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American College of Radiology
ACR Appropriateness Criteria®
Suspected Abdominal Neoplasm-Child

Variant: 1 Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
US abdomen	Usually Appropriate	O
Radiography abdomen	Usually Appropriate	☢☢
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢☢
US pelvis transabdominal	May Be Appropriate	O
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	O
CT chest abdomen pelvis with IV contrast	May Be Appropriate	☢☢☢☢
US abdomen with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/MRI skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢☢
MIBG scan whole body	Usually Not Appropriate	☢☢☢☢
MIBG scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	Varies
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 2 Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.

Procedure	Appropriateness Category	Peds Relative Radiation Level
US abdomen	Usually Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢☢
US pelvis transabdominal	May Be Appropriate (Disagreement)	O
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	O
CT abdomen without and with IV contrast	May Be Appropriate	☢☢☢☢☢
CT chest abdomen pelvis with IV contrast	May Be Appropriate	☢☢☢☢

US abdomen with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/MRI skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢☢
MIBG scan whole body	Usually Not Appropriate	☢☢☢☢
MIBG scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	Varies
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

<u>Variant: 3</u> Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
US abdomen	Usually Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
MRI abdomen without and with IV contrast	May Be Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
CT chest abdomen pelvis with IV contrast	May Be Appropriate	☢☢☢☢
US abdomen with IV contrast	Usually Not Appropriate	O
US pelvis transabdominal	Usually Not Appropriate	O
Radiography abdomen	Usually Not Appropriate	☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/MRI skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢☢
MIBG scan whole body	Usually Not Appropriate	☢☢☢☢
MIBG scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	Varies
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

Suspected abdominal neoplasms in children encompass a wide range of potential malignant and benign tumors originating from various abdominal organs, including the liver, kidneys, adrenal glands, bowel, lymph nodes, and soft tissues [1-6]. The most common malignant abdominal neoplasms in children are neuroblastoma, Wilms tumor, hepatoblastoma, and lymphoma [1, 2, 4, 5]. Neoplasms often present with a palpable abdominal mass, which may be accompanied by other symptoms such as abdominal pain, distension, constipation, or systemic signs like fever, weight loss, and anorexia [7]. The presence of a palpable abdominal mass in a child warrants prompt evaluation to determine the underlying cause and initiate appropriate management. However, not all palpable masses are tumors. A palpable abdominal mass may also be due to large stool burden associated with constipation. Additionally, palpable abdominal wall masses also include benign etiologies such as hernia. Consequently, imaging plays a vital role in differentiating and directing management.

The American Cancer Society estimates that in 2021, about 1,050 new cases of Wilms tumor, 800 cases of neuroblastoma, and 100 cases of hepatoblastoma will be diagnosed in children in the United States [1, 2, 4]. The incidence of these neoplasms varies with age. Neuroblastoma is more common in infants and young children, whereas Wilms tumor and hepatoblastoma typically occur in children <5 years of age [1, 2, 4, 8]. Accurate and timely diagnosis of abdominal neoplasms in children is crucial for optimal treatment planning and improved outcomes [7, 9]. Imaging plays a vital role in the initial evaluation, staging, and follow-up of these patients [7, 10-12]. The choice of imaging modality depends on various factors, including the child's age, clinical presentation, and suspected tumor type [7, 10, 11]. This document will discuss the appropriateness of different imaging modalities for the evaluation of suspected abdominal neoplasms in children, focusing on three clinical variants: 1) child with a palpable abdominal mass and suspected neoplasm, initial imaging; 2) child with a palpable abdominal mass and suspected neoplasm, radiographs negative, and next imaging study; and 3) child with a palpable abdominal wall mass and suspected abdominal wall neoplasm, initial imaging. Please note, subsequent follow-up or surveillance imaging is beyond the scope of this document and is addressed in peer reviewed literature.

Special Imaging Considerations

When preforming abdominopelvic MRI, specific sequences such as diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) mapping, can provide additional information about tumor cellularity and can help differentiate benign from malignant lesions [2, 4, 6, 13]. The use of gadolinium-based contrast agents in MRI can further enhance the characterization of tumor vascularity and delineate the extent of tumor involvement [1-6]. However, the need for sedation or general anesthesia in young or developmentally delayed children undergoing MRI should be carefully weighed against the potential risks [10, 14]. Additionally, there are concerns about gadolinium deposition in the brain and other tissues with repeated use of gadolinium-based contrast agents, especially in patients undergoing multiple scans. This potential risk should be considered when planning imaging strategies, and the necessity of contrast-enhanced MRI should be carefully evaluated for each patient. Of note, unlike renal masses, when imaging hepatic masses, MRI with hepatobiliary agents is recommended [2-6]. Consequently, ultrasound (US) is often used in the evaluation of suspected pediatric abdominal tumors as it can identify the organ of origin and direct the next best imaging study and contrast agent. Further comprehensive discussion is beyond the scope of this document and is covered within the provided references.

Radiomics, which uses detailed measurements from MRI to identify characteristics of tumors, is becoming especially important for certain types of tumor imaging, including pediatric abdominal and abdominal wall masses. By using dynamic contrast-enhanced MRI, time-activity curves can be useful to monitor how tumors respond to treatment. This technique can help distinguish between active disease, responding masses, and benign tissues based on how they appear over time during imaging and is available only with MRI. Similarly, maps of ADCs from MRI have been reported to provide additional relevant information in the research setting, suggesting they will be clinically useful as another tool to assess treatment response [2-6].

CT may also be used rather than MRI in children requiring sedation for MRI. Radiation dose may be considered when deciding between CT and MR in scenarios where the examinations have equivalent diagnostic accuracy and usefulness. Nearly universally in pediatric patients, multiphase CT should not be performed for any child-specific protocols [10, 14, 15].

When considering nuclear medicine studies such as single-photon emission computed tomography (SPECT) and PET, it is crucial to note these studies may also require sedation, particularly in the case of SPECT with CT and PET/MRI [2-5, 16-19]. Finally, innovations in radiotherapy and new types of radiotracers could further enhance diagnostic options for rare pediatric abdominal tumors, but are beyond the scope of this document [6].

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient’s care).

Discussion of Procedures by Variant

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.

When a child presents with a palpable abdominal mass and a neoplasm is suspected, the choice of initial imaging modality is crucial for diagnosis or to provide planning for additional diagnostic imaging. Initial imaging is also crucial to help identify nonneoplastic etiologies for abdominal mass.

