neuroendocrine Tumors

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented neuroendocrine cancer.

Well-differentiated neuroendocrine tumor

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest~~, abdomen, and pelvis~~	Indicated	Indicated	~~As clinically indicated~~Indicated
CT abdomen and pelvis	Indicated	Indicated	Indicated
~~MRI brain~~	~~As clinically indicated (note: especially useful for poorly differentiated NET)~~	~~As clinically indicated for evaluation of suspected or known brain metastases~~	~~Not indicated~~
~~FDG-PET/CT~~	~~As clinically indicated when standard imaging studies are equivocal or nondiagnostic for metastatic disease (note: especially useful for poorly differentiated NET)~~	~~As clinically indicated (note: especially useful for poorly differentiated NET)~~	~~Not indicated~~
MRI abdomen	Indicated	Indicated	Indicated
MRI pelvis	Indicated	Indicated	Indicated
~~68Ga dotatate PET/CT~~ Somatostatin receptor-based imaging	~~As clinically indicated~~Indicated in EITHER of the following scenarios: • Biopsy-proven well-differentiated neuroendocrine tumor • Suspected well-differentiated neuroendocrine tumor based on endoscopy, conventional imaging[1], or biochemical markers[2] not amenable to biopsy	~~As clinically indicated~~Indicated in EITHER of the following scenarios: • Prior to planned peptide receptor radioligand therapy (PRRT) for well-differentiated neuroendocrine tumor • When identification of more extensive disease will change management and ANY of the following criteria are met: ○ Equivocal findings of disease progression on conventional imaging ○ Clinical or biochemical progression with negative conventional imaging ○ When the original disease was only detectable by ~~68Ga dotatate~~ somatostatin receptor-based imaging.	Not indicated

~~*Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).*~~

1 Conventional imaging includes MRI or contrast-enhanced CT.

2 Biochemical evidence for suspected neuroendocrine cancers may include elevated levels of chromogranin A, pancreatic polypeptide, neuron-specific enolase, vasoactive intestinal polypeptide, serotonin (urinary 5-HIAA), gastrin, somatostatin, catecholamines, metanephrines, calcitonin, fasting insulin, C-peptide (proinsulin), or glucagon.

Poorly-differentiated neuroendocrine tumor

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	Indicated	Indicated	Indicated
CT abdomen and pelvis	Indicated	Indicated	Indicated
MRI abdomen	Indicated	Indicated	Indicated
MRI pelvis	Indicated	Indicated	Indicated
FDG-PET/CT	Indicated when standard imaging cannot be performed or is nondiagnostic for metastatic disease	Indicated	Not indicated

Rationale

Neuroendocrine cancers are a rare type of cancer in which tumors arise from neuroendocrine cells, but may also occur anywhere in the body. The most common neuroendocrine tumors are carcinoid tumors, the majority of which occur in the gastrointestinal tract. Well-differentiated neuroendocrine tumors are known to have a hereditary component. Poorly differentiated tumors are classically nonsecretory and tend to cause symptoms related to local tumor growth or metastatic disease, whereas secretory tumors such as carcinoid most often present with symptoms such as diarrhea, flushing, and wheezing due to excessive production of hormones.

DIAGNOSTIC WORKUP

Neuroendocrine cancer is staged using the American Joint Committee on Cancer TNM system. As an adjunct to TNM staging, the World Health Organization classification scheme also takes into account proliferation rate (Ki-67) in grading of tumors. ~~Carcinoid~~ Neuroendocrine tumors of the GI tract, lung and thymus ~~is a highly~~are highly vascular tumors and multiphasic imaging (abdominal ± pelvic multiphasic CT or MRI per NCCN) should be used to improve detection.[1,3] MRI is more sensitive than CT for detection of liver metastases; however, one study found no statistically significant difference between the 2 modalities for this indication.[2] Smaller lesions, especially in the small bowel and appendix, may be difficult to visualize with either modality. ~~Somatostatin receptor-based imaging should also be considered in well-differentiated neuroendocrine tumors. MRI brain with contrast is indicated for poorly differentiated tumors arising from the thorax.~~

~~The National Comprehensive Cancer Network does not recommend MIBG scintigraphy as routine imaging in patients with pheochromocytoma and paraganglioma. However, in patients with high risk disease or suspected metastases, the addition of MIBG, especially with its higher specificity, may provide additional information which could affect definitive therapy. CT and MRI have a 98%-100% sensitivity for detection of pheochromocytoma. However, the specificity only approaches 70%. In a 2010 meta-analysis of 22 studies, the sensitivity and specificity of MIBG were reported to be 94% (95% CI, 91%-97%) and 92% (95% CI, 87%-98%). Individual prospective and retrospective studies also appear to support the continued role of MIBG scintigraphy.[3]~~

Somatostatin receptor imaging is recommended by multiple professional societies including ACR, NCCN, and ENTS as a part of initial staging of well-differentiated neuroendocrine tumors when indicated. 68Ga dotatate PET is generally preferred. In the FDA review, OctreoScan when compared to conventional imaging was consistent with the final diagnosis in 267 of 309 evaluable patients (86.4%). In patients with nonfunctioning NET, Octreoscan success detected NET in 27 of 32 patients (84.4%). Octreoscan localized previously unidentified tumors in 57/204 patients. In a small subgroup of 39 patients who had tissue confirmation, the sensitivity rate for Octreoscan scintigraphy was 85.7%; for CT/MRI the rate was 68%. The specificity rate for Octreoscan scintigraphy was 50%, the rate for CT/MRI was 12%. In a 2018 systematic review of 15 studies with 679 patients evaluating the diagnostic accuracy of SSTR-PET with OctreoScan, 18FDG PET or CT/MRI, Hope et al. reported that SSTR-PET was associated with greater sensitivity than OctreoScan (difference in sensitivity ranged from 14% to 56%) as well as CT and/or MRI (differences in sensitivity ranged from 12% to 49%).

Multiple prospective trials confirm the overall superiority of 68Ga dotatate PET to somatostatin receptor scintigraphy. Several ~~p~~other systematic reviews, a meta-analysis, and prospective studies of variable quality have

consistently shown that 68Ga dotatate has a moderate-to-high diagnostic accuracy for the staging of de novo, recurrent, or suspected neuroendocrine cancer with a moderate-to-high positive likelihood ratio in the range of 5-13 and a high negative likelihood ratio in the range of 0.04-0.21 to exclude neuroendocrine cancer. ~~In addition, comparative studies with 111In pentetreotide SPECT/CT and conventional imaging confirms its superior diagnostic accuracy and sensitivity in this setting, although these studies have several methodological limitations.~~[4, 5]

FDG-PET for staging of poorly differentiated neuroendocrine cancer remains controversial. In a limited number of small studies, FDG-PET appears to be useful in detecting poorly differentiated neuroendocrine tumors and well-differentiated neuroendocrine tumors with high Ki-67.[6-8]

MANAGEMENT

Imaging to assess disease response to therapy should be performed with the same modality used to detect the initial abnormality and the same modality should be used over time. For most cases, CT chest~~,~~ and abdominal ± pelvic multiphasic CT or MRI ~~abdomen, and pelvis with or without contrast~~ is sufficient. Limited evidence supports the use of 68Ga dotatate for monitoring disease during treatment.

~~MIBG scintigraphy is indicated prior to 131I iobenguane treatment. In an open-label, single-arm, multicenter phase II clinical trial (Study IB12B [NCT00874614]) that prompted the approval of 131I iobenguane (Azedra), patients were required have positive MIBG scintigraphy prior to therapeutic treatment.~~

Somatostatin analog receptor imaging is vital prior to PRRT. Based on the increased sensitivity for detection of somatostatin receptors and expected change in management, 68Ga dotatate also appears to play a role prior to therapy. 68Ga dotatate changed management in 13%-60% of patients, with a wide variation depending on the clinical scenario in which the radiotracer is used. No study has compared the utility of SSTR-PET with alternative imaging modalities for predicting response to PRRT or somatostatin analog therapy.[4]

SCREENING AND SURVEILLANCE

Poorly differentiated tumors have a higher risk of recurrent disease after definitive treatment; therefore, routine surveillance imaging may include CT chest, abdomen, and pelvis. Limited evidence supports the use of 68Ga dotatate for monitoring disease after completion of treatment.

References

1. Paulson EK, McDermott VG, Keogan MT, et al. Carcinoid metastases to the liver: role of triple-phase helical CT. Radiology. 1998;206(1):143-50. PMID: 9423664
2. Dromain C, de Baere T, Lumbroso J, et al. Detection of liver metastases from endocrine tumors: a prospective comparison of somatostatin receptor scintigraphy, computed tomography, and magnetic resonance imaging. J Clin Oncol. 2005;23(1):70-8. PMID: 15625361
3. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Neuroendocrine and Adrenal Tumors (Version 1.2019). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2019.
4. Food and Drug Administration (FDA). NETSPOT (kit for the preparation of gallium Ga 68 dotatate injection), for intravenous use, (2016) Available from: https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/208547s000lbl.pdf.
5. Curium US LLC, Octreoscan™ kit for the preparation of indium In 111 pentetreotide, (2018) Maryland Heights, MO 63043, Available from: https://dailymed.nlm.nih.gov/dailymed/fda/fdaDrugXsl.cfm?setid=93d8f3b2-1216-41dc-a63d-0e812b33891d&type=display.
6. Abgral R, Leboulleux S, Deandreis D, et al. Performance of (18)fluorodeoxyglucose-positron emission tomography and somatostatin receptor scintigraphy for high Ki67 (>=10%) well-differentiated endocrine carcinoma staging. J Clin Endocrinol Metab. 2011;96(3):665-71. PMID: 21193541
7. Adams S, Baum R, Rink T, et al. Limited value of fluorine-18 fluorodeoxyglucose positron emission tomography for the imaging of neuroendocrine tumours. Eur J Nucl Med. 1998;25(1):79-83. PMID: 9396878
8. ~~8.~~ Pasquali C, Rubello D, Sperti C, et al. Neuroendocrine tumor imaging: can 18F-fluorodeoxyglucose positron emission tomography detect tumors with poor prognosis and aggressive behavior? World J Surg. 1998;22(6):588-92. PMID: 9597933

Ovarian Cancer ~~(Epithelial) –~~ All Variants

Advanced imaging is considered medically necessary for the diagnostic workup and management of documented ovarian cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated	~~Not indicated~~ Indicated when tumor markers or exam are considered unreliable and/or there is a high risk of recurrence.
CT abdomen and pelvis	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated	~~Not indicated~~ Indicated when tumor markers or exam are considered unreliable and/or there is a high risk of recurrence.
MRI abdomen and pelvis	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated	~~Not indicated~~ Indicated when tumor markers or exam are considered unreliable and/or there is a high risk of recurrence.
FDG-PET/CT	~~As clinically indicated~~ Indicated to direct management ~~for evaluation~~ of indeterminate lesions detected by other imaging modalities	~~As clinically indicated~~ Indicated for clinical suspicion ~~for evaluation of objective evidence~~ of recurrent disease (such as rising tumor markers or increasing ascites) when CT or MRI ~~does not clearly demonstrate recurrence or progression~~ cannot be performed or is nondiagnostic	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Ovarian cancer is the ~~fourth~~ fifth most common cause of cancer-related death in women in the U.S. Ovarian tumors may arise from epithelial cells, germ cells, and sex cord-gonadal stroma. Epithelial ovarian cancers make up over 95% of ovarian cancers and are further classified as serous, mucinous, endometrioid, or clear cell carcinoma. Incidence increases with age; other risk factors include ~~infertility, endometriosis, polycystic ovarian syndrome,~~ cigarette smoking, and BRCA gene mutations. Ovarian cancer most commonly presents with pain, bloating, or gastrointestinal symptoms, while more acute presentations from disseminated disease may include bowel obstruction, pulmonary complaints from pleural effusions, or venous thromboembolic disease.

