American College of Radiology
ACR Appropriateness Criteria®
Chronic Liver Disease

Variant 1: **Chronic liver disease. Diagnosis and staging of liver fibrosis. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US shear wave elastography abdomen	Usually Appropriate	O
MR elastography abdomen	Usually Appropriate	O
MRI abdomen without and with IV contrast	May Be Appropriate	O
CT abdomen with IV contrast multiphase	May Be Appropriate	☢☢☢☢
MRI abdomen without and with hepatobiliary contrast	May Be Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
US abdomen	May Be Appropriate	O
US duplex Doppler abdomen	May Be Appropriate	O
US abdomen with IV contrast	May Be Appropriate	O
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

Variant 2: **Chronic liver disease. No prior diagnosis of hepatocellular carcinoma (HCC). Screening and surveillance for HCC.**

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
MRI abdomen without and with IV contrast	Usually Appropriate	O
MRI abdomen without and with hepatobiliary contrast	Usually Appropriate	O
CT abdomen with IV contrast multiphase	May Be Appropriate (Disagreement)	☢☢☢☢
US duplex Doppler abdomen	May Be Appropriate (Disagreement)	O
MRI abdomen without IV contrast	May Be Appropriate	O
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
MR elastography abdomen	Usually Not Appropriate	O
US abdomen with IV contrast	Usually Not Appropriate	O
US shear wave elastography abdomen	Usually Not Appropriate	O
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

Variant 3: **Chronic liver disease. Previous diagnosis of HCC. Post-treatment monitoring for HCC.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast	Usually Appropriate	O
CT abdomen with IV contrast multiphase	Usually Appropriate	☢☢☢☢
CT abdomen without and with IV contrast	Usually Appropriate	☢☢☢☢
MRI abdomen without and with hepatobiliary contrast	Usually Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
US abdomen with IV contrast	May Be Appropriate	O
US abdomen	May Be Appropriate	O
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
MR elastography abdomen	Usually Not Appropriate	O
US duplex Doppler abdomen	Usually Not Appropriate	O
US shear wave elastography abdomen	Usually Not Appropriate	O
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

CHRONIC LIVER DISEASE

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Summary of Literature Review

Introduction/Background

Chronic liver disease encompasses a variety of causes of chronic liver injury, including nonalcoholic fatty liver disease, hepatitis C, hepatitis B, alcohol-related liver disease, primary sclerosing cholangitis, autoimmune hepatitis, and others. These diseases can progress to hepatic fibrosis and cirrhosis, with associated complications of portal hypertension, gastrointestinal hemorrhage, refractory ascites, hepatic encephalopathy, and primary liver cancer [1-3]. Liver disease accounts for approximately 2 million deaths per year worldwide, 1 million due to complications of cirrhosis and 1 million due to viral hepatitis and hepatocellular carcinoma. Cirrhosis and liver cancer account for 3.5% of all deaths worldwide [4]. In the United States, the leading cause of cirrhosis is hepatitis C, with approximately 1.3% of the population having chronic hepatitis C infection [1-3], and mortality related to cirrhosis and liver cancer is underestimated and may be increasing [5,6].

The progression of hepatic fibrosis to compensated cirrhosis to decompensated cirrhosis can be slow and clinically silent. Although the standard for diagnosis of hepatic fibrosis and cirrhosis is liver biopsy, this technique is costly, plagued by sampling errors, can be morbid, and is not well accepted for longitudinal disease monitoring [7,8]. Thus, accurate noninvasive methods are desperately needed for establishing and grading severity of liver fibrosis as well as monitoring disease progression or response to therapy. Although a variety of serum markers exist for this purpose, they are inaccurate for intermediate stages of fibrosis, and imaging by conventional ultrasound (US), CT, and MRI is frequently performed to assess for cirrhosis and its complications in this patient population [9]. More advanced techniques such as MR elastography and US have been shown to be more accurate than conventional morphological imaging methods and are gaining acceptance for these applications.

Hepatocellular carcinoma (HCC) is the most common primary liver cancer arising in patients with cirrhosis, and the American Association for the Study of Liver Disease (along with other major international guidelines) recommends surveillance for HCC in patients with cirrhosis who would benefit from early detection of HCC [10,11].

Imaging plays a central role in detection, staging, and treatment guidance for HCC. Surveillance has traditionally been performed with conventional US, followed by contrast-enhanced CT or MRI used for definitive diagnosis and staging of HCC [12,13]. However, there may be an emerging role for MRI-based surveillance in patients whose livers are poorly assessed by US. Contrast-enhanced US (CEUS) is becoming established as an accurate technique for assessment of liver masses, including HCC [14].