In the discussion below, "area of interest" can refer to the following: pelvis, abdomen, and chest. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
A. CT abdomen and pelvis with IV contrast

CT abdomen and pelvis with intravenous (IV) contrast can accurately assess the extent of the tumor, detect lymph node involvement, and evaluate for distant metastases [22-27]. CT can also identify complications such as tumor rupture or vascular involvement [25, 27]. However, in a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages over CT, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. However, CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. The need for imaging the pelvis or chest in addition to the abdomen depends on the potential suspected malignancy type [2-5, 22, 26] but, if relevant, should be included in assessment.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

CT of the abdomen and pelvis without and with IV contrast can provide a comprehensive evaluation of pediatric abdominal neoplasms [20, 22, 23, 25, 26]. The noncontrast phase can assess for tumor calcification or hemorrhage, whereas the contrast-enhanced phase can evaluate tumor vascularity, enhancement patterns, and lymph node involvement [20, 22, 23, 25, 26]. Additionally, in a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. Single-phase CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. Although performing both without and with contrast phases can add information, it is not recommended for initial imaging. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
C. CT abdomen and pelvis without IV contrast

Per expert opinion, this procedure may not be useful as the initial study. Noncontrast CT can provide useful information for evaluating pediatric abdominal neoplasms [22, 23, 25-27]. It may assess the size and location of the tumor and detect complications such as tumor rupture [25, 27]. However, the lack of contrast limits the evaluation of tumor vascularity, enhancement patterns, and lymph node involvement [22-25, 27], and in these cases, other modalities are preferred. Additionally, if metastases are suspected, contrast-enhanced CT is useful as it is better for identifying metastases [3, 5]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.

D. CT abdomen with IV contrast

The need for imaging the pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. CT can accurately assess the extent of the tumor, detect lymph node involvement, and evaluate for metastases in the abdomen [22-27]. CT can also identify complications such as tumor rupture or vascular involvement [25, 27]. However, in a study that directly compared the performance of single-phase-enhanced CT and US for the preoperative evaluation of solid abdominal tumors in children, US showed some advantages over CT, including the detection of tumor invasion of adjacent structures, including vasculature, in 14% of cases [1]. CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. Per expert opinion, abdomen CT alone is not typically useful for initial imaging for this scenario. Abdomen and pelvis is recommended per expert consensus.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
E. CT abdomen without and with IV contrast

CT of the abdomen without and with IV contrast can provide a comprehensive evaluation of pediatric abdominal neoplasms [20, 22, 23, 25, 26]. The noncontrast phase can assess for tumor calcification or hemorrhage, whereas the contrast-enhanced phase can evaluate tumor vascularity, enhancement patterns, and lymph node involvement [20, 22, 23, 25, 26]. Additionally, in a study that directly compared the performance of single-phase-enhanced CT and US for the preoperative evaluation of solid abdominal tumors in children, US showed some advantages over CT, including the detection of tumor invasion of adjacent structures, including vasculature, in 14% of cases [1]. However, single-phase CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. Finally, in liver masses, including in pediatric patients' multiple phases on CT are indicated [2], but should not performed as initial imaging, until it is known there is a liver mass. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
F. CT abdomen without IV contrast

Noncontrast CT of the abdomen can provide useful information for evaluating pediatric abdominal neoplasms, when necessary [22, 23, 25-27]. It may assess the size and location of the tumor and detect complications such as tumor rupture [25, 27]. However, the lack of contrast limits the evaluation of tumor vascularity, enhancement patterns, and lymph node involvement [22-25, 27], and in these cases, other modalities are preferred. Additionally, if metastases are suspected, contrast-enhanced CT is indicated as it is better for identifying metastases [3, 5]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
G. CT chest abdomen pelvis with IV contrast

CT of the chest, abdomen, and pelvis with IV contrast can provide a comprehensive staging evaluation for pediatric abdominal neoplasms, particularly when there is concern for distant metastases [22-27, 29]. CT can assess the primary tumor, detect lymph node involvement, and evaluate for pulmonary or bony metastases [22-27, 29]. However, the inclusion of the chest should be limited to patients in whom pulmonary metastases are suspected [29]. Additionally, in a study that directly compared the performance of single-phase-enhanced CT and US for the preoperative evaluation of solid abdominal tumors in children, US showed some advantages over CT, including the detection of tumor invasion of adjacent structures, including vasculature, in 14% of cases [1]. CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. Finally, the chest should be included for patients in whom metastases can be found in the chest [29].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
H. CT chest abdomen pelvis without and with IV contrast

CT of the chest, abdomen, and pelvis without and with IV contrast can offer a detailed staging assessment for pediatric abdominal neoplasms, especially when there is concern for distant metastases [22-27]. The noncontrast phase can detect tumor calcification or hemorrhage, whereas the contrast-enhanced phase can evaluate tumor vascularity, enhancement patterns, and lymph node involvement [22-27]. However, imaging the chest should be in a single phase only and limited to patients in whom pulmonary metastases are suspected. Additionally, in a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. Single-phase CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [29]. Although performing both without and with contrast phases can add information, it is not recommended for initial imaging. The inclusion of the chest should be limited to patients in whom malignancies can be found in the chest. The need for imaging the pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
I. CT chest abdomen pelvis without IV contrast

Noncontrast CT of the chest, abdomen, and pelvis can provide a staging evaluation for pediatric abdominal neoplasms [22, 23, 25-27]. It can assess the primary tumor, detect lymph node involvement, and evaluate for pulmonary or bony metastases [22, 23, 25-27]. However, the lack of contrast may limit the evaluation of tumor vascularity and enhancement patterns. Finally, the inclusion of the chest should be limited to patients in whom pulmonary metastases are suspected [29]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
J. FDG-PET/CT skull base to mid-thigh

There is no relevant literature to support the use of FDG-PET/CT skull base to mid-thigh in the initial evaluation of suspected abdominal neoplasms in children.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
K. FDG-PET/CT whole body

There is no relevant literature to support the use of FDG-PET/CT whole body in the initial evaluation of suspected abdominal neoplasms in children.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
L. FDG-PET/MRI skull base to mid-thigh

There is no relevant literature to support the use of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/MRI skull base to mid-thigh in the initial evaluation of suspected abdominal neoplasms in children.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
M. FDG-PET/MRI whole body

There is no relevant literature to support the use of FDG-PET/MRI whole body in the initial evaluation of suspected abdominal neoplasms in children.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
N. MIBG scan whole body

There is no relevant literature to support the use of meta-iodobenzylguanidine (MIBG) scan whole body in the initial evaluation of suspected abdominal neoplasms in children.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
O. MIBG scan whole body with SPECT or SPECT/CT area of interest

There is no relevant literature to support the use of MIBG scan whole body with SPECT or SPECT/CT area of interest in the initial evaluation of suspected abdominal neoplasms in children.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
P. MRI abdomen and pelvis without and with IV contrast

MRI of the abdomen and pelvis without and with IV contrast is a comprehensive imaging modality for evaluating pediatric abdominal neoplasms, offering excellent soft tissue contrast and multiplanar imaging capabilities [10, 13, 14, 20, 28-31]. MRI can accurately assess the extent of tumors and their relationship to adjacent structures, and also potential bone marrow involvement, which is important for staging and surgical planning [14, 18, 20, 29-31]. DWI can help differentiate benign from malignant lesions [13]. The usefulness of both pre- and postcontrast sequences has been demonstrated; for example, in a study assessing precontrast MRI for pediatric oncology patients, precontrast MRIs showed nearly 90% accuracy in detecting lesions when compared to 100% for pre- and postcontrast. However, the addition of gadolinium contrast significantly enhanced radiologists' diagnostic confidence [30]. In patients with known renal masses, MRI has shown better sensitivity than CT in detecting small and contralateral renal lesions, but the direct relevance of this sensitivity in initial imaging of patients with suspected abdominal neoplasm has not been evaluated [29]. Similarly, in patients with known liver masses, MRI without and with a hepatobiliary contrast agent is recommended over CT for diagnosing and staging the tumor extent and guide surgical planning [2]. However, this is in patients with known masses, and direct relevance to suspected but not known abdominal neoplasms has not been studied. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

MRI is often used as a comprehensive imaging modality for the evaluation of many pediatric abdominal tumors [1-6, 8-10, 14, 20]. MRI offers excellent soft tissue contrast, multiplanar imaging capabilities, and the ability to characterize the internal structure of the tumor [1-6, 8-10, 14, 20].