DIAGNOSTIC WORKUP

Ovarian cancer is most commonly staged using the FIGO system, although the American Joint Committee on Cancer TNM system may also be utilized. Until more conclusive data is available, CT abdomen and pelvis with contrast remains the preferred imaging modality for staging. CT abdomen and pelvis has a reported accuracy of 77%. The positive predictive value for cancer nonresectability was 100% and the negative predictive value was 92%. Results of CT are comparable to MRI in terms of accuracy, positive predictive value, and negative predictive value: 78%, 91%, and 99%. In one study, no difference was seen between MRI and CT in detection of abdominal disease.[1] In a second prospective study comparing ultrasound, CT, and MRI, CT and MRI were again found to be equivalent in detecting stage III/IV disease.[2] In a smaller study, MRI outperformed CT for detection of small tumors in extrahepatic sites and was particularly advantageous for evaluating the peritoneum, mesentery, and bowel.[3]

FDG-PET/CT or MRI may be useful for indeterminate lesions if results will alter management.[16] The use of PET for initial staging is not universally supported; sensitivity and specificity have been reported at 86% and 54%, respectively. False negatives can be seen with borderline tumors, early carcinomas, and adenocarcinomas and false positives occur in some benign conditions.[4] ~~Other studies have shown sensitivity and specificity of PET/CT as high as 100% and 85%, respectively.[5]~~ A small prospective trial (N = 50) found PET/CT had a 69% correlation with final pathologic staging while the correlation for CT was 53%. CT imaging missed 11% of patients with distant metastasis in the liver, pleura, mediastinum, and in left supraclavicular lymph nodes.[6,5] In a review of 18 studies, PET was superior to both CT and MRI at detecting involved lymph nodes. PET had a sensitivity of 73.2% and specificity of 96.7%.[7,6] ~~Conversely, a small prospective trial showed that PET/CT was not superior to CT for the detection of intra-abdominal disease spread, though it was more effective for the detection of extra-abdominal disease.[8]~~

MANAGEMENT

If treated with neoadjuvant therapy, reassessment should be performed using the same imaging modality that was used in the original assessment (CT, MRI, PET/CT or PET as clinically indicated without modality preference per NCCN, level of evidence category 2A).[16] ~~CT chest, abdomen, and pelvis are preferred.~~ However, in ~~In~~ patients with suspected recurrence, PET may be more accurate at detecting recurrence than CT; in one prospective, multicenter cohort study, PET/CT detected additional sites of disease in 68% of patients compared to conventional imaging and led to a change in management in 60%.[9,7] A second study in patients with suspected recurrence showed that PET detected recurrence in 66% of patients while CT only detected 50%. The sensitivities of CT and PET/CT for diagnosing recurrence were 81% and 97%, respectively, and the specificity was 90% for both modalities.[10,8] These findings have been validated in 2 large meta-analyses.[11, 12,9,10]

SCREENING AND SURVEILLANCE

Based on a review of the Surveillance Epidemiology & End Results database, up to 95% of recurrences are detected by ~~physician~~ physical exam or rising cancer antigen (CA) 125.[13,11] Studies using radiographic surveillance for ovarian cancer have reported the sensitivity and specificity of CT 40%-93% and 50%-98%, respectively.[14,12] In a retrospective Italian study, recurrence in asymptomatic patients was detected by physician exam in 14.8%, by serum CA 125 in 23%, and by imaging in 27.2%. No difference was seen in survival with symptomatic or asymptomatic presentation at time or relapse.[15,13] In a post-hoc analysis of the AURELIA trial (Avastin [Bevacizumab] Use in Platinum-Resistant Epithelial Ovarian Cancer), progression-free survival was improved with earlier recurrence detection, but no difference in overall survival was demonstrated.[16,14] Additionally, Rustin et al. reported in a randomized trial that there was no evidence of a survival benefit with early treatment of relapse on the basis of a raised CA 125 concentration alone.[17,15] ~~Limited data is available for MRI and PET/CT in surveillance of asymptomatic patients.[14]~~ While t~~T~~he Society of Gynecologic Oncology and the NCCN ~~National Comprehensive Cancer Network Guidelines for Ovarian Cancer Including Fallopian Tube and Primary Peritoneal Cancer~~ do not recommend routine use of surveillance imaging, it may be indicated when tumor markers are considered unreliable, the physical exam is unreliable, and/or there is a high risk of recurrence.[14,18,12,16]

References

1. Forstner R, Hricak H, Occhipinti KA, et al. Ovarian cancer: staging with CT and MR imaging. Radiology. 1995;197(3):619-26. PMID: 7480729
2. Tempany CM, Zou KH, Silverman SG, et al. Staging of advanced ovarian cancer: comparison of imaging modalities--report from the Radiological Diagnostic Oncology Group. Radiology. 2000;215(3):761-7. PMID: 10831697
3. Low RN, Semelka RC, Worawattanakul S, et al. Extrahepatic abdominal imaging in patients with malignancy: comparison of MR imaging and helical CT, with subsequent surgical correlation. Radiology. 1999;210(3):625-32. PMID: 10207459
4. Mitchell DG, Javitt MC, Glanc P, et al. ACR Appropriateness Criteria® staging and follow-up of ovarian cancer. J Am Coll Radiol. 2013;10(11):822-7. PMID: 24183551
5. ~~Yamamoto Y, Oguri H, Yamada R, et al. Preoperative evaluation of pelvic masses with combined 18F-fluorodeoxyglucose positron emission tomography and computed tomography. Int J Gynaecol Obstet. 2008;102(2):124-7. PMID: 18423470~~
6. ~~6~~5. Castellucci P, Perrone AM, Picchio M, et al. Diagnostic accuracy of 18F-FDG PET/CT in characterizing ovarian lesions and staging ovarian cancer: correlation with transvaginal ultrasonography, computed tomography, and histology. Nucl Med Commun. 2007;28(8):589-95. PMID: 17625380
7. ~~7~~6. Yuan Y, Gu ZX, Tao XF, et al. Computer tomography, magnetic resonance imaging, and positron emission tomography or positron emission tomography/computer tomography for detection of metastatic lymph nodes in patients with ovarian cancer: a meta-analysis. Eur J Radiol. 2012;81(5):1002-6. PMID: 21349672
8. ~~Hynninen J, Kemppainen J, Lavonius M, et al. A prospective comparison of integrated FDG-PET/contrast-enhanced CT and contrast-enhanced CT for pretreatment imaging of advanced epithelial ovarian cancer. Gynecol Oncol. 2013;131(2):389-94. PMID: 23994535~~

~~9~~7. Fulham MJ, Carter J, Baldey A, et al. The impact of PET-CT in suspected recurrent ovarian cancer: a prospective multi-centre study as part of the Australian PET Data Collection Project. Gynecol Oncol. 2009;112(3):462-8. PMID: 19150121

~~10~~8. Risum S, Hogdall C, Markova E, et al. Influence of 2-(18F) fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography on recurrent ovarian cancer diagnosis and on selection of patients for secondary cytoreductive surgery. Int J Gynecol Cancer. 2009;19(4):600-4. PMID: 19509556

~~11~~9. Limei Z, Yong C, Yan X, et al. Accuracy of positron emission tomography/computed tomography in the diagnosis and restaging for recurrent ovarian cancer: a meta-analysis. Int J Gynecol Cancer. 2013;23(4):598-607. PMID: 23502451

~~12~~10. Xu B, Ma J, Jiang G, et al. Diagnostic value of positron emission tomography (PET) and PET/computed tomography in recurrent/metastatic ovarian cancer: a meta-analysis. J Obstet Gynaecol Res. 2017;43(2):378-86. PMID: 28150407

~~13~~11. Armstrong A, Otvos B, Singh S, et al. Evaluation of the cost of CA-125 measurement, physical exam, and imaging in the diagnosis of recurrent ovarian cancer. Gynecol Oncol. 2013;131(3):503-7. PMID: 24060416

~~14~~12. Salani R, Khanna N, Frimer M, et al. An update on post-treatment surveillance and diagnosis of recurrence in women with gynecologic malignancies: Society of Gynecologic Oncology (SGO) recommendations. Gynecol Oncol. 2017;146(1):3-10. PMID: 28372871

~~15~~13. Gadducci A, Fuso L, Cosio S, et al. Are surveillance procedures of clinical benefit for patients treated for ovarian cancer?: a retrospective Italian multicentric study. Int J Gynecol Cancer. 2009;19(3):367-74. PMID: 19407561

~~16~~14. Lindemann K, Kristensen G, Mirza MR, et al. Poor concordance between CA-125 and RECIST at the time of disease progression in patients with platinum-resistant ovarian cancer: analysis of the AURELIA trial. Ann Oncol. 2016;27(8):1505-10. PMID: 27407100

~~17~~15. Rustin GJ, van der Burg ME, Griffin CL, et al. Early versus delayed treatment of relapsed ovarian cancer (MRC OV05/EORTC 55955): a randomised trial. Lancet. 2010;376(9747):1155-63. PMID: 20888993

~~18~~16. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Ovarian Cancer Including Fallopian Tube Cancer and Primary Peritoneal Cancer (Version ~~1.2019~~1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

Pancreatic Cancer

The following criteria address all cancers originating in the pancreas other than neuroendocrine tumors.

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented pancreatic cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated (note: usually CT abdomen pancreatic protocol is needed)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: usually CT abdomen pancreatic protocol is needed)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
MRI abdomen	Indicated in ANY of the following scenarios: • CT contraindicated or expected to be suboptimal • Characterization of CT-indeterminate liver lesions • Need to further establish resectability in borderline resectable patients, when CT imaging provides insufficient information	Not indicated	Not indicated

FDG-PET/CT	~~As clinically indicated~~ Indicated when ALL of the following are true:
	• Dedicated, high-quality imaging of the pancreas has been performed
	• Extra-pancreatic disease has not been clearly identified
	• ANY of the following high-risk features are present:
	  ○ Cancer antigen 19-9 level greater than 100 U/ml
	  ○ Primary tumor greater than 2 cm in size
	  ○ Enlarged regional nodes
	  ○ Tumor is considered borderline resectable
		~~As clinically indicated~~ Indicated in EITHER of the following scenarios:
		• Radiation planning for preoperative or definitive treatment in patients without distant metastasis
		• Standard imaging ~~is equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease
			Not indicated

Note: Imaging of the pancreas should include a dedicated pancreatic protocol CT (multi-detector computed tomography angiography using a dual-phase pancreatic protocol, with images obtained in the pancreatic and portal venous phase of contrast enhancement) or MRI if CT is contraindicated. MRI may also be used to clarify CT-indeterminate liver lesions or suspected pancreatic tumors not visible on CT.

Rationale

Pancreatic cancer is the fourth leading cause of cancer mortality in the U.S. The most common type of pancreatic cancer is adenocarcinoma, which accounts for 85% of pancreatic cancers. Diagnosis is rare prior to the age of 45 and the rate is slightly higher in females. Risk factors include genetic predisposition, smoking, and obesity. Presentation is variable and may include pain, jaundice, and cancer anorexia/cachexia syndrome.

DIAGNOSTIC WORKUP

Pancreatic cancer is staged using the American Joint Committee on Cancer TNM system. The Society of Abdominal Radiology and the American Pancreatic Association recommend a dedicated pancreatic CT, performed

with multidetector CT angiography using a dual-phase pancreatic protocol.[1] CT using this protocol has demonstrated sensitivity of 89%-97% for diagnosis and a positive predictive value for assessing resectability of 89%-100%. Although a high-quality CT abdomen may suffice in some circumstances, comparison studies have found that scans performed with pancreatic protocol have changed staging and management in up to 56% of cases.[2]

MRI is most commonly used as a problem-solving tool, particularly for CT-indeterminate liver lesions, when CT-occult pancreatic tumors are suspected or when contrast enhanced CT cannot be done.[1] Accuracy of MRI abdomen is similar to that for CT with pancreatic protocol. In a 2016 meta-analysis reviewing different imaging modalities, the pooled sensitivity was 89% and the specificities were 90% and 89% for MRI and CT, respectively.[3]

PET/CT has been studied as an adjunctive staging modality. The sensitivity of detecting metastatic disease for PET/CT alone, standard CT alone, and the combination of PET/CT and CT were 61%, 57%, and 87%, respectively. PET/CT influenced the clinical management in 11% of cases.[4] Treadwell et al. reported no statistically significant difference in sensitivity or specificity in a pooled analysis of six studies comparing PET scan to CT scan for initial treatment staging.[3] A 2017 meta-analysis of 16 articles concluded that high pretreatment PET standardized uptake values predicted poorer event-free survival and overall survival.[5]

MANAGEMENT

There is limited data comparing imaging modalities for post-treatment assessment. One study found that multidetector CT underestimates resectability, but no additional studies exist assessing accuracy for evaluation of lymph node and systemic metastases. Limited information is available for MRI or PET/CT in this setting.[6] In a pooled analysis of the phase III MPACT (Molecular Profiling-based targeted therapy in treating patients with Advanced solid Tumors) trial, response by PET after chemotherapy was associated with improved survival regardless of regimen used (11.3 vs 6.9 months; HR 0.56; P < .001).[7]

SCREENING AND SURVEILLANCE

A study using the Surveillance, Epidemiology, and End Results (SEER)-Medicare database showed no survival benefit to annual CT surveillance.[8] ~~National Comprehensive Cancer Network Guidelines for Pancreatic Adenocarcinoma categorize~~ Thus, surveillance CT ~~abdomen~~ scans (chest, abdomen, pelvis) with contrast after surgical resection is a category ~~as level~~ 2B ~~based on consensus~~recommendation from the NCCN.[9]

References

1. Al-Hawary MM, Francis IR, Chari ST, et al. Pancreatic ductal adenocarcinoma radiology reporting template: consensus statement of the society of abdominal radiology and the american pancreatic association. Gastroenterology. 2014;146(1):291-304.e1. PMID: 24355035
2. Walters DM, Lapar DJ, de Lange EE, et al. Pancreas-protocol imaging at a high-volume center leads to improved preoperative staging of pancreatic ductal adenocarcinoma. Ann Surg Oncol. 2011;18(10):2764-71. PMID: 21484522
3. Treadwell JR, Zafar HM, Mitchell MD, et al. Imaging tests for the diagnosis and staging of pancreatic adenocarcinoma: a meta-analysis. Pancreas. 2016;45(6):789-95. PMID: 26745859
4. Farma JM, Santillan AA, Melis M, et al. PET/CT fusion scan enhances CT staging in patients with pancreatic neoplasms. Ann Surg Oncol. 2008;15(9):2465-71. PMID: 18551347
5. Zhu D, Wang L, Zhang H, et al. Prognostic value of 18F-FDG-PET/CT parameters in patients with pancreatic carcinoma: a systematic review and meta-analysis. Medicine (Baltimore). 2017;96(33):e7813. PMID: 28816978
6. Qayyum A, Tamm EP, Kamel IR, et al. ACR Appropriateness Criteria® staging of pancreatic ductal adenocarcinoma. J Am Coll Radiol. 2017;14(11S):S560-S9. PMID: 29101993
7. Ramanathan RK, Goldstein D, Korn RL, et al. Positron emission tomography response evaluation from a randomized phase III trial of weekly nab-paclitaxel plus gemcitabine versus gemcitabine alone for patients with metastatic adenocarcinoma of the pancreas. Ann Oncol. 2016;27(4):648-53. PMID: 26802153
8. Witkowski ER, Smith JK, Ragulin-Coyne E, et al. Is it worth looking? abdominal imaging after pancreatic cancer resection: a national study. J Gastrointest Surg. 2012;16(1):121-8. PMID: 21972054
9. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Pancreatic Adenocarcinoma (Version ~~2.2019~~1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.