Discussion of Procedures by Variant

Variant 1: Chronic liver disease. Diagnosis and staging of liver fibrosis. Initial imaging.

Patients with chronic liver disease can present with findings of frank cirrhosis and portal hypertension, including jaundice and ascites. However, in many patients, the severity of liver disease is not apparent based on clinical or laboratory findings. In general, imaging can be helpful to confirm the presence of cirrhosis based on morphological

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features. For patients without cirrhosis, determining the presence and severity of earlier stages of liver fibrosis may help guide management.

A variety of morphologic changes that accompany cirrhosis can be assessed on CT, MRI, and US. These include liver surface nodularity, right lobe atrophy, caudate lobe hypertrophy, the right hepatic posterior “notch,” and others [15-18]. However, even in aggregate, the sensitivity of these features for the diagnosis of cirrhosis and noncirrhotic fibrosis is too low for excluding hepatic fibrosis. Recently, quantitative methods for assessing liver surface nodularity have been developed, but are still early in development and are not yet considered well-validated for this application [19,20].

CT Abdomen

Noncontrast CT has limited utility in the assessment of hepatic fibrosis because it relies on the demonstration of gross structural changes, which are typically not present until very advanced stages of the disease. Contrast-enhanced CT can be more useful because it can demonstrate parenchymal heterogeneity and enhancement of lattice-like macroscopic bands of fibrosis throughout the hepatic parenchyma [21,22]. CT perfusion has been described for the assessment of hepatic fibrosis and cirrhosis, predominantly relying on increased proportion of arterial blood supply to the liver as fibrosis progresses [23]. However, this methodology is highly technique dependent and requires substantial postprocessing and therefore is not considered a clinical standard method for establishing the diagnosis of cirrhosis. There is no relevant literature that demonstrates incremental value of combining noncontrast with contrast-enhanced CT for this application.

FDG-PET/CT Skull Base to Mid-Thigh

Fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET is not a useful test for detecting liver fibrosis. Data are limited regarding its utility, and no advantage over alternative imaging or serum tests has been demonstrated.

MR Elastography Abdomen

MR elastography is currently the most accurate imaging modality for the diagnosis and staging of hepatic fibrosis [24,25]. MR elastography compares favorably with US shear wave elastography (SWE), in part, because of improved performance in patients with obesity [26]. MR elastography does have limitations in patients with hepatic iron deposition and patients imaged at 3T due to susceptibility artifacts, which can result in undersampling of the liver or nondiagnostic evaluations. Stiffness measurement may also be confounded by parenchymal edema, inflammation, cholestasis, cardiogenic hepatic congestion, recent meal, and other factors [27].

MRI Abdomen

Conventional MRI can be used to assess the same structural changes as those visualized on CT, with the added advantage of greater visibility of bands of fibrosis on both noncontrast and contrast-enhanced sequences [28]. However, its utility for detecting early liver fibrosis remains limited because these changes do not occur until fibrosis has progressed to a very advanced stage.

A number of advanced MRI techniques have been assessed for detecting liver fibrosis. Diffusion-weighted imaging has been used to assess the restriction of free water proton movement in the hepatic parenchyma as a marker of collagen deposition, the microscopic manifestation of liver fibrosis. A meta-analysis of studies on diffusion-weighted imaging for this application showed that diffusion-weighted imaging was most useful for detecting advanced fibrosis but had lower performance for detecting early fibrosis (sensitivity 77%, specificity 78%) [29]. Additionally, questions about the optimal acquisition technique and image processing methodologies (apparent diffusion coefficient, intravoxel incoherent motion, etc) remain unresolved.

MR perfusion techniques have been described and found to be relatively accurate for the diagnosis and staging of liver fibrosis [30]. However, like CT perfusion, these are dependent on details of the acquisition and processing techniques and can be quite laborious, so they are not broadly used in clinical practice.

Hepatobiliary MR contrast agent (gadoxetate disodium) uptake has been described as a method for measuring liver “function” and has been found to correlate with hepatic fibrosis stage [31,32]. A variety of metrics of contrast agent uptake has been explored, but in general, this methodology has been found to be less accurate than MR elastography and has not been widely adopted.