Specific MRI sequences, such as DWI and ADC mapping, can provide additional information about tumor cellularity and can help differentiate benign from malignant lesions [2, 4, 6, 13]. The use of gadolinium-based contrast agents in MRI can further enhance the characterization of tumor vascularity and delineate the extent of tumor involvement [1-6]. However, the need for sedation or general anesthesia in young or developmentally delayed children undergoing MRI should be carefully weighed against the potential risks [10, 14]. Additionally, there are concerns about gadolinium deposition in the brain and other tissues with repeated use of gadolinium-based contrast agents, especially in patients undergoing multiple scans. This potential risk should be considered when planning imaging strategies, and the necessity of contrast-enhanced MRI should be carefully evaluated for each patient. Of note, unlike renal masses, when imaging hepatic masses, MRI with hepatobiliary agents is recommended [2-6]. Consequently, US is often used in the evaluation of suspected pediatric abdominal tumors as it can identify the organ of origin and direct the next best imaging study and contrast agent. Further comprehensive discussion is beyond the scope of this document and is covered within the provided references.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
Q. MRI abdomen and pelvis without IV contrast

Noncontrast MRI of the abdomen and pelvis can provide useful information for evaluating pediatric abdominal neoplasms when needed [13, 29, 30]. DWI can aid in lesion characterization without the need for contrast [13]. The usefulness of MRI without IV contrast has been demonstrated in a study assessing precontrast MRI for pediatric oncology patients, precontrast MRIs showed nearly 90% accuracy in detecting lesions when compared to 100% for pre- and postcontrast. However, in this study the addition of gadolinium contrast significantly enhanced radiologists' diagnostic confidence [30]. Additionally, the lack of contrast limits the assessment of tumor vascularity and enhancement patterns [3, 5, 10, 13, 29, 30]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
R. MRI abdomen without and with IV contrast

Per expert opinion, MRI may not be useful as the initial study for this scenario. MRI of the abdomen without and with IV contrast is an effective modality for evaluating the extent and characteristics of pediatric abdominal neoplasms [10, 13, 14, 20, 28-31]. MRI can accurately assess the extent of tumors and their relationship to adjacent structures, which is important for staging and surgical planning [14, 20, 28-31]. DWI can help differentiate benign from malignant lesions [13]. The usefulness of both pre- and postcontrast sequences has been demonstrated; for example, in a study assessing precontrast MRI for pediatric oncology patients, precontrast MRIs showed nearly 90% accuracy in detecting lesions when compared to 100% for pre- and postcontrast. However, the addition of gadolinium contrast significantly enhanced radiologists' diagnostic confidence, underscoring its value [30]. In patients with known renal masses, MRI has shown better sensitivity than CT in detecting small and contralateral renal lesions, but the direct relevance of this sensitivity in initial imaging of patients with suspected abdominal neoplasm has not been evaluated [29]. Similarly, in patients with known liver masses, MRI without and with a hepatobiliary contrast agent is recommended over CT for diagnosing and staging using the PRE-Treatment Extent of tumor (PRETEXT) system to classify tumor extent and guide surgical planning [2]. However, this is in patients with known masses, and direct relevance to suspected by not known abdominal neoplasms has not been studied. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

MRI is often used as a comprehensive imaging modality for the evaluation of many pediatric abdominal tumors [1-6, 8-10, 14, 20]. MRI offers excellent soft tissue contrast, multiplanar imaging capabilities, and the ability to characterize the internal structure of the tumor [1-6, 8-10, 14, 20].

Specific MRI sequences, such as DWI and ADC mapping, can provide additional information about tumor cellularity and can help differentiate benign from malignant lesions [2, 4, 6, 13]. The use of gadolinium-based contrast agents in MRI can further enhance the characterization of tumor vascularity and delineate the extent of tumor involvement [1-6]. However, the need for sedation or general anesthesia in young or developmentally delayed children undergoing MRI should be carefully weighed against the potential risks [10, 14]. Additionally, there are concerns about gadolinium deposition in the brain and other tissues with repeated use of gadolinium-based contrast agents, especially in patients undergoing multiple scans. This potential risk should be considered when planning imaging strategies, and the necessity of contrast-enhanced MRI should be carefully evaluated for each patient. Of note, unlike renal masses, when imaging hepatic masses, MRI with hepatobiliary agents is recommended [2-6]. Consequently, US is often used in the evaluation of suspected pediatric abdominal tumors as it can identify the organ of origin and direct the next best imaging study and contrast agent. Further comprehensive discussion is beyond the scope of this document and is covered within the provided references.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
S. MRI abdomen without IV contrast

Per expert opinion, MRI may not be useful as the initial study. Noncontrast MRI of the abdomen can provide valuable information for assessing pediatric abdominal neoplasms, when necessary [10, 13, 29, 30]. DWI can aid in lesion characterization without the need for contrast [13]. However, the lack of contrast may limit the evaluation of tumor vascularity and enhancement patterns [3, 5, 10, 13, 29, 30].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
T. Radiography abdomen

Radiography may detect large masses or calcifications associated with certain tumors such as neuroblastoma or Wilms tumor, and is a useful initial imaging study to direct the need for further imaging [20, 21]. Additionally, radiography is useful when large stool burden is the favored etiology for palpable abdominal mass, and the suspicion for neoplasm is low. However, radiography is limited in assessing the full extent of a mass and its relationship to adjacent structures, and other studies will typically be needed to direct management if a mass is identified radiographically.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
U. US abdomen

US is the preferred initial imaging modality for evaluating suspected abdominal neoplasms in children due to its ability to identify the organ of origin and the ability to characterize the solid and cystic nature of the mass [1, 3]. In a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages over CT, including the detection of tumor invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. However, CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. US is useful for its ability to identify free fluid in the abdomen, which could indicate tumor rupture and if identified, impacts patient management [2]. In conclusion, US may be limited in assessing the full extent of a suspected mass and metastases, and other studies are often needed to direct management, particularly for preoperative planning when a mass is identified sonographically [1, 3].