Paraneoplastic Syndrome

Advanced imaging is considered medically necessary for the diagnostic workup of paraneoplastic disease. Periodic surveillance of paraneoplastic disease is indicated when initial evaluation has not detected a primary tumor.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT neck	~~As clinically indicated~~ Indicated	Further management based on primary cancer identified	~~As clinically indicated~~ Indicated
CT chest	~~As clinically indicated~~ Indicated	Further management based on primary cancer identified	~~As clinically indicated~~ Indicated
CT abdomen and pelvis	~~As clinically indicated~~ Indicated	Further management based on primary cancer identified	~~As clinically indicated~~ Indicated
MRI brain	~~As clinically indicated~~ Indicated	Further management based on primary cancer identified	Not indicated
FDG-PET/CT	Indicated for initial evaluation of individuals with paraneoplastic syndrome	Further management based on primary cancer identified	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Paraneoplastic disease is a rare manifestation of cancer that is not related directly to tumor involvement, metastases, or metabolic derangements. Autoantibodies have been identified as a cause in up to 60% of the recognized syndromes attributed to paraneoplastic disease.[1] In many cases, symptoms occur prior to discovery of the primary tumor. The most common presentations are neurologic (central or peripheral), but paraneoplastic disease also manifests in muscle and other soft tissue. The most common malignancies associated with paraneoplastic disease are small cell lung cancer, thymoma, and hematologic cancers.[2]

DIAGNOSTIC WORKUP

PET/CT has been found to be more accurate than CT in the detection of occult malignancy associated with paraneoplastic syndrome. In a retrospective study, PET outperformed CT by 50%. The sensitivity and specificity of PET compared to CT were 80% and 67%, vs 30% and 71%, respectively.[3] Another retrospective study from the same institution found that PET/CT detected an additional 18% of cancers in patients with CT-negative paraneoplastic disease.[4] In a review and meta-analysis of 21 studies, PET imaging demonstrated high diagnostic accuracy and moderate to high sensitivity (81%) and specificity (86%) for detection of underlying malignancy in suspected paraneoplastic syndrome.[5]

SCREENING AND SURVEILLANCE

The benefit of advanced imaging for surveillance of paraneoplastic syndrome without an identified malignancy has not been demonstrated. The European Federation of Neurological Sciences endorses continued surveillance with repeat screening every 6 months for up to 4 years.[6]

References

1. Kannoth S. Paraneoplastic neurologic syndrome: a practical approach. Ann Indian Acad Neurol. 2012;15(1):6-12. PMID: 22412264
2. Titulaer MJ, Soffietti R, Dalmau J, et al. Screening for tumours in paraneoplastic syndromes: report of an EFNS task force. Eur J Neurol. 2011;18(1):19-e3. PMID: 20880069
3. Patel RR, Subramaniam RM, Mandrekar JN, et al. Occult malignancy in patients with suspected paraneoplastic neurologic syndromes: value of positron emission tomography in diagnosis. Mayo Clin Proc. 2008;83(8):917-22. PMID: 18674476
4. McKeon A, Apiwattanakul M, Lachance DH, et al. Positron emission tomography-computed tomography in paraneoplastic neurologic disorders: systematic analysis and review. Arch Neurol. 2010;67(3):322-9. PMID: 20065123

5. Sheikhbahaei S, Marcus CV, Fragomeni RS, et al. Whole-body 18F-FDG PET and 18F-FDG PET/CT in patients with suspected paraneoplastic syndrome: a systematic review and meta-analysis of diagnostic accuracy. J Nucl Med. 2017;58(7):1031-6. PMID: 27980049
6. Sheikhbahaei S, Trahan TJ, Xiao J, et al. FDG-PET/CT and MRI for evaluation of pathologic response to neoadjuvant chemotherapy in patients with breast cancer: a meta-analysis of diagnostic accuracy studies. Oncologist. 2016;21(8):931-9. PMID: 27401897

Penile, Vaginal, and Vulvar Cancers

Note: The following information primarily addresses squamous cell carcinomas of the vagina, vulva, and penis; however, applicability and coverage include all cancers originating in the vagina, vulva, and penis unless expressly addressed elsewhere in Oncologic Imaging. Specific imaging considerations are addressed below.

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented vaginal, vulvar, or penile cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated (note: for penile cancer especially useful with T1b or higher or palpable inguinal LN; for vulvar cancer especially useful with T2 or higher. Chest imaging can be performed either with CT or radiograph.)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated for penile cancer
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: for penile cancer especially useful with T1b or higher or palpable inguinal LN; for vulvar cancer especially useful with T2 or higher)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated for penile cancer
MRI pelvis	~~As clinically indicated~~ Indicated for vaginal or vulvar cancer	~~As clinically indicated~~ Indicated for vaginal or vulvar cancer	Not indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated in EITHER of the following scenarios: • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for metastatic disease • Staging of penile cancer when pelvic lymph nodes are enlarged on CT or MRI and needle biopsy is not technically feasible	~~As clinically indicated~~ Indicated in ANY of the following scenarios: • Radiation planning for preoperative or definitive treatment only • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease • Restaging of local recurrence when pelvic exenteration surgery is planned	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Vaginal, vulvar, and penile cancers are relatively uncommon, accounting for less than 1% of all cancers in the U.S.[1] The most common histologic subtype is squamous cell carcinoma, although adenocarcinoma is also seen in the vagina. Risk factors for developing genital cancers are human papillomavirus infection, human immunodeficiency virus infection, smoking, and exposure to diethylstilbestrol. The most common presentation is local symptoms such as bleeding, irritation, discharge, or skin changes.

DIAGNOSTIC WORKUP

Vaginal, vulvar, and penile cancers are staged using the American Joint Committee on Cancer TNM system.

In a retrospective study, MRI performed prior to surgery for vulvar cancer had a local staging accuracy of 83% and an overall staging accuracy of 69.4%, which increased to 75%-85% when combined with CT.[2] Comparable findings regarding the utility of MRI for the diagnosis, local staging, and spread of disease of vaginal cancer have been reported in 2 small studies.[3, 4] There is a lack of high-quality prospective studies evaluating PET/CT for staging vaginal and vulvar cancer. Cohn et al. found that PET/CT had sensitivity of 80%, specificity of 90%, and negative predictive value of 80% in identifying lymph node metastases; thus, PET/CT does not obviate the need for surgical staging.[5] In the largest study (N = 50) comparing PET and conventional imaging data for vulvar and vaginal cancer, FDG PET/CT detected nodes suspicious for metastases in 35% of patients, as compared to MRI and CT, 13% and 7%, respectively. Distant metastases were seen in an additional 4% when compared to conventional CT, and overall resultant change in management occurred in 36% of cases.[6] In a small prospective study (N = 23) of patients with vaginal cancer, PET detected lymph node involvement in 35% of patients compared to 17% for CT alone.[7]

The NCCN recommends sentinel lymph node detection in patients with T1 or T2 and clinically lymph node-negative vulvar cancer. The use of sentinel lymph node detection has been shown to decrease extent and morbidity of surgery without compromise to outcome. Patients with higher stage disease may require full lymph node dissections.[8]

For penile cancer, imaging is not indicated for low-risk disease (Tis,Ta, T1a). Distant metastatic disease is rare and occurs in less than 4% of cases without bulky disease.[7, 9] For intermediate to high risk (T1b, T2 or greater) and/or palpable inguinal lymph nodes, chest imaging should be performed in addition to CT abdomen and pelvis with contrast. Preoperative CT has a reported sensitivity of 95% and a specificity of 82%. In a study of 10 patients, MRI with lymphotropic nanoparticles had a sensitivity, specificity, positive predictive value, and negative predictive value of 100%, 97%, 81%, and 100%, respectively.[10] There is insufficient data to support the routine use of PET/CT for staging of penile cancer. In a comparative study, the sensitivity of PET was 80% compared to 100% in MRI and specificities were equivalent.[11] Another trial looking at 13 patients confirmed these findings.[12] In a meta-analysis of 7 studies, PET had a pooled sensitivity and specificity of 80.9% and 92.4%. Sensitivity was 96.4% when inguinal lymph nodes were detected clinically, but fell to 56.5% when nodes were clinically negative.[13]

The NCCN recommends sentinel lymph node detection for clinically lymph node-negative penile cancer. The use of sentinel lymph node detection has been shown to decrease extent and morbidity of surgery without compromise to outcome. Patients with higher stage disease may require full lymph node dissections.[14]

SCREENING AND SURVEILLANCE

As most recurrences of vulvar and vaginal cancer are local, surveillance imaging is not indicated. In concordance with both National Comprehensive Cancer Network and Society of Gynecologic Oncology guidelines, imaging should only be performed when recurrence is suspected based on symptoms or exam findings.[8, 15] For penile cancer, surveillance with CT may be performed for N2/3 disease, but is not indicated beyond 2 years.[14]

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2018. CA Cancer J Clin. 2018;68(1):7-30. PMID: 29313949
2. Kataoka MY, Sala E, Baldwin P, et al. The accuracy of magnetic resonance imaging in staging of vulvar cancer: a retrospective multi-centre study. Gynecologic oncology. 2010;117(1):82-7. Epub 2010/01/23. PMID: 20092880
3. Chang YC, Hricak H, Thurnher S, et al. Vagina: evaluation with MR imaging. Part II. Neoplasms. Radiology. 1988;169(1):175-9. PMID: 3420257
4. Taylor MB, Dugar N, Davidson SE, et al. Magnetic resonance imaging of primary vaginal carcinoma. Clin Radiol. 2007;62(6):549-55. PMID: 17467392
5. Cohn DE, Dehdashti F, Gibb RK, et al. Prospective evaluation of positron emission tomography for the detection of groin node metastases from vulvar cancer. Gynecologic oncology. 2002;85(1):179-84. Epub 2002/04/02. PMID: 11925141
6. Robertson NL, Hricak H, Sonoda Y, et al. The impact of FDG-PET/CT in the management of patients with vulvar and vaginal cancer. Gynecologic oncology. 2016;140(3):420-4. Epub 2016/01/23. PMID: 26790773
7. Lamoreaux WT, Grigsby PW, Dehdashti F, et al. FDG-PET evaluation of vaginal carcinoma. Int J Radiat Oncol Biol Phys. 2005;62(3):733-7. PMID: 15936553
8. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Vulvar Cancer (Squamous Cell Carcinoma) (Version ~~2.2019~~2.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.
9. Ornellas AA, Kinchin EW, Nobrega BL, et al. Surgical treatment of invasive squamous cell carcinoma of the penis: Brazilian National Cancer Institute long-term experience. J Surg Oncol. 2008;97(6):487-95. PMID: 18425779

10. Tabatabaei S, Harisinghani M, McDougal WS. Regional lymph node staging using lymphotropic nanoparticle enhanced magnetic resonance imaging with ferumoxtran-10 in patients with penile cancer. J Urol. 2005;174(3):923-7; discussion 7. PMID: 16093989
11. Mueller-Lisse UG, Scher B, Scherr MK, et al. Functional imaging in penile cancer: PET/computed tomography, MRI, and sentinel lymph node biopsy. Current opinion in urology. 2008;18(1):105-10. Epub 2007/12/20. PMID: 18090498
12. Scher B, Seitz M, Reiser M, et al. 18F-FDG PET/CT for staging of penile cancer. J Nucl Med. 2005;46(9):1460-5. PMID: 16157528
13. Sadeghi R, Gholami H, Zakavi SR, et al. Accuracy of 18F-FDG PET/CT for diagnosing inguinal lymph node involvement in penile squamous cell carcinoma: systematic review and meta-analysis of the literature. Clin Nucl Med. 2012;37(5):436-41. PMID: 22475891
14. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Penile Cancer (Version ~~1.2019~~1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.
15. Salani R, Khanna N, Frimer M, et al. An update on post-treatment surveillance and diagnosis of recurrence in women with gynecologic malignancies: Society of Gynecologic Oncology (SGO) recommendations. Gynecol Oncol. 2017;146(1):3-10. PMID: 28372871

Prostate Cancer

Note: The following information addresses adenocarcinoma of the prostate; however, applicability and coverage include all cancers originating in the prostate unless expressly addressed in another AIM imaging guideline. Specific imaging considerations are addressed below.

Advanced imaging is considered medically necessary for diagnostic workup and management of documented prostate cancer.

Imaging Study	Diagnostic Workup and Diagnosis	Management	Screening & Surveillance
CT chest	Indicated for patients with intermediate or high risk disease	Indicated for restaging patients with intermediate or high risk disease (note: generally not needed for low risk patients)	Not indicated
CT abdomen and/or pelvis	Indicated for patients with intermediate or high risk disease	Indicated for restaging patients with intermediate or high risk disease (note: generally not needed for low risk patients)	Not indicated
MRI pelvis including multiparametric technique	Indicated in ANY of the following scenarios: • Indicated for patients with intermediate or high risk • Persistent and unexplained elevation in PSA levels* or very suspicious DRE • Risk-stratification for potential active surveillance	Indicated in ANY of the following scenarios: • Persistent or recurrent PSA elevation-especially useful if local salvage surgery planned after radiation therapy • Assessment of extracapsular extension prior to radical prostatectomy • Active surveillance annually • Restaging intermediate or high risk disease	Not indicated
FDG-PET/CT	Not indicated	Not indicated	Not indicated
18F Fluciclovine PET/CT or 11C Choline PET/CT	Not indicated	Indicated when ALL of the following criteria are met: • Original clinical stage T1-T3 and NX or N0 treated with prostatectomy and/or radiation therapy • Biochemically recurrent/persistent disease[1] • Results of conventional imaging[2] performed within the past 60 days are negative for metastasis • Patient is a candidate for curative intent salvage therapy[3] • PSA level is > 1 ng/ml; OR PSA is rising and multiparametric MRI of the pelvis[4] cannot be performed or is nondiagnostic • PET/CT with 18F Fluciclovine or 11C Choline has not been performed within the past 3 months	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Note: Low-risk prostate cancer defined as Gleason score of 6, PSA less than 10 ng/mL, and stage T1 or T2a.