US Abdomen

Conventional US can be used in the assessment of liver fibrosis for detecting ultrastructural changes such as surface nodularity, coarsened echotexture, and lobar atrophy/hypertrophy, similar to conventional CT and MRI [24,33,34].

US has an advantage in that high spatial resolution imaging of the liver surface can be performed with high frequency transducers, which can demonstrate subtle surface nodularity.

US Abdomen with IV Contrast

US abdomen with IV contrast or CEUS has been assessed for evaluation of liver fibrosis. Similar to CT and MRI perfusion techniques, CEUS uses contrast media transit characteristics to make deductions about liver hemodynamics that relate to the presence and severity of liver fibrosis [35,36]. Although early data on the utility of CEUS for assessing liver fibrosis and portal hypertension are promising, this is an area of ongoing research at this time.

US Shear Wave Elastography Abdomen

SWE extends the capabilities of conventional US by assessing tissue deformation in response to high-intensity US pulses and the generation of shear waves, from which deductions about tissue stiffness can be made. SWE techniques allow simultaneous visualization of the liver to direct measurements to a representative region of parenchyma. Two-dimensional SWE allows for interrogation of large or distributed regions of the liver in order to obtain representative stiffness measures across the liver. As with MR elastography, sonographic assessments of liver stiffness can be confounded by parenchyma, edema, inflammation, cholestasis, and other factors [37,38]. Additionally, high-quality data can be difficult to obtain in obese patients. Although less sensitive for intermediate stages of fibrosis, SWE can provide an overall accurate assessment of hepatic fibrosis, with a reported area under the receiver operating characteristic curves of 0.88 for predicting advanced stages of fibrosis (stage ≥2) and 0.91 for cirrhosis (stage 4) in a meta-analysis of 21 studies (2,691 patients with chronic hepatitis B and C infections) [39].

US Duplex Doppler Abdomen

Doppler US can demonstrate hemodynamic alterations indicative of portal hypertension, though these are typically only seen in the setting of long-standing fibrosis or cirrhosis [40,41]. Though only moderately sensitive for advanced fibrosis/cirrhosis, it can be used for initial assessment of patients with suspected long-standing chronic liver disease in combination with conventional grayscale US.

Variant 2: Chronic liver disease. No prior diagnosis of hepatocellular carcinoma (HCC). Screening and surveillance for HCC.

Imaging plays a vital role in surveillance for HCC in at-risk patients. The patient population with adequate risk to warrant surveillance can loosely be defined as those with chronic viral hepatitis B and cirrhosis of nonvascular causes, including chronic hepatitis B and C, primary sclerosing cholangitis, and others. Imaging is more effective than serum biomarkers (most notably α-fetoprotein level) or other techniques for detecting HCC at a treatable stage [42]. Imaging is also critical for characterizing benign, premalignant, and malignant nodules, staging HCC, guiding locoregional ablative treatments, and assessing treatment response.

Cirrhosis due to vascular conditions is a special case in which surveillance for HCC is more complex. Underlying vascular conditions include Budd-Chiari syndrome, hepatic congestion particularly in the setting of congenital heart disease, hereditary hemorrhagic telangiectasia, and others. The utility of imaging for diagnosis of cirrhosis and accuracy for characterizing HCC is less well established, particularly because these patients often develop benign regenerative liver nodules. Optimal utilization of imaging in these patients must be established for each condition based on available data and is not addressed in this document.

It should be noted that this document deals specifically with screening and surveillance for HCC, whereas the ACR Appropriateness Criteria® topic on "Liver Lesion—Initial Characterization" [43] specifically addresses the characterization of liver lesions once they have been detected. The ACR Liver Imaging Reporting and Data System also provides specifics on screening and diagnosis of HCC using CEUS, CT, MRI, and US [44].

CT Abdomen

Data supporting noncontrast CT for HCC screening and surveillance are limited. Multiphase contrast-enhanced CT is highly sensitive for the detection and characterization of HCC, particularly for lesions >2 cm, with sensitivity reported up to 98% [45]. However, multiphase CT with intravenous (IV) contrast suffers from lower sensitivity for smaller lesions, ranging from 40% to 68% [45-48]. Additionally, the utility of CT surveillance in a "high-risk" population, in which expected incidence of HCC development is typically 1.5 to 5% per year, is not well established. CT is not commonly used for HCC surveillance, though it may be useful in patients with obesity or hepatic steatosis in whom the utility of US may be limited. Little value has been demonstrated for the addition of noncontrast to contrast-enhanced CT in this setting.