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
V. US abdomen with IV contrast

There is no relevant literature to support the use of US abdomen with IV contrast in the evaluation of suspected abdominal neoplasms in children. Although performing contrast-enhanced US can add information, it is not recommended for initial imaging.

Variant 1:Child. Palpable abdominal mass. Suspected neoplasm. Initial imaging.
W. US pelvis transabdominal

Transabdominal pelvic US can be useful in assessing the extent of abdominal neoplasms that may involve the pelvis when combined with abdominal US [1]. Additionally, US is useful for its ability to identify free fluid in the pelvis, which could indicate tumor rupture and if identified, impacts patient management [2]. It also could identify a primary pelvic mass (such as ovarian, bladder, or prostate), which has either extended into the abdomen or has abdominal metastases. However, its usefulness may be limited by patient factors such as obesity or bowel gas, and it should not be performed as a stand-alone examination without an US of the abdomen in the setting of palpable abdominal mass [1].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.

When a child presents with a palpable abdominal mass and a neoplasm is suspected, but radiography is negative, the next imaging study should be selected based on the clinical suspicion and the need for further characterization of the mass. The subsequent imaging modality is crucial for diagnosis or to provide planning for additional diagnostic imaging. US is often the first-line imaging tool. However other imaging modalities may be used based on the patient's age, clinical presentation, and suspected tumor type.

In the discussion below, "area of interest" can refer to the following: pelvis, abdomen, and chest. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
A. CT abdomen and pelvis with IV contrast

CT of the abdomen and pelvis with IV contrast can accurately assess the extent of the tumor, detect lymph node involvement, and evaluate for distant metastases [22-27]. CT can also identify complications such as tumor rupture or vascular involvement [25, 27]. However, in a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
B. CT abdomen and pelvis without and with IV contrast

CT of the abdomen and pelvis without and with IV contrast can provide a comprehensive evaluation of pediatric abdominal neoplasms [22-27]. The noncontrast phase can assess for tumor calcification or hemorrhage, whereas the contrast-enhanced phase can evaluate tumor vascularity, enhancement patterns, and lymph node involvement [22-27]. Additionally, in a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. Single-phase CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. Per expert opinion, two phase CT is not necessary for this scenario.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
C. CT abdomen and pelvis without IV contrast

Noncontrast CT of the abdomen and pelvis can provide useful information for evaluating pediatric abdominal neoplasms when needed [22, 23, 25-27]. It can typically assess the size and location of the tumor and detect complications such as tumor rupture [25, 27]. However, the lack of contrast limits the evaluation of tumor vascularity, enhancement patterns, and lymph node involvement [22-25, 27], and in these cases, other modalities are preferred. Additionally, if metastases are suspected, contrast-enhanced CT is indicated as it is better for identifying metastases [3, 5]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
D. CT abdomen with IV contrast

CT of the abdomen with IV contrast is a rapid imaging modality for evaluating pediatric abdominal neoplasms [22-27]. The need for imaging the pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. CT can accurately assess the extent of the tumor, detect lymph node involvement, and evaluate for distant metastases [22-27]. CT can also identify complications such as tumor rupture or vascular involvement [25, 27]. However, in a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. Per expert consensus, abdomen alone is not recommended in isolation for cross-sectional imaging for this scenario. Abdomen and pelvis is preferred.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
E. CT abdomen without and with IV contrast

CT of the abdomen and pelvis without and with IV contrast can provide a comprehensive evaluation of pediatric abdominal neoplasms [22-27]. The noncontrast phase can assess for tumor calcification or hemorrhage, whereas the contrast-enhanced phase can evaluate tumor vascularity, enhancement patterns, and lymph node involvement [22-27]. Additionally, in a study, which directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not

[1]. Single-phase CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
F. CT abdomen without IV contrast

Noncontrast CT can provide useful information for evaluating pediatric abdominal neoplasms when needed [22, 23, 25-27]. It can typically assess the size and location of the tumor and detect complications such as tumor rupture [25, 27]. However, the lack of contrast limits the evaluation of tumor vascularity, enhancement patterns, and lymph node involvement [22-25, 27], and in these cases, other modalities are preferred. Additionally, if metastases are suspected, contrast-enhanced CT is indicated as it is better for identifying metastases [3, 5]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
G. CT chest abdomen pelvis with IV contrast

CT of the chest, abdomen, and pelvis with IV contrast can provide a comprehensive staging evaluation for pediatric abdominal neoplasms, particularly when there is concern for distant metastases [22-27, 29]. It can assess the primary tumor, detect lymph node involvement, and evaluate for pulmonary or bony metastases [22-27, 29]. Additionally, in a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. The need for imaging the chest is dependent on the suspected malignancy type [2-5, 22, 26].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
H. CT chest abdomen pelvis without and with IV contrast

CT of the chest, abdomen, and pelvis without and with IV contrast can offer a detailed staging assessment for pediatric abdominal neoplasms, especially when there is concern for distant metastases [22-27]. The noncontrast phase can detect tumor calcification or hemorrhage, whereas the contrast-enhanced phase can evaluate tumor vascularity, enhancement patterns, and lymph node involvement [22-27]. However, imaging the chest should be in a single phase only and limited to patients in whom pulmonary metastases are suspected. Additionally, in a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. Single-phase CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [1]. Finally, the inclusion of the chest and pelvis should be limited to patients in whom pulmonary metastases are suspected [29]. The need for imaging the pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next

imaging study.
I. CT chest abdomen pelvis without IV contrast

Noncontrast CT of the chest, abdomen, and pelvis can provide a staging evaluation for pediatric abdominal neoplasms when needed [22, 23, 25-27]. It can assess the primary tumor, detect lymph node involvement, and evaluate for pulmonary or bony metastases [22, 23, 25-27]. However, the lack of contrast may limit the evaluation of tumor vascularity and enhancement patterns [22-27]. Finally, the inclusion of the chest should be limited to patients in whom pulmonary metastases are suspected [29]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
J. FDG-PET/CT skull base to mid-thigh

FDG-PET/CT from the skull base to mid-thigh is a valuable imaging modality for staging and follow-up, particularly for pediatric lymphoma and neuroblastoma [11, 12, 16, 28, 36-42]. However, FDG-PET/CT is generally reserved for staging and follow-up of confirmed malignancies rather than initial evaluation of suspected abdominal neoplasms in children. It can detect primary tumors, lymph node involvement, and distant metastases with high sensitivity and specificity [11, 12, 16, 28, 36-42]. FDG-PET/CT can also provide prognostic information and assess treatment response [31, 36, 39, 41]. However, its usefulness as initial imaging for suspected abdominal mass has not been directly studied, though other studies typically performed as initial imaging, in part because FDG-PET/CT may require sedation in young children [10, 14]. Additionally, FDG-PET/CT may be less ubiquitous than other imaging modalities such as US and CT [10].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
K. FDG-PET/CT whole body