*Note: * Elevated PSA levels defined as > 3 ng/ml in patients 45-75 years or > 4.0 ng/ml in patients 75 years or older*

1 Post-prostatectomy (PSA should be 0 after surgery):

Persistence: Detection of a PSA higher than 0 within the first three months after surgery; Recurrence: PSA initially undetectable, then rising PSA ≥ 0.2 ng/ml, with a second confirmatory level ≥ 0.2 ng/mL (American Urological Association definition)

Post-radiation therapy:

Recurrence: rise by ≥ 2 ng/mL above the nadir PSA (Radiation Therapy Oncology Group-American Society of Therapeutic Radiology and Oncology (RTOG-ASTRO) Phoenix Consensus)

2 Conventional imaging: CT Abdomen/Pelvis (MRI if CT contraindicated) ± bone scan. Conventional imaging not required for low-risk disease (T1-T2a, PSA < 10 ng/ml, and Gleason 6).

3 External beam radiation therapy ± androgen deprivation therapy after prostatectomy OR radical prostatectomy, cryosurgery, high-intensity focused ultrasound, or brachytherapy after external beam radiation therapy.

4 Multiparametric MRI (mpMRI) of the pelvis = dedicated MRI Prostate protocol

Rationale

Prostate cancer is the most common malignancy among men in the U.S. The most common histological subtype is adenocarcinoma.

DIAGNOSTIC WORKUP

Prostate cancer is staged using the American Joint Committee on Cancer TNM system. Advanced imaging is not indicated for very low and low-risk groups. Multiparametric MRI (mpMRI, defined as imaging acquired with at least one more sequence in addition to the anatomical T2-weighted images, and referring to prostate MRI protocol within this guideline) can be used in the staging and characterization of prostate cancer. CT is generally not sufficient to evaluate the prostate gland, but can be used for initial evaluation of nodal and/or visceral metastatic disease.

The prospective multicenter, randomized Phase III PRECISION (PRostate Evaluation for Clinically Important Disease: Sampling Using Image-guidance Or Not?) trial compared mpMRI-targeted biopsy to standard transrectal ultrasound-guided biopsy in 500 men with clinical suspicion of prostate cancer (elevated PSA, abnormal digital rectal exam, or both) who had not undergone biopsy previously. The mpMRI-targeted evaluation was able to detect prostate cancer in 38% of men compared with 26% in the standard biopsy group (P = 0.005). Fewer men in the mpMRI group were diagnosed with clinically insignificant cancers (defined as Gleason 6). The results of this study suggest that mpMRI may be superior to standard biopsy.[1]

In a meta-analysis of 75 studies comparing CT to MRI for initial staging, the pooled data for extracapsular extension and T3 detection showed sensitivity and specificity of 57% and 91% for CT vs 61% and 88% for MRI.[2] For detection of lymph node metastases, the differences in performance of CT and MRI were not statistically significant.[3] Findings from another prospective study confirmed the equivalency of CT and MRI for lymph node staging.[4] For intermediate risk or above, abdominal imaging with contrast should be performed if the risk of pelvic lymph node metastases is greater than 10%.

FDG-PET is not indicated, as physiologic activity in the bladder obscures tumor detection.[5] Additionally, there is limited evidence to support 11C-choline and 18F fluciclovine PET for initial staging of prostate cancer.

MANAGEMENT

For active surveillance, the NCCN recommends mpMRI be considered for suspected anterior and/or aggressive cancers when PSA increases and prostate biopsies are negative.[6] Although there are some studies showing a correlation between MRI stability and Gleason stability, the American Urological Association/American Society for Radiation Oncology/Society of Urologic Oncology 2017 Guidelines for Clinically Localized Prostate Cancer do not currently recommend serial MRI for surveillance.[7-10]

Studies of 11C-choline and 18F-fluciclovine PET support their accuracy in evaluating biochemical recurrence (BCR) (11C-choline: positive likelihood ratio of 7.66; negative likelihood ratio of 0.14; 18F-fluciclovine: positive likelihood ratio of 2.6, negative likelihood ratio of 0.20). [11-15] In the setting of recurrent disease, 11C-choline and 18F-fluciclovine PET findings sometimes change disease management (range 20%-70% of cases), including avoidance of local radiation when metastatic disease is identified (sparing the patient from the toxicity of ineffective therapy), and improving the precision of therapy through either a change in radiotherapy or demonstration of a specific local target for salvage therapy. [13,16,17]

The recent prospective FALCON (^{18}F-Fluciclovine PET/CT in biochemicAL reCurrence Of Prostate caNcer) trial found the detection ability of 18F-fluciclovine PET after radical treatment (prostatectomy or radiation therapy/brachytherapy) broadly proportional to PSA level (one-third scans positive when PSA ≤ 1 ng/mL, compared to 93% positive with PSA greater than 2 ng/mL).[17] Results from this study were similar to that of the previous US-based 18F Fluciclovine (FACBC) PET/CT in Patients with Rising PSA after Initial Prostate Cancer Treatment (LOCATE) study (patient-level detection of 56% with overall 63% management changes, compared with 57% and 59%, respectively), the latter limited to patients with negative or equivocal conventional imaging before 18F-

fluciclovine PET/CT. Where 18F-fluciclovine guided salvage therapy, the PSA response rate was higher than when 18F-fluciclovine was not involved (15 out of 17 [88%] vs 28 out of 39 [72%]).[17]

References

1. Kasivisvanathan V, Rannikko AS, Borghi M, et al. MRI-targeted or standard biopsy for prostate-cancer diagnosis. N Engl J Med. 2018;378(19):1767-77. PMID: 29552975
2. de Rooij M, Hamoen EH, Witjes JA, et al. Accuracy of Magnetic Resonance Imaging for Local Staging of Prostate Cancer: A Diagnostic Meta-analysis. Eur Urol. 2016;70(2):233-45. PMID: 26215604
3. Hovels AM, Heesakkers RA, Adang EM, et al. The diagnostic accuracy of CT and MRI in the staging of pelvic lymph nodes in patients with prostate cancer: a meta-analysis. Clin Radiol. 2008;63(4):387-95. PMID: 18325358
4. Heck MM, Souvatzoglou M, Retz M, et al. Prospective comparison of computed tomography, diffusion-weighted magnetic resonance imaging and [11C]choline positron emission tomography/computed tomography for preoperative lymph node staging in prostate cancer patients. Eur J Nucl Med Mol Imaging. 2014;41(4):694-701. PMID: 24297503
5. Jadvar H. PET of Glucose Metabolism and Cellular Proliferation in Prostate Cancer. J Nucl Med. 2016;57(Suppl 3):25S-9S. PMID: 27694167
6. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Prostate Cancer (Version 2.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2020.
7. Felker ER, Wu J, Natarajan S, et al. Serial Magnetic Resonance Imaging in Active Surveillance of Prostate Cancer: Incremental Value. J Urol. 2016;195(5):1421-7. PMID: 26674305
8. Sanda MG, Cadeddu JA, Kirkby E, et al. Clinically Localized Prostate Cancer: AUA/ASTRO/SUO Guideline. Part I: Risk Stratification, Shared Decision Making, and Care Options. J Urol. 2017;15:15. PMID: 29203269
9. Lai WS, Gordetsky JB, Thomas JV, et al. Factors predicting prostate cancer upgrading on magnetic resonance imaging-targeted biopsy in an active surveillance population. Cancer. 2017;123(11):1941-8. PMID: 28140460
10. Rais-Bahrami S, Turkbey B, Rastinehad AR, et al. Natural history of small index lesions suspicious for prostate cancer on multiparametric MRI: recommendations for interval imaging follow-up. Diagn Interv Radiol. 2014;20(4):293-8. PMID: 24808435
11. Mitchell CR, Lowe VJ, Rangel LJ, et al. Operational characteristics of (11)c-choline positron emission tomography/computerized tomography for prostate cancer with biochemical recurrence after initial treatment. J Urol. 2013;189(4):1308-13. PMID: 23123372
12. Evangelista L, Zattoni F, Guttilla A, et al. Choline PET or PET/CT and biochemical relapse of prostate cancer: a systematic review and meta-analysis. Clin Nucl Med. 2013;38(5):305-14. PMID: 23486334
13. Umbehr MH, Muntener M, Hany T, et al. The role of 11C-choline and 18F-fluorocholine positron emission tomography (PET) and PET/CT in prostate cancer: a systematic review and meta-analysis. Eur Urol. 2013;64(1):106-17. PMID: 23628493
14. Ren J, Yuan L, Wen G, et al. The value of anti-1-amino-3-18F-fluorocyclobutane-1-carboxylic acid PET/CT in the diagnosis of recurrent prostate carcinoma: a meta-analysis. Acta Radiol. 2016;57(4):487-93. PMID: 25907118
15. Yu CY, Desai B, Ji L, et al. Comparative performance of PET tracers in biochemical recurrence of prostate cancer: a critical analysis of literature. Am J Nucl Med Mol Imaging. 2014;4(6):580-601. PMID: 25250207
16. von Eyben FE, Kairemo K. Meta-analysis of (11)C-choline and (18)F-choline PET/CT for management of patients with prostate cancer. Nucl Med Commun. 2014;35(3):221-30. PMID: 24240194
17. Scarsbrook AF, Bottomly D, Teoh EJ. Effect of 18F-Fluciclovine Positron Emission Tomography on the Management of Patients With Recurrence of Prostate Cancer. Int J Radiat Oncol Biol Phys. 2020 Jun 1;107(2): 316-324

Sarcoma of Bone and Soft Tissue

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented bone, cartilage, connective tissue, and other soft tissue sarcoma.

Bone Sarcoma

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT primary site	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: especially useful for Ewing sarcoma and osteosarcoma in first 5 years)
CT chest	Indicated	~~As clinically indicated~~ Indicated	Indicated
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: especially useful for chordoma OR with Ewing sarcoma and osteosarcoma if PET not performed)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
MRI primary site	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: especially useful for Ewing sarcoma and osteosarcoma in first 5 years)
MRI brain	~~As clinically indicated~~ Indicated (note: especially useful for chordoma)	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
MRI ~~total spine~~ cervical, thoracic, and lumbar spine	~~As clinically indicated~~ Indicated (note: especially useful for chordoma)	~~As clinically indicated~~ Indicated for evaluation of suspected or known spinal metastases	Not indicated
MRI ~~spine and~~ pelvis	~~As clinically indicated~~ Indicated (note: especially useful for Ewing sarcoma)	~~As clinically indicated~~ Indicated for evaluation of suspected or known spinal or pelvic metastases	Not indicated
FDG-PET/CT	Indicated in ANY of the following scenarios (all tumor types): • Initial work-up of Ewing sarcoma and osteosarcoma if curative treatment planned	~~As clinically indicated~~ Indicated following completion of neoadjuvant chemotherapy ~~for deep lesions larger than 3 cm~~	Not indicated

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
	• Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for metastatic disease • Standard imaging suggests a resectable solitary metastasis • Baseline study prior to neoadjuvant chemotherapy ~~for deep tumors larger than 3 cm~~		

Soft Tissue Sarcoma of the extremity, superficial trunk, head, and neck

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT of primary site	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated (note: especially useful for Stage II/III)
CT chest	Indicated	~~As clinically indicated~~ Indicated	Indicated
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: especially useful for myxoid/round cell liposarcoma, epithelioid sarcoma, angiosarcoma, and leiomyosarcoma)	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
MRI of primary site	Indicated	~~As clinically indicated~~ Indicated	Indicated
MRI brain	~~As clinically indicated~~ Indicated (note: especially useful for alveolar soft part sarcoma and angiosarcoma)	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain metastases	Not indicated
MRI spine	~~As clinically indicated~~ Indicated (note: especially useful for myxoid/round cell liposarcoma)	~~As clinically indicated~~ Indicated for evaluation of suspected or known spinal metastases	Not indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated in ANY of the following scenarios (all tumor types): • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for metastatic disease • Standard imaging suggests a resectable solitary metastasis	~~As clinically indicated~~ Indicated following completion of neoadjuvant chemotherapy ~~for deep lesions larger than 3 cm~~	Not indicated

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
	• Baseline study prior to neoadjuvant chemotherapy ~~for deep tumors larger than 3 cm~~		

Soft Tissue Sarcoma: retroperitoneal/intraabdominal/gastrointestinal stromal tumors

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest, abdomen, and pelvis	Indicated	~~As clinically indicated~~ Indicated	Indicated
MRI of abdomen and/or pelvis	Indicated	Indicated	Indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated in ANY of the following scenarios (all tumor types): • Standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for metastatic disease • Standard imaging suggests a resectable solitary metastasis • Baseline study prior to neoadjuvant chemotherapy ~~for deep tumors larger than 3 cm~~	~~As clinically indicated~~ Indicated to assess treatment response following completion of neoadjuvant chemotherapy ~~for deep lesions larger than 3 cm~~	Not indicated

Rationale

Sarcomas account for fewer than 1% of all adult malignancies.[1] Sarcomas are a heterogeneous group of cancers which arise from mesenchymal cells and occur in many different types of tissue, most commonly bone, muscle, and cartilage. Risk factors are not well characterized but may include genetic predisposition, prior chemotherapy or radiation therapy, and environmental exposure.

DIAGNOSTIC WORKUP

Sarcomas are staged using the American Joint Committee on Cancer TNM system. Imaging of the primary tumor is important to assess resectability and local invasion. CT or MRI may be done as part of initial workup. However, MRI is often preferred for imaging ~~of~~ the primary tumor due to superior resolution of tumor versus surrounding muscle and neurovascular bundles, and for delineating disease involving the pelvis.[2-5] In a large prospective trial comparing CT and MRI imaging in both soft tissue sarcomas and bone cancer, the accuracy of local staging ~~of primary malignant bone and soft tissue tumors~~ was not statistically different between the 2 modalities.[6] ~~Since CT is less susceptible to motion artifact, CT is preferable to MRI for patients with retroperitoneal and intra-abdominal soft tissue sarcomas. Anatomic relationship of the tumor to other abdominal organs is well visualized by CT, as is metastatic disease in the liver or peritoneum. Bone scintigraphy can also be considered for primary bone cancer or suspected malignancy based on clinical, radiographic, or biochemical evidence.~~

Imaging of the lungs is critical, as this is the most common site of metastases. Additional imaging recommendations for soft tissue sarcoma vary by subtype. Multiple studies have shown a correlation between FDG uptake and tumor grade, which is a strong indicator of prognosis. However, the evidence has not shown that PET significantly impacts staging or management.[7,8]

For Ewing sarcoma and osteosarcoma, NCCN recommends ~~MRI of the spine and pelvis is indicated for detection of skeletal metastases~~whole body PET/CT and/or bone scan as part of initial workup (level of evidence category 2A).[9] A meta-analysis showed a pooled sensitivity of 96% and pooled specificity of 92% ~~with resultant change in management~~ for staging and restaging Ewing sarcoma when PET was combined with conventional imaging.[9-10] ~~PET response correlates with histopathologic response, improvement in progression-free survival, and potential change in management.[10-12]~~ In another meta-analysis of 42 trials, PET had a pooled sensitivity and specificity of

96% and 79% for differentiating primary bone sarcomas from benign lesions, 92% and 93% for detecting recurrence, and 90% and 85% for detecting distant metastasis, respectively.[13][11]

MANAGEMENT

PET has been shown to be a useful adjunct in assessing treatment response to neoadjuvant therapy, as well as an indicator of prognosis.[13-15][11-13] A review and meta-analysis of 11 studies confirmed the prognostic value of PET response to overall survival in soft tissue and bone sarcoma.[14,15][12,13]

SCREENING AND SURVEILLANCE

Imaging of the primary site for soft tissue sarcoma is based on the risk of recurrence and the accessibility of the primary cancer site.[16][14] Particularly for younger patients where the radiation risks from multiple CT examinations might cause some concern, the follow up can be performed with MRI of the abdomen and pelvis supplemented with CT thorax. Ultrasound is an underutilized tool for surveillance of soft tissue sarcoma; one study found no discernable difference in detection of local recurrences when comparing ultrasound with MRI.[17]

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2018. 2018;68(1):7-30. PMID: 29313949
2. Aisen AM, Martel W, Braunstein EM, et al. MRI and CT evaluation of primary bone and soft-tissue tumors. AJR Am J Roentgenol. 1986;146(4):749-56. PMID: 3485348
3. Demas BE, Heelan RT, Lane J, et al. Soft-tissue sarcomas of the extremities: comparison of MR and CT in determining the extent of disease. AJR Am J Roentgenol. 1988;150(3):615-20. PMID: 3257620
4. Manaster BJ. Soft-tissue masses: optimal imaging protocol and reporting. AJR Am J Roentgenol. 2013;201(3):505-14. PMID: 23971442
5. Sundaram M, McGuire MH, Herbold DR. Magnetic resonance imaging of soft tissue masses: an evaluation of fifty-three histologically proven tumors. Magn Reson Imaging. 1988;6(3):237-48. PMID: 3398729
6. Panicek DM, Gatsonis C, Rosenthal DI, et al. CT and MR imaging in the local staging of primary malignant musculoskeletal neoplasms: report of the Radiology Diagnostic Oncology Group. Radiology. 1997;202(1):237-46. PMID: 8988217
7. Schuetze SM. Utility of positron emission tomography in sarcomas. Curr Opin Oncol. 2006;18(4):369-73. PMID: 16721133
8. Eary JF, O'Sullivan F, Powitan Y, et al. Sarcoma tumor FDG uptake measured by PET and patient outcome: a retrospective analysis. Eur J Nucl Med Mol Imaging. 2002;29(9):1149-54. PMID: 12192559
9. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Bone Cancer (Version 1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2020.
9[10]. Treglia G, Salsano M, Stefanelli A, et al. Diagnostic accuracy of 18F-FDG-PET and PET/CT in patients with Ewing sarcoma family tumours: a systematic review and a meta-analysis. Skeletal Radiol. 2012;41(3):249-56. PMID: 22072239
10. Hawkins DS, Conrad EU, 3rd, Butrynski JE, et al. [F-18]-fluorodeoxy-D-glucose-positron emission tomography response is associated with outcome for extremity osteosarcoma in children and young adults. Cancer. 2009;115(15):3519-25. PMID: 19517457
11. Hawkins DS, Rajendran JG, Conrad EU, 3rd, et al. Evaluation of chemotherapy response in pediatric bone sarcomas by [F-18]-fluorodeoxy-D-glucose positron emission tomography.[Erratum appears in Cancer. 2003 Jun 195;97(12):3130]. Cancer. 2002;94(12):3277-84. PMID: 12115361
12. Hawkins DS, Schuetze SM, Butrynski JE, et al. [18F]Fluorodeoxyglucose positron emission tomography predicts outcome for Ewing sarcoma family of tumors. J Clin Oncol. 2005;23(34):8828-34. PMID: 16314643
13[11]. Liu F, Zhang Q, Zhu D, et al. Performance of positron emission tomography and positron emission tomography/computed tomography using fluorine-18-fluorodeoxyglucose for the diagnosis, staging, and recurrence assessment of bone sarcoma: a systematic review and meta-analysis.[Erratum appears in Medicine (Baltimore). 2016 Jan;95(2):e187a Note: Liu, Fengxia [Added]]. Medicine (Baltimore). 2015;94(36):e1462. PMID: 26356700
14[12]. Li YJ, Dai YL, Cheng YS, et al. Positron emission tomography (18)F-fluorodeoxyglucose uptake and prognosis in patients with bone and soft tissue sarcoma: A meta-analysis. Eur J Surg Oncol. 2016;42(8):1103-14. PMID: 27189833
15[13]. Chen L, Wu X, Ma X, et al. Prognostic value of 18F-FDG PET-CT-based functional parameters in patients with soft tissue sarcoma: A meta-analysis. Medicine (Baltimore). 2017;96(6):e5913. PMID: 28178131

~~16~~14. Patel SR, Zagars GK, Pisters PW. The follow-up of adult soft-tissue sarcomas. Semin Oncol. 2003;30(3):413-6. PMID: 12870143

~~17. Choi H, Varma DG, Fornage BD, et al. Soft-tissue sarcoma: MR imaging vs sonography for detection of local recurrence after surgery. AJR Am J Roentgenol. 1991;157(2):353-8. PMID: 1853821~~

Cancers of the Pleura, Thymus, Heart, and Mediastinum

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of documented pleural malignancies, cancers of the thymus, heart, and mediastinum.

Imaging Study	Diagnostic Workup	Management	Screening and Surveillance
CT chest	Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
CT abdomen	~~As clinically indicated~~ Indicated (note: especially useful for malignant pleural mesothelioma)	~~As clinically indicated~~ Indicated (note: not routinely required)	~~As clinically indicated~~ Indicated (note: not routinely required)
CT pelvis	~~As clinically indicated~~ Indicated (note: not routinely required)	~~As clinically indicated~~ Indicated (note: not routinely required)	~~As clinically indicated~~ Indicated (note: not routinely required)
MRI chest	~~As clinically indicated~~ Indicated (note: for thymoma and thymic carcinoma and as an adjunct to CT chest for malignant pleural mesothelioma)	~~As clinically indicated~~ Indicated (note: for thymoma and thymic carcinoma and as an adjunct to CT chest for malignant pleural mesothelioma)	Not indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated when surgical resection is being considered and metastatic disease has not been detected by CT or MRI	~~As clinically indicated~~ Indicated in EITHER of the following scenarios: • Radiation planning for definitive treatment • Restaging after induction chemotherapy, if patient is a surgical candidate	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Cancers of the pleura, thymus, heart, and mediastinum represent a heterogeneous group of diseases that can be either benign or malignant. The most common malignancies in this group are malignant pleural mesothelioma, thymoma, and thymic carcinoma. Myasthenia gravis is a paraneoplastic syndrome often associated with thymic neoplasms. Patients with mediastinal masses often present with symptoms resulting from direct compression of mediastinal structures, which may include cough, shortness of breath, superior vena cava syndrome, or Horner's syndrome. Malignant pleural mesothelioma may present with nonspecific pulmonary symptoms or systemic symptoms due to distant metastases.

DIAGNOSTIC WORKUP

MRI has been shown to be superior to CT for evaluating solitary foci of chest wall invasion, endothoracic fascial involvement, and diaphragmatic muscle invasion.[1] MRI should be considered for suspected chest wall, spinal, diaphragmatic, or vascular involvement based on CT. Although not highly accurate at staging T4 disease or N2 lymphadenopathy, PET plays a role in detection of extra-thoracic disease, eliminating the need for surgery in 16%-40% of patients.[2-6] For thymoma or thymic carcinoma, MRI chest may help differentiate benign cysts and thymoma from thymic carcinoma, thus avoiding the need for surgery.[7, 8] PET can be used for initial staging to differentiate low grade thymoma from FDG-avid thymic carcinoma.[8, 9] In a small number of patients (6%), PET identified unresectable metastatic disease not detected by CT.[9, 10] In a review of 14 studies, PET/CT was able to consistently

differentiate benign and malignant disease and detect extrathoracic metastases. Results were mixed regarding correlation with the Masaoka staging system for thymoma, which is based on tumor invasion and metastases.[11]

MANAGEMENT

The American Society for Clinical Oncology recommends CT with assessment of response of malignant pleural mesothelioma based on the RECIST criteria.

SCREENING AND SURVEILLANCE

American Society for Clinical Oncology and the National Comprehensive Cancer Network (NCCN) guidelines do not address surveillance imaging for asymptomatic malignant pleural mesothelioma. In most cases, CT should provide adequate information for routine surveillance.

AIM Oncologic Imaging guidelines are in concordance with the NCCN Guidelines® for Thymomas and Thymic Carcinomas, NCCN Guidelines® for Malignant Pleural Mesothelioma, and the American Society for Clinical Oncology guidelines for evaluation of malignant pleural mesothelioma.[12-14]

References

1. Heelan RT, Rusch VW, Begg CB, et al. Staging of malignant pleural mesothelioma: comparison of CT and MR imaging. AJR Am J Roentgenol. 1999;172(4):1039-47. PMID: 10587144
2. Flores RM, Akhurst T, Gonen M, et al. Positron emission tomography defines metastatic disease but not locoregional disease in patients with malignant pleural mesothelioma. J Thorac Cardiovasc Surg. 2003;126(1):11-6. PMID: 12878934
3. Sharif S, Zahid I, Routledge T, et al. Does positron emission tomography offer prognostic information in malignant pleural mesothelioma? Interact Cardiovasc Thorac Surg. 2011;12(5):806-11. PMID: 21266493
4. Sorensen JB, Ravn J, Loft A, et al. Preoperative staging of mesothelioma by 18F-fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography fused imaging and mediastinoscopy compared to pathological findings after extrapleural pneumonectomy. Eur J Cardiothorac Surg. 2008;34(5):1090-6. PMID: 18799318
5. Wilcox BE, Subramaniam RM, Peller PJ, et al. Utility of integrated computed tomography-positron emission tomography for selection of operable malignant pleural mesothelioma. Clin Lung Cancer. 2009;10(4):244-8. PMID: 19632941
6. Zahid I, Sharif S, Routledge T, et al. What is the best way to diagnose and stage malignant pleural mesothelioma? Interact Cardiovasc Thorac Surg. 2011;12(2):254-9. PMID: 21044972
7. Abdel Razek AA, Khairy M, Nada N. Diffusion-weighted MR imaging in thymic epithelial tumors: correlation with World Health Organization classification and clinical staging. Radiology. 2014;273(1):268-75. PMID: 24877982
8. Yabuuchi H, Matsuo Y, Abe K, et al. Anterior mediastinal solid tumours in adults: characterisation using dynamic contrast-enhanced MRI, diffusion-weighted MRI, and FDG-PET/CT. Clin Radiol. 2015;70(11):1289-98. PMID: 26272529
9. Treglia G, Sadeghi R, Giovanella L, et al. Is (18)F-FDG PET useful in predicting the WHO grade of malignancy in thymic epithelial tumors? a meta-analysis. Lung Cancer. 2014;86(1):5-13. PMID: 25175317
10. Sung YM, Lee KS, Kim BT, et al. 18F-FDG PET/CT of thymic epithelial tumors: usefulness for distinguishing and staging tumor subgroups. J Nucl Med. 2006;47(10):1628-34. PMID: 17015898
11. Viti A, Terzi A, Bianchi A, et al. Is a positron emission tomography-computed tomography scan useful in the staging of thymic epithelial neoplasms? Interact Cardiovasc Thorac Surg. 2014;19(1):129-34. PMID: 24648467
12. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Malignant Pleural Mesothelioma (Version ~~2.2019~~1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.
13. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Thymomas and Thymic Carcinomas (Version ~~2.2019~~1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.
14. Kindler HL, Ismaila N, Armato SG, 3rd, et al. Treatment of malignant pleural mesothelioma: American Society of Clinical Oncology clinical practice guideline. J Clin Oncol. 2018;36(13):1343-73. PMID: 29346042

Thyroid Cancer

Advanced imaging is considered medically necessary for the diagnostic workup, management, and surveillance of documented thyroid cancer.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT head	Indicated (note: most useful for anaplastic thyroid cancer)	~~As clinically indicated~~ Indicated (note: most useful for anaplastic thyroid cancer)	~~As clinically indicated~~ Indicated (note: most useful for anaplastic thyroid cancer)
CT neck	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated
CT chest	Indicated (note: especially useful for fixed, bulky, or substernal lesions and anaplastic thyroid cancer)	~~As clinically indicated~~ Indicated (note: especially useful based on known site of metastases or as clinically indicated for medullary thyroid cancer with calcitonin > 150 pg/mL AND anaplastic thyroid cancer)	~~As clinically indicated~~ Indicated
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: especially useful for anaplastic thyroid cancer)	~~As clinically indicated~~ Indicated (note: especially useful in patients with metastases or medullary thyroid cancer with calcitonin > 150 pg/mL AND anaplastic thyroid cancer)	~~As clinically indicated~~ Indicated
MRI neck	~~As clinically indicated~~ Indicated	~~As clinically indicated~~ Indicated when used in place of CT for initial treatment strategy	Not indicated
MRI chest	Indicated (note: for fixed, bulky, or substernal lesions)	~~As clinically indicated~~ Indicated when used in place of CT for initial treatment strategy	Not indicated
FDG-PET/CT	~~As clinically indicated~~ Indicated for ANY of the following subtypes: • Poorly differentiated papillary • Anaplastic • Medullary • Hurthle Cell (note: especially useful for anaplastic thyroid cancer)	~~As clinically indicated~~ Indicated in EITHER of the following scenarios: • Follow up of poorly differentiated papillary, anaplastic, medullary, or Hurthle cell carcinoma • Evaluation of suspected recurrence of well-differentiated papillary or follicular thyroid cancer when I 131 scan is negative (or has been negative in the past) and stimulated thyroglobulin level is > 2 ng/dL ~~in the absence of antibodies~~	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Thyroid cancer is the most common endocrine cancer in the U.S. The most common histologic subtypes are papillary and follicular carcinoma, which together account for 95% of all thyroid cancers. Risk factors include

environmental factors, radiation exposure, and genetic predisposition (in medullary thyroid cancer). The most common presentation is a palpable mass.