Whole body FDG-PET/CT is an effective imaging modality for comprehensive staging and follow-up, particularly for pediatric lymphoma and neuroblastoma [11, 12, 16, 28, 34, 36-42]. However, FDG-PET/CT is generally reserved for staging and follow-up of confirmed malignancies rather than initial evaluation of suspected abdominal neoplasms in children. It can detect primary tumors, lymph node involvement, and distant metastases with high sensitivity and specificity [11, 12, 16, 28, 34, 36-42]. FDG-PET/CT can also provide prognostic information, assess treatment response, and guide biopsy site selection [31, 34, 36, 39, 41]. In an International Atomic Energy Agency multicenter prospective study comparing whole body to skull base to mid-thigh PET/CT, the study found that whole body PET/CT identified additional lesions in 11.1% of patients, leading to upstaging in 5.6% [40]. This study was for staging and following in patients with lymphoma, and generalizability to other patient populations is uncertain. Additionally, its usefulness as initial imaging for suspected abdominal wall mass has not been directly studied, though other studies typically performed as initial imaging, in part because FDG-PET/CT may require sedation in young children [10, 14]. Additionally, FDG-PET/CT may be less ubiquitous than other imaging modalities such as US and CT [10].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
L. FDG-PET/MRI skull base to mid-thigh

FDG-PET/MRI combines the soft tissue contrast and multiplanar capabilities of MRI with the metabolic information of FDG-PET [21, 32, 33]. It can accurately stage pediatric malignancies, particularly lymphoma and neuroblastoma compared to FDG-PET/CT [21, 32, 33]. However, FDG-PET is generally reserved for staging and follow-up of confirmed malignancies rather than initial evaluation of suspected abdominal neoplasms in children. Other studies are typically preferred as initial imaging due to FDG-PET/MRI's longer imaging times, and need for sedation in young children compared to modalities like US and MRI [10, 21, 32, 33]. Additionally, FDG-PET/MRI's role in evaluating pediatric abdominal neoplasms is still being defined [21, 32, 33]. Consequently, FDG-PET/MRI is primarily reserved for staging and follow-up of confirmed malignancies.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
M. FDG-PET/MRI whole body

Whole body FDG-PET/MRI can provide comprehensive staging information for pediatric malignancies, particularly pediatric lymphoma and neuroblastoma [21, 32, 33]. It combines the soft tissue contrast and multiplanar capabilities of MRI with the metabolic information of FDG-PET [21, 32, 33]. FDG-PET is generally reserved for staging and follow-up of confirmed malignancies rather than initial evaluation of suspected abdominal neoplasms in children and FDG-PET/MRI's role in evaluating pediatric abdominal neoplasms is still being defined [21, 32, 33]. There is no relevant literature that directly compares the usefulness of whole body PET/MRI compared to skull base to mid-thigh PET/MRI. Other studies are typically preferred as initial imaging due to FDG-PET/MRI's longer imaging times, and need for sedation in young children compared to modalities like US and MRI [10, 21, 32, 33].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
N. MIBG scan whole body

MIBG scintigraphy is a valuable tool for detecting and staging neuroblastoma, the most common extracranial solid tumor in children, pheochromocytoma, and other neuroblastic tumors [2-5, 16-19, 28]. Whole body MIBG scans can identify primary tumors, regional lymph node involvement, and distant metastases [2-5, 16-19, 28, 34] . MIBG does not play a role in most suspected abdominal neoplasms [3]. MIBG avidity correlates with clinical features, tumor biology, and outcomes in neuroblastoma [9, 12]. Of note, approximately 10% of neuroblastoma tumors do not take up MIBG and other imaging modalities such as FDG-PET/CT [8, 11, 12, 16, 34] may also be needed.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
O. MIBG scan whole body with SPECT or SPECT/CT area of interest

MIBG scintigraphy is a valuable tool for detecting and staging neuroblastoma, which may present as a radiographically occult abdominal mass in children, pheochromocytoma, and other neuroblastic tumors [2-5, 16-19, 28]. MIBG is only indicated in the setting of neuroblastoma, and does not play a role in any other suspected abdominal neoplasms [3]. Whole body MIBG scans can identify primary tumors, regional lymph node involvement, and distant metastases [2-5, 16-19, 34]. MIBG avidity correlates with clinical features, tumor biology, and outcomes in neuroblastoma [9, 12]. The addition of SPECT or SPECT/CT to whole body MIBG scintigraphy improves the detection and localization of neuroblastoma lesions compared to planar imaging alone and can prevent false positives due to physiologic uptake [2, 3, 5, 8, 9, 16, 34]. SPECT/CT provides superior anatomic localization and can impact Curie and SIOPEN (International Society of Pediatric Oncology Europe Neuroblastoma) scoring, which have prognostic significance [35]. Of note, approximately 10% of neuroblastoma tumors do not take up MIBG and some neuroblastoma lesions may have mixed avidity that are better detected by other imaging modalities such as FDG-PET/CT [8, 11, 12, 16, 34], and both studies may be useful. Finally, MIBG does not play a role most abdominal neoplasms. These studies may also require sedation, particularly in the case of SPECT with CT and PET/MRI [2-5, 16-19, 34].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
P. MRI abdomen and pelvis without and with IV contrast

MRI without and with IV contrast is a comprehensive imaging modality for evaluating pediatric abdominal neoplasms, offering excellent soft tissue contrast and multiplanar imaging capabilities [10, 13, 14, 20, 28-31]. MRI can accurately assess the extent of tumors and their relationship to adjacent structures, which is important for staging and surgical planning [14, 18, 20, 28-31]. DWI can help differentiate benign from malignant lesions [13]. The usefulness of both pre- and postcontrast sequences has been demonstrated; for example. in a study assessing precontrast MRI for pediatric oncology patients, precontrast MRIs showed nearly 90% accuracy in detecting lesions when compared to 100% for pre- and postcontrast. However, the addition of gadolinium contrast significantly enhanced radiologists' diagnostic confidence [30]. In patients with known renal masses, MRI has shown better sensitivity than CT in detecting small and contralateral renal lesions, but the direct relevance of this sensitivity in initial imaging of patients with suspected abdominal neoplasm has not been evaluated [29]. Similarly, in patients with known liver masses, MRI without and with a hepatobiliary contrast agent is recommended over CT for diagnosing and staging using the PRETEXT system to classify tumor extent and guide surgical planning [2]. However, this is in patients with known masses, and direct relevance to suspected by not known abdominal neoplasms has not been studied. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

The decision to image with CT or MRI is in part, dependent on the type of suspected abdominal neoplasm [1-5, 26]. Specifically, if hepatoblastoma or a nonneuroblastoma adrenal mass is suspected, MRI offers optimal tissue characterization. For most other masses, there are advantages to either CT or MRI, and the preferred modality depends on multiple factors. CT is faster to perform and may not require sedation. CT can detect tumoral calcifications and provides a global view of anatomy for staging. However, MRI provides superior contrast resolution. MRI is particularly advantageous for characterizing liver masses, assessing intraspinal extension of neuroblastoma, and detecting bone marrow metastases. Ultimately, the choice between CT and MRI depends on the patient's age, the suspected tumor type, and the need to avoiding sedation (often required for MRI).