DIAGNOSTIC WORKUP

Thyroid cancer is staged using the American Joint Committee on Cancer TNM system. Thyroid cancer frequently involves cervical lymph nodes, and the addition of ultrasound can result in detection and alteration in management in up to 40% of patients.[1,2] Compared to CT, high-resolution ultrasound is more accurate for evaluation of extrathyroidal tumor extension and at least equivalent for evaluation of lateral lymph nodes.[3] Sensitivity, specificity, and diagnostic accuracy of ultrasound were 77%, 70%, and 74%, respectively, while those for CT were 62%, 79%, and 68%.[4] MRI and PET have relatively low sensitivities ranging from 30%-40%.[5, 6] ~~When PET was compared to CT, no benefit in detection of nodal disease was seen. In one study, PET/CT showed a sensitivity of 30.4%, a specificity of 96.2% and a diagnostic accuracy of 86.9%; corresponding values for CT were 34.8%, 96.2% and 87.2%.[7] In another study, CT outperformed PET for detection of lung and mediastinal lymph node disease. Evaluation of the liver was most accurate with MRI and CT while evaluation of bone was most accurate with MRI and bone scan.[8]~~

~~High quality evidence and medical society recommendations support the use of thyroid scintigraphy after thyroidectomy in patients with intermediate to high-risk differentiated thyroid cancer and in whom radioactive iodine treatment is planned. In a large systematic review, no clear improvement in overall survival or disease free survival was seen in low risk patients treated with radioactive iodine.[9] In a retrospective review of 1298 patients with low-risk differentiated thyroid cancer, radioactive iodine resulted in a 10-yr overall survival of 95.8% while patients not treated with radioactive iodine after surgery had a 10-yr overall survival of 94.6%.[10] Conversely, a review of the NCI database of 21,870 patients with intermediate-risk differentiated thyroid cancer who underwent total thyroidectomy with or without radioactive iodine showed improved overall survival (P < .001). After a multivariate adjustment for demographic and clinical factors, radioactive idone was associated with a 29% reduction in the risk of death, with a hazard risk 0.71 (95% CI, 0.62-0.82, P < .001).[11] In a 2015 NTCTCS Registry analysis of 4941 patients, improved overall survival was seen in stage III patients who received radioactive iodine (risk ratio [RR], 0.66; P = .04) and stage IV patients who received both total/near-total thyroidectomy and radioactive iodine (RR, 0.66 and 0.70; combined P = .049).[12]~~

For dedifferentiated thyroid cancer, PET is indicated. Although there is a lack of prospective evidence, PET has been shown to detect metastatic disease not identified by conventional imaging in 35% of patients.[13] [8] Change in management based on PET imaging findings can be as high as 25%-50%.[14] [9]

MANAGEMENT

For follow up of well-differentiated thyroid cancer, CT or MRI is not indicated unless there is clinical evidence of recurrence. Patients with high-risk features generally undergo additional imaging and/or treatment with radioactive iodine. For suspected iodine non-avid papillary or follicular thyroid cancer, PET may be useful. The overall accuracy, sensitivity, and specificity for PET/CT in I-131 negative patients were 93%, 93%, and 81%, respectively.[15] [10]

For suspected recurrence of medullary thyroid cancer, a study comparing several imaging modalities found that ultrasound outperformed CT and PET for detection of locally recurrent disease (56% accuracy for ultrasound vs 42% and 32% for CT and PET, respectively). CT was superior to PET for evaluation of metastatic lung and mediastinal lymph node involvement, with a reported sensitivity and specificity for CT of 35% and 31%, respectively, versus 15% and 20% for PET. Detection of liver metastases with MRI, CT, ultrasound, and PET showed accuracy rates of 49%, 44%, 41%, and 27%, respectively, while bone metastases were better detected using bone scan or MRI (40%) as compared to PET (35%).[8] [7] In a review of PET for evaluation of recurrent anaplastic thyroid cancer, higher sensitivity (66% to 100%) and specificity (79% to 90%) were seen when compared to conventional imaging modalities.[16] [11]

~~Relatively weak evidence and medical society recommendations support the use of thyroid scintigraphy after radioactive iodine treatment evaluation. Up to 25% of images show lesions that may be clinically important but which were not originally detected on diagnostic imaging. In a retrospective study comparing whole body scans obtained before and after radioactive iodine in patients (N = 93) with thyroid carcinoma, in 27% of treatment cycles, the results of posttreatment and pretreatment scans differed. Only 10% of posttreatment scans detected new locations of metastatic disease.~~

AIM Oncologic Imaging guidelines for thyroid cancer are in concordance with the National Comprehensive Cancer Network Guidelines for Thyroid Carcinoma as well as the American Thyroid Association Practice Guidelines.[17, 18] [12,13]

SCREENING AND SURVEILLANCE

Biochemical monitoring remains the most vital component for surveillance of differentiated ~~thyroid~~thyroid cancer; although conventional imaging may also be considered when clinically indicated. ~~High quality evidence and medical society recommendations do not support the use of thyroid scintigraphy for asymptomatic surveillance of patients without evidence of disease.~~ Both the American Thyroid Association and National Comprehensive Cancer Network do give consideration to a single exam after completion of therapy in intermediate and high risk differentiated thyroid cancer patients. The value of continued monitoring if no evidence of disease is seen is controversial.[6, 17] [6, 12]

References

1. Stulak JM, Grant CS, Farley DR, et al. Value of preoperative ultrasonography in the surgical management of initial and reoperative papillary thyroid cancer. Archives of surgery (Chicago, Ill : 1960). 2006;141(5):489-94; discussion 94-6. Epub 2006/05/17. PMID: 16702521
2. Kouvaraki MA, Shapiro SE, Fornage BD, et al. Role of preoperative ultrasonography in the surgical management of patients with thyroid cancer. Surgery. 2003;134(6):946-54; discussion 54-5. Epub 2003/12/12. PMID: 14668727
3. Choi JS, Kim J, Kwak JY, et al. Preoperative staging of papillary thyroid carcinoma: comparison of ultrasound imaging and CT. AJR American journal of roentgenology. 2009;193(3):871-8. Epub 2009/08/22. PMID: 19696304
4. Ahn JE, Lee JH, Yi JS, et al. Diagnostic accuracy of CT and ultrasonography for evaluating metastatic cervical lymph nodes in patients with thyroid cancer. World journal of surgery. 2008;32(7):1552-8. Epub 2008/04/15. PMID: 18408961
5. Chen Q, Raghavan P, Mukherjee S, et al. Accuracy of MRI for the diagnosis of metastatic cervical lymphadenopathy in patients with thyroid cancer. La Radiologia medica. 2015;120(10):959-66. Epub 2015/03/03. PMID: 25725789
6. Haugen BR, Alexander EK, Bible KC, et al. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: the American Thyroid Association Guidelines Task Force on thyroid nodules and differentiated thyroid cancer. Thyroid. 2016;26(1):1-133. PMID: 26462967
7. ~~Jeong HS, Baek CH, Son YI, et al. Integrated 18F-FDG PET/CT for the initial evaluation of cervical node level of patients with papillary thyroid carcinoma: comparison with ultrasound and contrast-enhanced CT. Clinical endocrinology. 2006;65(3):402-7. Epub 2006/08/22. PMID: 16918964~~
8. 7. Giraudet AL, Vanel D, Leboulleux S, et al. Imaging medullary thyroid carcinoma with persistent elevated calcitonin levels. The Journal of clinical endocrinology and metabolism. 2007;92(11):4185-90. Epub 2007/08/30. PMID: 17726071
9. ~~Sawka AM, Brierley JD, Tsang RW, et al. An updated systematic review and commentary examining the effectiveness of radioactive iodine remnant ablation in well-differentiated thyroid cancer. Endocrinol Metab Clin North Am. 2008;37(2):457-80, x. PMID: 18502337~~
10. ~~Schvartz C, Bonnetain F, Dabakuyo S, et al. Impact on overall survival of radioactive iodine in low-risk differentiated thyroid cancer patients. J Clin Endocrinol Metab. 2012;97(5):1526-35. PMID: 22344193~~
11. ~~Ruel E, Thomas S, Dinan M, et al. Adjuvant radioactive iodine therapy is associated with improved survival for patients with intermediate-risk papillary thyroid cancer. J Clin Endocrinol Metab. 2015;100(4):1529-36. PMID: 25642591~~
12. ~~Carhill AA, Litofsky DR, Ross DS, et al. Long-term outcomes following therapy in differentiated thyroid carcinoma: NTCTCS registry analysis 1987-2012. J Clin Endocrinol Metab. 2015;100(9):3270-9. PMID: 26171797~~
13. 8. Poisson T, Deandreis D, Leboulleux S, et al. 18F-fluorodeoxyglucose positron emission tomography and computed tomography in anaplastic thyroid cancer. European journal of nuclear medicine and molecular imaging. 2010;37(12):2277-85. Epub 2010/08/10. PMID: 20694463
14. 9. Bogsrud TV, Karantanis D, Nathan MA, et al. 18F-FDG PET in the management of patients with anaplastic thyroid carcinoma. Thyroid : official journal of the American Thyroid Association. 2008;18(7):713-9. Epub 2008/07/18. PMID: 18630999
15. 10. Caetano R, Bastos CR, de Oliveira IA, et al. Accuracy of positron emission tomography and positron emission tomography-CT in the detection of differentiated thyroid cancer recurrence with negative (131) I whole-body scan results: A meta-analysis. Head & neck. 2016;38(2):316-27. Epub 2014/09/25. PMID: 25251544
16. 11. Khan N, Oriuchi N, Higuchi T, et al. Review of fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET) in the follow-up of medullary and anaplastic thyroid carcinomas. Cancer control : journal of the Moffitt Cancer Center. 2005;12(4):254-60. Epub 2005/11/01. PMID: 16258498
17. 12. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Thyroid Carcinoma (Version 3.2018~~2.2019~~). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2018~~2019.
18. 13. Yeh MW, Bauer AJ, Bernet VA, et al. American Thyroid Association statement on preoperative imaging for thyroid cancer surgery. Thyroid. 2015;25(1):3-14. PMID: 25188202

Uterine Cancer

Advanced imaging is considered medically necessary for the diagnostic workup and management of documented uterine cancer (including uterine sarcoma).

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT chest	~~As clinically indicated~~ Indicated (note: chest X-ray usually sufficient unless abnormal chest X-ray OR high-risk patient)	~~As clinically indicated~~ Indicated	~~Not indicated~~ Indicated for uterine sarcoma ONLY
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: especially useful in high-risk patients)	~~As clinically indicated~~ Indicated	~~Not indicated~~ Indicated for uterine sarcoma ONLY
MRI pelvis	~~As clinically indicated~~ Indicated (note: especially useful prior to fertility-sparing treatment)	~~As clinically indicated~~ Indicated	Not indicated
FDG-PET/CT	As clinically indicated when standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for extent of metastatic disease	As clinically indicated when standard imaging ~~studies are equivocal or~~ cannot be performed or is nondiagnostic for recurrent or progressive disease	Not indicated

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

Uterine cancer is the most common gynecologic cancer and fourth most common cancer among women in the U.S. The most common type of uterine cancer is endometrial, which originates in the uterine lining. Risk factors include exposure to estrogen, obesity, and genetic predisposition. The most common presentation is abnormal bleeding; the cancer may also be found incidentally on exam. Over 80% of endometrial cancers are confined to the uterus upon discovery. The initial staging of patients with suspected endometrial cancer includes local imaging with endovaginal ultrasound or MRI pelvis.

DIAGNOSTIC WORKUP

The staging system most widely adopted for uterine cancer is the International Federation of Gynecology and Obstetrics (FIGO) system, although the American Joint Committee on Cancer TNM system is also used. MRI pelvis is the preferred modality for assessing the extent of local disease and extension into the cervix.[1, 2] For fertility-sparing therapy, an MRI pelvis is indicated prior to hormonal therapy and dilatation and curettage; a review comparing MRI to transvaginal ultrasound reported better sensitivity for evaluating myometrial invasion with MRI although statistically the two exams were equivalent.[3] When evaluation of lymph nodes is required, both CT and MRI provide similar sensitivity and specificity.[4, 5] In several small studies, PET has been shown to be equivalent or moderately better for detecting nodal disease when compared to MRI and CT; however, these differences rarely affect the decision for lymphadenectomy.[6-11]

As the majority of endometrial cancers are confined to the uterus (75%) and lymph nodes (10%), systemic imaging is reserved for high-risk patients.[12] In an international prospective trial, the negative predictive value for low-risk endometrial cancer was 97%.[13] There is insufficient data to recommend PET/CT for routine assessment. Based on the National Comprehensive Cancer Network (NCCN) uterine cancer guidelines, European Society for Medical Oncology-European Society of Gynecological Oncology-European Society for Therapeutic Radiology and Oncology Consensus, and American College of Radiology guidelines, additional imaging for metastatic workup is optional.[14-16]

~~The NCCN recommends sentinel lymph node detection in patients with uterine confined and clinically lymph node-negative uterine cancer. Prospective and retrospective studies demonstrate that compared to systemic lymphadenectomy, sentinel lymph node mapping with ultrastaging may increase the detection of lymph node metastasis with low false-negative rates in women with apparent uterine-confined disease. Recent evidence indicates that sentinel lymph node mapping may also be used in high-risk histologies (serous carcinoma, clear cell carcinoma, carcinosarcoma).[14]~~

MANAGEMENT

Follow-up imaging should be guided by patient symptoms, risk assessment, and clinical concern for recurrent or metastatic disease. For patients with endometrial carcinoma who have undergone fertility-sparing treatment, MRI pelvis with contrast is preferred after 6 months of failed medical therapy, especially if considering further fertility-sparing approaches. ~~If recurrence is suspected, pelvic MRI may be used for patients with an intact uterus, and CT abdomen and pelvis should be performed if clinically indicated.~~ In a small prospective study from Korea, PET for suspected disease recurrence had a sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of 100%, 83.3%, 96%, 95%, and 100%, respectively. PET/CT detected 3/24 (12.5%) recurrences in patients with elevated tumor markers but negative CT abdomen and pelvis findings.[17]

SCREENING AND SURVEILLANCE

Following treatment for uterine sarcoma specifically, the NCCN recommends CT of the Chest, Abdomen and Pelvis every 3-6 months for the first 3 years, and then every 6-12 months for the next 2 years.[14] Otherwise, the National Comprehensive Cancer Network, American College of Radiology, and Society of Gynecologic Oncology do not recommend routine use of surveillance imaging.[14, 16, 20]

The most important component for surveillance of asymptomatic uterine cancer is physician history and physical with vaginal cytology, as the vaginal cuff is the most common site of recurrence. Cancer antigen (CA) 125 may be used if initially elevated. ~~Advanced imaging is not indicated for surveillance.~~ In a systematic review by Fung et al., the overall risk of recurrence was 13% for all patients and 3% or less for patients at low risk. Approximately 70% of all recurrences were symptomatic. ~~Detection of asymptomatic recurrences ranged from 5% to 33% of patients with physical examination, 15% with CA 125, 0% to 14% with chest X-ray, and 5% to 21% with CT abdomen and pelvis.[18]~~ In a retrospective study, recurrences in high-grade endometrial carcinomas were discovered by symptoms 56% of the time and physical exam 18% of the time. Surveillance CT only detected 15% of asymptomatic recurrences.[19]

Limited data is available for MRI and PET/CT in surveillance of asymptomatic patients.[20] In a small prospective study, PET detected asymptomatic uterine cancer recurrence in only 4% of patients.[17] A retrospective study evaluating adherence to Society of Gynecological Oncology guidelines resulted in an appreciable decline in CT imaging, CA 125, and clinical exams with no effect on outcomes.[21] ~~The National Comprehensive Cancer Network, American College of Radiology, and Society of Gynecologic Oncology do not recommend routine use of surveillance imaging for uterine cancer.[14, 16, 20]~~

References

1. Sala E, Rockall AG, Freeman SJ, et al. The added role of MR imaging in treatment stratification of patients with gynecologic malignancies: what the radiologist needs to know. Radiology. 2013;266(3):717-40. PMID: 23431227
2. Kinkel K, Kaji Y, Yu KK, et al. Radiologic staging in patients with endometrial cancer: a meta-analysis. Radiology. 1999;212(3):711-8. PMID: 10478237
3. Alcazar JL, Gaston B, Navarro B, et al. Transvaginal ultrasound versus magnetic resonance imaging for preoperative assessment of myometrial infiltration in patients with endometrial cancer: a systematic review and meta-analysis. Journal of Gynecologic Oncology. 2017;28(6):e86. PMID: 29027404
4. Connor JP, Andrews JI, Anderson B, et al. Computed tomography in endometrial carcinoma. Obstet Gynecol. 2000;95(5):692-6. PMID: 10775731
5. Rockall AG, Meroni R, Sohaib SA, et al. Evaluation of endometrial carcinoma on magnetic resonance imaging. Int J Gynecol Cancer. 2007;17(1):188-96. PMID: 17291252
6. Bese T, Sal V, Demirkiran F, et al. The Combination of Preoperative Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography and Sentinel Lymph Node Mapping in the Surgical Management of Endometrioid Endometrial Cancer. Int J Gynecol Cancer. 2016;26(7):1228-38. PMID: 27643647

7. Bollineni VR, Ytre-Hauge S, Bollineni-Balabay O, et al. High Diagnostic Value of 18F-FDG PET/CT in Endometrial Cancer: Systematic Review and Meta-Analysis of the Literature. J Nucl Med. 2016;57(6):879-85. PMID: 26823564
8. Kitajima K, Murakami K, Yamasaki E, et al. Accuracy of 18F-FDG PET/CT in detecting pelvic and paraaortic lymph node metastasis in patients with endometrial cancer. AJR Am J Roentgenol. 2008;190(6):1652-8. PMID: 18492920
9. Kitajima K, Suzuki K, Senda M, et al. Preoperative nodal staging of uterine cancer: is contrast-enhanced PET/CT more accurate than non-enhanced PET/CT or enhanced CT alone? Ann Nucl Med. 2011;25(7):511-9. PMID: 21670955
10. Park JY, Kim EN, Kim DY, et al. Comparison of the validity of magnetic resonance imaging and positron emission tomography/computed tomography in the preoperative evaluation of patients with uterine corpus cancer. Gynecol Oncol. 2008;108(3):486-92. PMID: 18201753
11. Signorelli M, Crivellaro C, Buda A, et al. Staging of High-Risk Endometrial Cancer With PET/CT and Sentinel Lymph Node Mapping. Clin Nucl Med. 2015;40(10):780-5. PMID: 26053711
12. Chan JK, Cheung MK, Huh WK, et al. Therapeutic role of lymph node resection in endometrioid corpus cancer: a study of 12,333 patients. Cancer. 2006;107(8):1823-30. PMID: 16977653
13. Kang S, Nam JH, Bae DS, et al. Preoperative assessment of lymph node metastasis in endometrial cancer: A Korean Gynecologic Oncology Group study. Cancer. 2017;123(2):263-72. PMID: 28067948
14. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®) for Uterine Neoplasms (Version ~~2.2019~~1.2020). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, ~~2019~~2020.
15. Colombo N, Creutzberg C, Amant F, et al. ESMO-ESGO-ESTRO Consensus Conference on Endometrial Cancer: diagnosis, treatment and follow-up. Ann Oncol. 2016;27(1):16-41. PMID: 26634381
16. Lalwani N, Dubinsky T, Javitt MC, et al. ACR Appropriateness Criteria® pretreatment evaluation and follow-up of endometrial cancer. Ultrasound Q. 2014;30(1):21-8. PMID: 24901775
17. Park JY, Kim EN, Kim DY, et al. Clinical impact of positron emission tomography or positron emission tomography/computed tomography in the posttherapy surveillance of endometrial carcinoma: evaluation of 88 patients. Int J Gynecol Cancer. 2008;18(6):1332-8. PMID: 18298562
18. Fung-Kee-Fung M, Dodge J, Elit L, et al. Follow-up after primary therapy for endometrial cancer: a systematic review. Gynecol Oncol. 2006;101(3):520-9. PMID: 16556457
19. Hunn J, Tenney ME, Tergas AI, et al. Patterns and utility of routine surveillance in high grade endometrial cancer. Gynecol Oncol. 2015;137(3):485-9. PMID: 25838164
20. Salani R, Khanna N, Frimer M, et al. An update on post-treatment surveillance and diagnosis of recurrence in women with gynecologic malignancies: Society of Gynecologic Oncology (SGO) recommendations. Gynecol Oncol. 2017;146(1):3-10. PMID: 28372871
21. Schwartz ZP, Frey MK, Philips S, et al. Endometrial cancer surveillance adherence reduces utilization and subsequent costs. Gynecol Oncol. 2017;146(3):514-8. PMID: 28734496

Suspected or Known Metastases, not otherwise specified

Advanced imaging is considered medically necessary for diagnostic workup, management, and surveillance of patients with a documented malignancy ~~and signs or symptoms concerning for~~ when clinical evaluation suggests metastatic disease.

Imaging Study	Diagnostic Workup	Management	Screening & Surveillance
CT brain	~~As clinically indicated~~ Indicated (note: exam should be done with contrast; MRI brain preferred imaging exam)	~~As clinically indicated~~ Indicated	Not indicated
CT neck	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)
CT chest	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)
CT abdomen and pelvis	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)	~~As clinically indicated~~ Indicated (note: refer to specific cancer section for guidance)
MRI abdomen	Indicated in the following scenario: • Suspected liver metastasis by other imaging (*note: see Abdomen Imaging*)	Indicated in EITHER of the following scenarios: • Prior to and post-procedural baseline following liver directed therapy or surgery • Signs or symptoms suggestive of recurrent or progressive hepatic metastatic disease	Not indicated
MRI brain	Indicated for evaluation of suspected or known brain or skull metastases	~~As clinically indicated~~ Indicated for evaluation of suspected or known brain or skull metastases	Not indicated
MRI ~~bone or spine~~ axial skeleton (cervical, thoracic or lumbar spine)	Indicated for evaluation of suspected or known vertebral or intradural metastases	~~As clinically indicated~~ Indicated for evaluation of suspected or known ~~bone~~ vertebral or intradural metastases	Not indicated
MRI appendicular skeleton (pelvis, lower or upper extremity)	Indicated for ANY of the following: • Evaluation of suspected or known bony pelvic metastases • Evaluation of known lower or upper extremity metastasis • Evaluation of suspected distal upper/lower metastasis when	Indicated for ANY of the following: • Evaluation of suspected or known bony pelvic metastases • Evaluation of known lower or upper extremity metastasis • Evaluation of suspected distal upper/lower metastasis when	Not indicated

	radiographs are nondiagnostic	radiographs are nondiagnostic	
FDG-PET/CT	~~As clinically indicated (note: refer~~ Refer to specific tumor type indications ~~cancer section for guidance)~~	~~As clinically indicated (note: refer~~ Refer to specific tumor type indications ~~cancer section for guidance)~~	Not indicated
NaF PET/CT	When performed as part of coverage under evidence determination (CED) in Medicare beneficiaries	When performed as part of coverage under evidence determination (CED) in Medicare beneficiaries	When performed as part of coverage under evidence determination (CED) in Medicare beneficiaries

Note: Criteria for the evaluation of known or suspected metastasis in specific tumor type indications supersede these criteria. These criteria should be used in patients with documented malignancy and with known or suspected metastatic disease when no criteria exist within the more specific tumor type indication

Note: MRI is considered medically necessary when criteria are met and CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity).

Rationale

In 2018, there will be an estimated 1,735,350 new cases and 609,640 deaths resulting from cancer in the United States.[1] When discovered early, many cancers can be completely eradicated through surgery, radiation, and/or systemic therapy. The rate at which cancers metastasize varies greatly based on initial stage and cancer type. Cancer metastasis is a leading cause of morbidity and accounts for approximately 90% of cancer-related mortality.[2] Metastasis involves the spread of cancer cells from the primary tumor to surrounding tissues and to distant organs through direct extension, blood, or lymphatics. ~~Common areas for metastases include bone, brain, and lungs.~~

DIAGNOSTIC WORKUP

In patients with biopsy-proven malignancy, a thorough history and physical exam, laboratory evaluation, and/or imaging may prompt concern for metastases. Symptoms may vary according the specific area of organ involvement or biochemical derangement.

- Lymph nodes: lymphadenopathy
- Lungs: cough, hemoptysis, shortness of breath
- Liver: hepatomegaly, nausea, jaundice, pain, elevated liver enzymes
- Bones: pain and fracture
- Brain: focal neurological deficit, cognitive dysfunction, headaches, seizures, ataxia

When metastases are clinically suspected, localized imaging is often warranted. Imaging of the body should be targeted to the suspected area of metastases as opposed to simultaneous ordering of multiple studies. For confirmation and initial management of metastatic disease to the liver (especially when liver-directed therapy or surgery is contemplated), MRI Abdomen (with hepatic contrast protocol) is preferred over CT (and PET/CT) to assess the exact number and distribution of metastatic foci for local treatment planning.[3] Appropriateness of additional imaging is dependent on the results of the lead study.