Specific MRI sequences, such as DWI and ADC mapping, can provide additional information about tumor cellularity and can help differentiate benign from malignant lesions [2, 4, 6, 13]. The use of gadolinium-based contrast agents in MRI can further enhance the characterization of tumor vascularity and delineate the extent of tumor involvement [1-6]. However, the need for sedation or general anesthesia in young or developmentally delayed children undergoing MRI should be carefully weighed against the potential risks [10, 14]. Additionally, there are concerns about gadolinium deposition in the brain and other tissues with repeated use of gadolinium-based contrast agents, especially in patients undergoing multiple scans. This potential risk should be considered when planning imaging strategies, and the necessity of contrast-enhanced MRI should be carefully evaluated for each patient. Of note, unlike renal masses, when imaging hepatic masses, MRI with hepatobiliary agents is recommended [2-6]. Consequently, US is often used in the evaluation of suspected pediatric abdominal tumors as it can identify the organ of origin and direct the next best imaging study and contrast agent. Further comprehensive discussion is beyond the scope of this document and is covered within the provided references.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
Q. MRI abdomen and pelvis without IV contrast

Noncontrast MRI can provide useful information for evaluating pediatric abdominal neoplasms when needed [13, 29, 30]. DWI can aid in lesion characterization without the need for contrast [13]. The usefulness of noncontrast MRI alone has been demonstrated in a study assessing precontrast MRI for pediatric oncology patients, precontrast MRIs showed nearly 90% accuracy in detecting lesions when compared to 100% for pre- and postcontrast. However, in this study the addition of gadolinium contrast significantly enhanced radiologists' diagnostic confidence, underlining its value [30]. Additionally, the lack of contrast limits the assessment of tumor vascularity and enhancement patterns [3, 5, 10, 13, 29, 30]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. Per expert consensus, MRI may not be useful prior to US and CT for this scenario.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
R. MRI abdomen without and with IV contrast

MRI of the abdomen without and with IV contrast is an effective modality for evaluating the extent and characteristics of pediatric abdominal neoplasms [10, 13, 14, 20, 28-31]. MRI can accurately assess the extent of tumors and their relationship to adjacent structures, which is important for staging and surgical planning [14, 20, 28-31]. DWI can help differentiate benign from malignant lesions [13]. The usefulness of both pre- and postcontrast sequences has been demonstrated; for example, in a study assessing precontrast MRI for pediatric oncology patients, precontrast MRIs showed nearly 90% accuracy in detecting lesions when compared to 100% for pre- and postcontrast. However, the addition of gadolinium contrast significantly enhanced radiologists' diagnostic confidence, underlining its value [30]. In patients with known renal masses, MRI has shown better sensitivity than CT in detecting small and contralateral renal lesions, but the direct relevance of this sensitivity in initial imaging of patients with suspected abdominal neoplasm has not been evaluated [29]. Similarly, in patients with known liver masses, MRI without and with a hepatobiliary contrast agent is recommended over CT for diagnosing and staging using the PRETEXT system to classify tumor extent and guide surgical planning [2]. However, this is in patients with known masses, and direct relevance to suspected by not known abdominal neoplasms has not been studied.

The decision to image with CT or MRI is in part, dependent on the type of suspected abdominal neoplasm [1-5, 26]. Specifically, if hepatoblastoma or a nonneuroblastoma adrenal mass is suspected, MRI offers optimal tissue characterization. For most other masses, there are advantages to either CT or MRI, and the preferred modality depends on multiple factors. CT is faster to perform and may not require sedation. CT can detect tumoral calcifications and provides a global view of anatomy for staging. However, MRI provides superior contrast resolution. MRI is particularly advantageous for characterizing liver masses, assessing intraspinal extension of neuroblastoma, and detecting bone marrow metastases. Ultimately, the choice between CT and

MRI depends on the patient's age, the suspected tumor type, and the need to avoiding sedation (often required for MRI).

Specific MRI sequences, such as DWI and ADC mapping, can provide additional information about tumor cellularity and can help differentiate benign from malignant lesions [2, 4, 6, 13]. The use of gadolinium-based contrast agents in MRI can further enhance the characterization of tumor vascularity and delineate the extent of tumor involvement [1-6]. However, the need for sedation or general anesthesia in young or developmentally delayed children undergoing MRI should be carefully weighed against the potential risks [10, 14]. Additionally, there are concerns about gadolinium deposition in the brain and other tissues with repeated use of gadolinium-based contrast agents, especially in patients undergoing multiple scans. This potential risk should be considered when planning imaging strategies, and the necessity of contrast-enhanced MRI should be carefully evaluated for each patient. Of note, unlike renal masses, when imaging hepatic masses, MRI with hepatobiliary agents is recommended [2-6]. Consequently, US is often used in the evaluation of suspected pediatric abdominal tumors as it can identify the organ of origin and direct the next best imaging study and contrast agent. Further comprehensive discussion is beyond the scope of this document and is covered within the provided references. Per expert consensus, MRI abdomen may not be useful prior to a US or CT for this scenario. Abdomen alone would less commonly be done in isolation, and more commonly abdomen and pelvis.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
S. MRI abdomen without IV contrast

Noncontrast MRI of the abdomen can provide valuable information for assessing pediatric abdominal neoplasms, especially when needed [10, 13, 29, 30]. DWI can aid in lesion characterization without the need for contrast [13]. However, the lack of contrast may limit the evaluation of tumor vascularity and enhancement patterns [3, 5, 10, 13, 29, 30].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
T. US abdomen

US is the preferred initial imaging modality for evaluating suspected abdominal neoplasms in children due to its ability to identify the organ of origin and the ability to characterize the solid and cystic nature of the mass [1, 2]. In a study that directly compared the performance of single-phase-enhanced CT and US for preoperative evaluation of solid abdominal tumors in children, US showed some advantages, including detecting invasion of adjacent structures, including vasculature, in 14% of cases where CT did not [1]. However, CT was still reported to be advantageous compared to US as it provides a more comprehensive evaluation of the abdomen, particularly for preoperative planning [3]. Additionally, US is useful for its ability to identify free fluid in the abdomen, which can indicate tumor rupture and if identified, impacts patient management [2]. In conclusion, US may be limited in assessing the full extent of a suspected mass and metastases, and other studies are often needed to direct management, particularly for preoperative planning when a mass is identified sonographically [1, 3].

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
U. US abdomen with IV contrast

There is no relevant literature to support the use of US abdomen with IV contrast in the evaluation of suspected abdominal neoplasms in children.