In patients with suspected brain metastases, both MRI and CT imaging with contrast may be used to evaluate CNS metastases; however, MRI is the preferred exam. Multiple studies have shown that contrast-enhanced MRI is more sensitive for detection of brain metastases as well as differentiating from primary CNS cancer than both CT imaging and non-contrast MRI.[3 4, 5]

In patients with suspected bone metastases, imaging studies may include plain radiographs, CT imaging, MRI imaging or PET imaging. Preliminary radiographs should be obtained for the distal extremities (hands/feet) as isolated metastatic disease presenting at these sites is less likely than within the axial and proximal appendicular skeleton, and findings may point to a different source for symptoms. In patients where there is concern for impending non-vertebral fracture or vertebral metastases, imaging should include a CT or MRI. ~~CT is used to diagnose bone metastases if MRI is contraindicated or expected to be suboptimal. Consideration should also be given when there is a need to evaluate extraosseous lesions in the region and assess the integrity of the bone cortex at a site with a known bone metastasis. However,~~ MRI remains the imaging modality of choice due to its greater sensitivity to CT for detection of metastases, better delineation of the extent of tumor, and particularly its usefulness in patients with spine metastases to evaluate the extent of medullary and extraspinal disease.[6-9] MRI can also be used to distinguish benign from malignant compression fractures with a sensitivity and specificity of over 90%.[10, 11] In 2011 and 2017 meta-analyses comparing MRI, CT, PET, and bone scintigraphy, the sensitivity of MRI and PET were both statistically better than CT imaging and bone scintigraphy. On a per-patient basis, the pooled sensitivity and specificity estimates for PET, CT, MRI and BS were 89.7%, 72.9%, 90.6%, 86.0% and

96.8%, 94.8%, 95.4% and 81.4% respectively.[12, 13] In patients where disseminated, non-vertebral metastases are suspected, plain films, bone scintigraphy, and PET are all reasonable choices. Additional guidance may be found in the specific cancer section.

MANAGEMENT

For patients with either active disease or localized disease in remission, follow-up frequency should be determined by clinical need with additional diagnostic tests based on symptomatology. In general terms, imaging used in the initial detection of the cancer may be used to assess for treatment response.

SCREENING AND SURVEILLANCE

Refer to specific cancer section for guidance.

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2018. CA Cancer J Clin. 2018;68(1):7-30. PMID: 29313949
2. Hanahan D, Weinberg RA. The hallmarks of cancer. Cell. 2000;100(1):57-70. PMID: 10647931
3. Niekel MC, Bipat S, Stoker J. Diagnostic imaging of colorectal liver metastases with CT, MR imaging, FDG PET, and/or FDG PET/CT: a meta-analysis of prospective studies including patients who have not previously undergone treatment. Radiology 2010;257:674-684

~~3~~4. Davis PC, Hudgins PA, Peterman SB, et al. Diagnosis of cerebral metastases: double-dose delayed CT vs contrast-enhanced MR imaging. AJNR Am J Neuroradiol. 1991;12(2):293-300. PMID: 1902031

~~4~~5. Schaefer PW, Budzik RF, Jr., Gonzalez RG. Imaging of cerebral metastases. Neurosurg Clin N Am. 1996;7(3):393-423. PMID: 8823771

~~5. Sze G, Milano E, Johnson C, et al. Detection of brain metastases: comparison of contrast-enhanced MR with unenhanced MR and enhanced CT. AJNR Am J Neuroradiol. 1990;11(4):785-91. PMID: 2114769~~

6. Baur-Melnyk A, Buhmann S, Becker C, et al. Whole-body MRI versus whole-body MDCT for staging of multiple myeloma. AJR Am J Roentgenol. 2008;190(4):1097-104. PMID: 18356461
7. Frank JA, Ling A, Patronas NJ, et al. Detection of malignant bone tumors: MR imaging vs scintigraphy. AJR Am J Roentgenol. 1990;155(5):1043-8. PMID: 2120933
8. Godersky JC, Smoker WR, Knutzon R. Use of magnetic resonance imaging in the evaluation of metastatic spinal disease. Neurosurgery. 1987;21(5):676-80. PMID: 3696401
9. Steinborn MM, Heuck AF, Tiling R, et al. Whole-body bone marrow MRI in patients with metastatic disease to the skeletal system. J Comput Assist Tomogr. 1999;23(1):123-9. PMID: 10050822
10. Luo Z, Litao L, Gu S, et al. Standard-b-value vs low-b-value DWI for differentiation of benign and malignant vertebral fractures: a meta-analysis. Br J Radiol. 2016;89(1058):20150384. PMID: 26612466
11. Suh CH, Yun SJ, Jin W, et al. ADC as a useful diagnostic tool for differentiating benign and malignant vertebral bone marrow lesions and compression fractures: a systematic review and meta-analysis. Eur Radiol. 2018;28(7):2890-902. PMID: 29450718
12. Liu T, Wang S, Liu H, et al. Detection of vertebral metastases: a meta-analysis comparing MRI, CT, PET, BS and BS with SPECT. J Cancer Res Clin Oncol. 2017;143(3):457-65. PMID: 27752772
13. Yang HL, Liu T, Wang XM, et al. Diagnosis of bone metastases: a meta-analysis comparing 18FDG PET, CT, MRI and bone scintigraphy. Eur Radiol. 2011;21(12):2604-17. PMID: 21887484

Codes

The following code list is not meant to be all-inclusive. Authorization requirements will vary by health plan. Please consult the applicable health plan for guidance on specific procedure codes.

CPT/HCPCS

Specific CPT codes for services should be used when available. Non-specific or not otherwise classified codes may be subject to additional documentation requirements and review.

70450	CT head/brain, without contrast
70460	CT head/brain, with contrast
70470	CT head/brain, without contrast, followed by re-imaging with contrast
70480	CT of orbit, sella, or posterior fossa and outer, middle or inner ear, without contrast
70481	CT of orbit, sella, or posterior fossa and outer, middle or inner ear, with contrast
70482	CT of orbit, sella, or posterior fossa and outer, middle or inner ear, without contrast, followed by re-imaging with contrast
70486	CT of maxillofacial area, without contrast
70487	CT of maxillofacial area, with contrast
70488	CT of maxillofacial area, without contrast, followed by re-imaging with contrast
70490	CT, soft tissue neck, without contrast
70491	CT, soft tissue neck, with contrast
70492	CT, soft tissue neck, without contrast, followed by re-imaging with contrast
70540	MRI orbit, face and neck, without contrast
70542	MRI orbit, face and neck, with contrast
70543	MRI orbit, face and neck, without contrast, followed by re-imaging with contrast
70551	MRI brain (including brain stem), without contrast
70552	MRI brain (including brain stem), with contrast
70553	MRI brain (including brain stem), without contrast, followed by re-imaging with contrast
70554	MRI brain functional, not requiring physician or psychologist administration
70555	MRI brain functional, requiring physician or psychologist administration of entire neurofunctional testing
71250	Chest CT without contrast
71260	Chest CT with contrast
71270	Chest CT without contrast, followed by re-imaging with contrast
71550	MRI chest, without contrast
71551	MRI chest, with contrast
71552	MRI chest, without contrast, followed by re-imaging with contrast
72125	CT cervical spine, without contrast
72126	CT cervical spine, with contrast
72127	CT cervical spine, without contrast, followed by reimaging with contrast
72128	CT thoracic spine, without contrast
72129	CT thoracic spine, with contrast
72130	CT thoracic spine, without contrast, followed by reimaging with contrast
72131	CT lumbar spine, without contrast
72132	CT lumbar spine, with contrast
72133	CT lumbar spine, without contrast, followed by reimaging with contrast
72141	MRI cervical spine, without contrast
72142	MRI cervical spine, with contrast
72146	MRI thoracic spine, without contrast
72147	MRI thoracic spine, with contrast
72148	MRI lumbar spine, without contrast
72149	MRI lumbar spine, with contrast
72156	MRI cervical spine, without contrast, followed by reimaging with contrast
72157	MRI thoracic spine, without contrast, followed by reimaging with contrast

72158	MRI lumbar spine, without contrast, followed by reimaging with contrast
72192	CT pelvis without contrast
72193	CT pelvis with contrast
72194	CT pelvis without contrast, followed by re-imaging with contrast
72195	MRI pelvis without contrast
72196	MRI pelvis with contrast
72197	MRI pelvis without contrast, followed by re-imaging with contrast
73200	CT upper extremity, without contrast
73201	CT upper extremity, with contrast
73202	CT upper extremity, without contrast, followed by re-imaging with contrast
73218	MRI upper extremity non-joint, without contrast
73219	MRI upper extremity non-joint, with contrast
73220	MRI upper extremity non-joint, without contrast, followed by re-imaging with contrast
73221	MRI upper extremity any joint, without contrast
73222	MRI upper extremity any joint, with contrast
73223	MRI upper extremity any joint, without contrast, followed by re-imaging with contrast
73700	CT lower extremity, without contrast
73701	CT lower extremity, with contrast
73702	CT lower extremity, without contrast, followed by re-imaging with contrast
73718	MRI lower extremity non-joint, without contrast
73719	MRI lower extremity non-joint, with contrast
73720	MRI lower extremity non-joint, without contrast, followed by re-imaging with contrast
73721	MRI lower extremity any joint, without contrast
73722	MRI lower extremity any joint, with contrast
73723	MRI lower extremity any joint, without contrast, followed by re-imaging with contrast
74150	CT abdomen without contrast
74160	CT abdomen with contrast
74170	CT abdomen without contrast, followed by re-imaging with contrast
74176	CT abdomen and pelvis without contrast
74177	CT abdomen and pelvis with contrast
74178	CT abdomen and pelvis without contrast in one or both body regions, followed by re-imaging with contrast
74181	MRI abdomen without contrast
74182	MRI abdomen with contrast
74183	MRI abdomen without contrast, followed by re-imaging with contrast
74261	CT colonography diagnostic, including image post-processing, without contrast
74262	CT colonography diagnostic, including image post-processing, with contrast including non-contrast images, if performed
74263	CT colonography screening, including image post-processing
76390	MRI spectroscopy
77046	MRI breast without contrast material(s); unilateral
77047	MRI breast without contrast material(s); bilateral
77048	MRI breast without and with contrast with CAD; unilateral
77049	MRI breast without and with contrast with CAD; bilateral
77084	MRI, bone marrow blood supply
78608	Brain imaging PET, metabolic evaluation
78609	Brain imaging PET, perfusion evaluation
78811	PET imaging, limited area
78812	PET imaging, skull to mid-thigh
78813	PET imaging, whole body
78814	PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; limited area
78815	PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; skull base to mid-thigh
78816	PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; whole body
C8903	MRI with contrast, breast; unilateral
C8905	MRI without contrast followed by with contrast, breast; unilateral
C8906	MRI with contrast, breast; bilateral

C8908 MRI without contrast followed by with contrast, breast; bilateral
G0219 PET imaging whole body; melanoma for non-covered indications
G0235 PET imaging, any site, not otherwise specified
G0252 PET imaging, full and partial-ring PET scanners only, for initial diagnosis of breast cancer and/or surgical planning for breast cancer (e.g., initial staging of axillary lymph nodes)
G0297 Low-dose CT scan (LDCT) for lung cancer screening
S8037 Magnetic resonance cholangiopancreatography (mrcp)
S8085 Fluorine-18 fluorodeoxyglucose (f-18 fdg) imaging using dual-head coincidence detection system (non-dedicated PET scan)

ICD-10 Diagnosis

Refer to the ICD-10 CM manual

History

Status	Review Date	Effective Date	Action
Revised	05/11/2020, 07/08/2020	03/14/2021	Independent Multispecialty Physician Panel (IMPP) review. Revised criteria for Cancer Screening, Anal, Bladder/renal pelvis/ureter, Breast, Cervical, Colorectal, Esophageal/gastroesophageal junction, Gastric, Germ Cell (now Testicular), Hepatobiliary, Kidney, Lung, Lymphoma- Hodgkin, Lymphoma- Non Hodgkin, Melanoma, Multiple myeloma, Neuroendocrine, Ovarian, Pancreatic, Penile/vaginal/vulvar, Prostate, Sarcoma of Bone and Soft Tissue, Thyroid, Uterine, and Suspected metastases, not otherwise specified. Added HCPCS codes C8903, C8905, C8906, C8908, G0219, G0235, G0252, S8037, and S8085.
Revised	10/28/2019	08/17/2020	~~Independent Multispecialty Physician Panel (~~IMPP~~)~~ review. Revised criteria for Cancer screening and Breast Cancer.
Revised	01/28/2019, 03/25/2019	11/10/2019	IMPP review. Revised criteria for Anal, Bladder/renal pelvis/ureter, Brain/spinal cord, Breast, Cervical, Colorectal, Esophageal/gastroesophageal junction, Germ cell tumors, Head and neck, Kidney, Lung, Lymphoma- Hodgkin, Lymphoma- Non Hodgkin, Mucosal melanoma, Multiple myeloma, Pancreatic, Penile/vaginal/vulvar, Prostate, and Uterine. New sections added for Hepatobiliary and Suspected metastases, not otherwise specified.
Revised	09/12/2018	07/14/2019	IMPP review. Guidelines for 11C-Choline and 18F-Fluciclovine added for Prostate Cancer. Guideline for 68Ga-Dotatate added for Neuroendocrine Cancer.
Restructured	09/12/2018	01/01/2019	IMPP review. Advanced Imaging guidelines redesigned and reorganized to a condition-based structure.
Revised	07/11/2018	03/09/2019	IMPP review. Renamed the Administrative Guidelines to “General Clinical Guideline.” Retitled Pretest Requirements to “Clinical Appropriateness Framework” to summarize the components of a decision to pursue diagnostic testing. Revised to expand applicability beyond diagnostic imaging, retitled Ordering of Multiple Studies to “Ordering of Multiple Diagnostic or Therapeutic Interventions” and replaced imaging-specific terms with “diagnostic or therapeutic

Status	Review Date	Effective Date	Action
			intervention." Repeated Imaging split into two subsections, "repeat diagnostic testing" and "repeat therapeutic intervention."
Revised	09/07/2017	03/12/2018	IMPP review. Revised criteria for Anal, Bladder, Bone/cartilage, Central nervous system, Cervical, Colorectal, Germ cell tumors, Lung cancer, Neuroendocrine tumor, Other cancers, Pancreatic, Skin, Thorax, Thyroid, Uterine, and Vaginal/vulvar/penile cancers.
Created	-	03/30/2005	Original effective date