Variant 2:Child. Palpable abdominal mass. Suspected neoplasm. Radiography negative. Next imaging study.
V. US pelvis transabdominal

Transabdominal pelvic US can be useful in assessing the extent of abdominal neoplasms that may involve the pelvis when combined with abdominal US [1]. Additionally, US is useful for its ability to identify free fluid in the pelvis, which can indicate tumor rupture and if identified, impacts patient management [2]. It also could identify a primary pelvic mass (such as ovarian, bladder, or prostate) which has either extended into the abdomen or has abdominal metastases. However, its usefulness may be limited by patient factors such as obesity or bowel gas, and it should not be performed as a stand-alone exam without an US of the abdomen in the setting of palpable abdominal mass [1].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.

When a child presents with a palpable abdominal wall mass and an abdominal wall neoplasm is suspected, the initial imaging approach should focus on characterizing the mass and assessing its relationship to adjacent structures. US is often the first-line imaging modality due to its ability to evaluate the size, location, and extent of the abdominal wall mass. CT or MRI also provide excellent soft tissue contrast and can delineate the mass and its relationship to surrounding tissues and may be initial imaging depending on the patient's age, the suspected tumor type, and the need for staging. Nuclear medicine studies, including PET, are infrequently performed as initial imaging.

In the discussion below, "area of interest” can refer to the following: pelvis, abdomen, and chest. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
A. CT abdomen and pelvis with IV contrast

CT abdomen and pelvis with IV contrast can provide valuable information about the extent of abdominal wall masses and their relationship to adjacent structures, including the pelvis. CT with IV contrast can assess the vascularity and enhancement patterns of the mass and detect calcifications [22-27]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

CT abdomen and pelvis without and with IV contrast can provide valuable information about the extent of a suspected abdominal mass and its relationship to adjacent structures. CT with IV contrast can assess the vascularity and enhancement patterns of the mass. Both CT with and without IV contrast can detect calcifications [22-27], and there is no relevant literature to support added benefit of performing both without and with contrast CT. Although performing both without and with contrast phases can add information, it is not recommended for initial imaging. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial

imaging.
C. CT abdomen and pelvis without IV contrast

CT of the abdomen and pelvis without IV contrast can provide information about the extent of a suspected abdominal wall mass and its relationship to adjacent structures, including the pelvis. Noncontrast CT can also detect calcifications associated with certain tumors [22-27]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. However, the lack of contrast may limit the evaluation of tumor vascularity and enhancement patterns [22-27].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
D. CT abdomen with IV contrast

CT abdomen with IV contrast is not useful for this scenario as abdomen is not done in isolation. CT abdomen and pelvis with IV contrast can provide valuable information about the extent of abdominal wall masses and their relationship to adjacent structures, including the pelvis. CT with IV contrast can assess the vascularity and enhancement patterns of the mass and detect calcifications [22-27]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
E. CT abdomen without and with IV contrast

CT abdomen without and with IV contrast can provide valuable information about the extent of a suspected abdominal mass and its relationship to adjacent structures. CT with IV contrast can assess the vascularity and enhancement patterns of the mass. Both CT with and without IV contrast can detect calcifications [22-27], and there is no relevant literature to support added benefit of performing both without and with contrast CT. Although performing both without and with contrast phases can add information, it is not recommended for initial imaging. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
F. CT abdomen without IV contrast

CT abdomen is not useful for this scenario as abdomen is not done in isolation. CT abdomen and pelvis without IV contrast can provide information about the extent of a suspected abdominal wall mass and its relationship to adjacent structures, including the pelvis. Noncontrast CT can also detect calcifications associated with certain tumors [22-27]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. However, the lack of contrast may limit the evaluation of tumor vascularity and enhancement patterns [22-27].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
G. CT chest abdomen pelvis with IV contrast

CT chest, abdomen, and pelvis with IV contrast can provide valuable information about the extent of a suspected abdominal wall mass and its relationship to adjacent structures, including the chest and pelvis. CT with IV contrast can assess the vascularity and enhancement patterns of the mass and detect calcifications [22-27]. However, the inclusion of the chest should be limited to patients in whom pulmonary metastases are suspected. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
H. CT chest abdomen pelvis without and with IV contrast

CT chest, abdomen, and pelvis without and with IV contrast can provide valuable information about the extent of a suspected abdominal wall mass and its relationship to adjacent structures, including the chest and pelvis. CT with IV contrast can assess the vascularity and enhancement patterns of the mass. Both CT with and without IV contrast can detect calcifications [22-27], and there is no relevant literature to support added benefit of performing both without and with contrast CT. Although performing both without and with contrast phases can add information, it is not recommended for initial imaging. The inclusion of the chest should be limited to patients in whom pulmonary metastases are suspected [29]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
I. CT chest abdomen pelvis without IV contrast

CT chest, abdomen, and pelvis without IV contrast can provide valuable information about the extent of a suspected abdominal wall mass and its relationship to adjacent structures. Noncontrast CT can also detect calcifications associated with certain tumors [22-27]. However, the inclusion of the chest should be limited to patients in whom pulmonary metastases are suspected [29]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [2-5, 22, 26]. The lack of contrast may limit the evaluation of tumor vascularity and enhancement patterns [22-27].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
J. FDG-PET/CT skull base to mid-thigh

There is no relevant literature to support the use of FDG-PET/CT skull base to mid-thigh in the initial evaluation of suspected abdominal wall neoplasms in children.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
K. FDG-PET/CT whole body

There is no relevant literature to support the use of FDG-PET/CT whole body in the initial evaluation of suspected abdominal wall neoplasms in children.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
L. FDG-PET/MRI skull base to mid-thigh

There is no relevant literature to support the use of FDG-PET/MRI skull base to mid-thigh in the initial evaluation of suspected abdominal wall neoplasms in children.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
M. FDG-PET/MRI whole body

There is no relevant literature to support the use of FDG-PET/MRI whole body in the initial evaluation of suspected abdominal wall neoplasms in children.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
N. MIBG scan whole body

There is no relevant literature to support the use of MIBG scan whole body in the initial evaluation of suspected abdominal wall neoplasms in children.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
O. MIBG scan whole body with SPECT or SPECT/CT area of interest

There is no relevant literature to support the use of MIBG scan whole body with SPECT or SPECT/CT area of Interest in the initial evaluation of suspected abdominal wall neoplasms in children.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
P. MRI abdomen and pelvis without and with IV contrast

MRI of the abdomen without and with IV contrast is an effective modality for evaluating the extent and characteristics of suspected abdominal wall neoplasms in children [10, 13, 14, 20, 28-31]. MRI can accurately assess the extent of tumors and their relationship to adjacent structures, which is important for staging and surgical planning [10, 13, 14, 20, 28-31]. The addition of contrast enhances the assessment of tumor vascularity and can help delineate the relationship of a mass to adjacent structures, providing crucial information for surgical or treatment planning [10, 13, 14, 20, 28-31]. DWI can help differentiate benign from malignant lesions, adding valuable diagnostic information [30]. The usefulness of both pre- and postcontrast sequences has been demonstrated, which is essential in complex cases such as abdominal wall neoplasms [30]. The need for imaging the chest and/or pelvis in addition to the abdomen depends on the suspected malignancy type [3].

The decision to image with CT or MRI is in part, dependent on the type of suspected abdominal neoplasm [1-5, 26], but to date, the literature has focused on intraabdominal masses rather than abdominal wall. Specifically, if hepatoblastoma or a nonneuroblastoma adrenal mass is suspected, MRI offers optimal tissue characterization. For most other masses, there are advantages to either CT or MRI, and the preferred modality depends on multiple factors. CT is faster to perform and may not require sedation. CT can detect tumoral calcifications and provides a global view of anatomy for staging. However, MRI provides superior contrast resolution. MRI is particularly advantageous for characterizing liver masses, assessing intraspinal extension of neuroblastoma, and detecting bone marrow metastases. Ultimately, the choice between CT and MRI depends on the patient's age, the suspected tumor type, and the need to avoiding sedation (often required for MRI).

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
Q. MRI abdomen and pelvis without IV contrast

Noncontrast MRI of the abdomen and pelvis could provide useful information for evaluating suspected abdominal wall neoplasms in children when needed [13, 29, 30]. However, to date, the literature has focused on intraabdominal masses rather than abdominal wall. DWI can aid in lesion characterization without the need for contrast [13]. However, the lack of contrast may limit the assessment of tumor vascularity and enhancement patterns [29, 30].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
R. MRI abdomen without and with IV contrast

MRI of the abdomen without and with IV contrast is an effective modality for evaluating the extent and characteristics of suspected abdominal neoplasms in children [10, 13, 14, 20, 28-31]. However, to date, the literature has focused on intraabdominal masses rather than abdominal wall. MRI can accurately assess the extent of tumors and their relationship to adjacent structures, which is important for staging and surgical planning [10, 13, 14, 20, 28-31]. The addition of contrast enhances the assessment of tumor vascularity and can help delineate the relationship of a mass to adjacent structures, providing crucial information for surgical or treatment planning [10, 13, 14, 20, 28-31]. DWI can help differentiate benign from malignant lesions, adding valuable diagnostic information [13]. The usefulness of both pre- and postcontrast sequences has been demonstrated, enhancing radiologists' diagnostic confidence, which is essential in complex cases such as abdominal wall neoplasms [30].

The decision to image with CT or MRI is in part, dependent on the type of suspected abdominal neoplasm [1-5, 26]. Specifically, if hepatoblastoma or a nonneuroblastoma adrenal mass is suspected, MRI offers optimal tissue characterization. For most other masses, there are advantages to either CT or MRI, and the preferred modality depends on multiple factors. CT is faster to perform and may not require sedation. CT can detect tumoral calcifications and provides a global view of anatomy for staging. However, MRI provides superior contrast resolution. MRI is particularly advantageous for characterizing liver masses, assessing intraspinal extension of neuroblastoma, and detecting bone marrow metastases. Ultimately, the choice between CT and MRI depends on the patient's age, the suspected tumor type, and the need to avoiding sedation (often required for MRI).

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
S. MRI abdomen without IV contrast

Noncontrast MRI of the abdomen could provide valuable information for assessing suspected abdominal wall neoplasms in children when needed [10, 13, 29, 30]. However, to date, the literature has focused on intraabdominal masses rather than abdominal wall. DWI can aid in lesion characterization without the need for contrast [13]. However, the lack of contrast may limit the evaluation of tumor vascularity and enhancement patterns [10, 13, 29, 30].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
T. Radiography abdomen

Although radiography is not the primary modality for evaluating suspected abdominal wall neoplasms in children, it may detect soft tissue masses or calcifications associated with certain tumors [20, 21]. However, radiography has limited sensitivity and specificity for characterizing abdominal wall masses [20, 21], and if an abdominal wall mass is identified radiographically, additional imaging will likely be needed.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.

U. US abdomen

US is the preferred initial imaging modality for evaluating suspected abdominal wall neoplasms in children due to its ability to characterize the solid and cystic nature of the mass [1]. It can assess the size, location, and extent of the abdominal wall mass and its relationship to adjacent structures [1]. However, US may be limited in evaluating the full extent of the tumor, particularly if it extends beyond the abdominal wall [1]. In conclusion, US may be limited in assessing the full extent of the tumor and its relationship to adjacent structures, and other studies are often needed to direct management, particularly for preoperative planning, if a mass is identified sonographically [1].

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
V. US abdomen with IV contrast

There is no relevant literature to support the use of US abdomen with IV contrast in the evaluation of suspected abdominal wall neoplasms in children. Although performing contrast-enhanced US can add information, it is not recommended for initial imaging.

Variant 3:Child. Palpable abdominal wall mass. Suspected abdominal wall neoplasm. Initial imaging.
W. US pelvis transabdominal

Transabdominal pelvic US can be useful in assessing the extent of abdominal wall neoplasms that may involve the pelvis, particularly when combined with abdominal US [1]. It also could identify a primary pelvic mass (such as ovarian, bladder, or prostate), which has either extended into the abdomen or has abdominal metastases. However, its usefulness may be limited by patient factors such as obesity or bowel gas, and it should not be performed as a stand-alone examination without an US of the abdomen in the setting of palpable abdominal wall mass [1].

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- Variant 1: For initial imaging of a child with a palpable abdominal mass and suspected neoplasm, US abdomen, radiography abdomen, and CT abdomen and pelvis with IV contrast are usually appropriate studies. US abdomen can identify a mass and typically its organ of origin, whereas radiography can typically identify large tumors. Both can be useful to direct further imaging. US abdomen and radiography abdomen are equivalent alternatives and are complementary to CT or MRI. CT abdomen and pelvis with IV contrast is also usually appropriate as it also provides comprehensive evaluation of the abdomen for preoperative planning, tumor extent assessment, and detection of lymph node involvement. US pelvis transabdominal may be appropriate to assess masses that may involve the pelvis, particularly when combined with US abdomen. MRI abdomen and pelvis without and with IV contrast may be appropriate, particularly when hepatoblastoma or adrenal mass is suspected. CT chest, abdomen, and pelvis with IV contrast may be appropriate when there is concern for distant metastases based on the suspected malignancy type.
- Variants 2 and 3: For a child with a palpable abdominal mass where radiography is negative (Variant 2), or for a child with a palpable abdominal wall mass and suspected abdominal wall neoplasm requiring initial imaging (Variant 3), US abdomen and CT abdomen and pelvis with IV contrast are usually appropriate studies. These are alternative studies that provide

complementary information. US can identify the organ of origin and characterize the solid and cystic nature of the mass, whereas CT provides more comprehensive evaluation for preoperative planning and lymph node involvement. MRI abdomen and pelvis without and with IV contrast may be appropriate, particularly for hepatoblastoma or adrenal masses. The choice between CT and MRI depends on the suspected tumor type and patient age. For Variant 3 specifically, MRI without and with IV contrast of the abdomen (with or without pelvis) may be appropriate for detailed soft tissue characterization of abdominal wall masses. CT chest abdomen pelvis with IV contrast may be appropriate when pulmonary metastases are suspected based on the malignancy type.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be

		unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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