FDG-PET/CT Skull Base to Mid-Thigh

FDG-PET/CT is not a useful test for screening or surveillance for HCC. FDG uptake by HCC is highly variable, and combined with high background liver FDG uptake, the PET portion of these examinations adds little to multiphase contrast-enhanced CT [49].

MR Elastography Abdomen

MR elastography has been investigated for the assessment of focal liver lesions with modest success [50]. However, limited spatial resolution and coverage of MR elastography renders it of limited utility for screening and surveillance.

MRI Abdomen

Dynamic contrast-enhanced MRI has been shown to be the most accurate modality in detecting and characterizing HCC, with sensitivity reported between 47% to 95% even for lesions <2 cm [46-48,51-54]. MRI most commonly serves as a second-line confirmatory diagnostic test for assessing nodules detected with US, though it may have a role for screening and surveillance of patients in whom US is expected to be of lower utility [55]. Because the detection and characterization of HCC relies mainly on the perfusion features of liver lesions, MRI without IV contrast is not typically performed for this purpose. MRI with hepatobiliary contrast agents has been shown to be similarly sensitive for detection of HCC compared with extracellular agents, and potentially more sensitive (up to 96% in a recent meta-analysis but only 88% in a more recent study) for detection of small lesions [56]. However, challenges with transient respiratory motion artifacts, judging washout, and other technical limitations must be considered [57,58].

Recently, there has been an interest in developing "abbreviated" MRI techniques for HCC surveillance, in the hope to take advantage of the modality's high sensitivity for detecting HCC [59-61]. Although emerging data are promising, over-detection of nonmalignant nodules remains a substantial challenge, and these techniques remain investigational. Future studies showing improvement in survival will be needed to show efficacy of MRI or "abbreviated" MRI screening. Furthermore, accuracy and potential harms need to be factored into the equation when discussing abbreviated MRI techniques [62].

US Abdomen

Nearly all international guidelines recommend conventional US every 6 months as the primary method for surveillance for HCC [10,13]. The only exception is the Japanese Society of Hepatology guideline, which recommends the use of US every 3 to 4 months in "super-high-risk" patients, as well as an optional multiphasic CT or MRI every 6 to 12 months [55,63]. Notably, the Japanese Society of Hepatology recommends the use of US every 6 months in "high-risk patients". Currently, the majority of the prospective evidence proving a survival benefit based on HCC surveillance is from Asia. A large prospective randomized controlled trial studying the efficacy of US screening was reported from a Chinese cohort of 18,816 patients predominantly with hepatitis B with or without cirrhosis in which a 37% reduction in HCC related mortality was shown. A different large prospective randomized controlled study of 17,920 patients in China, showed that patients whose HCC were detected through US surveillance imaging had a significant improvement in survival of 88% and 78% at 1 and 2 years compared to 0% at 1 and 2 years in those who did not undergo surveillance [64]. In addition, a prospective single mass screening study using US in 8,962 Taiwanese patients showed a 31% reduction in HCC related mortality. Although it is unclear whether the same survival benefit can be realized in the general American population, with a preponderance of nonhepatitis B related cirrhosis, nonalcoholic steatohepatitis related cirrhosis, and obesity, it is unlikely that such large randomized controlled prospective studies will be performed in the United States due to the ethical ramifications of not performing screening in a lethal yet treatable disease. Nonetheless, several large retrospective cohort studies using US for surveillance in the United States have shown significant survival benefit and early detection of tumors compared to populations without screening and surveillance [65,66].

US Abdomen with IV Contrast

CEUS has been shown to be highly sensitive for the diagnosis of HCC at centers of excellence [14,67,68]. However, CEUS requires focused observation of a single region of interest, and although the ability to reinject after a period of washout allows for more than one region to be evaluated during a single examination, this may not be well-suited for whole-liver assessment as is needed for screening and surveillance [69].

US Shear Wave Elastography Abdomen
The use of SWE has been described for assessment of focal liver lesions in a limited number of small studies [70,71]. However, SWE assessments are typically performed slice by slice; thus, the technique is poorly suited to whole-liver surveillance. To date, most reported investigations on the application of SWE in the liver have focused on liver fibrosis assessment and, to a lesser extent, on differentiating benign from malignant focal lesions.

US Duplex Doppler Abdomen
Doppler US is typically performed in conjunction with conventional grayscale US assessment. The duplex Doppler component may add value to the grayscale examination, allowing tumor in vein to be more readily identified.

Variant 3: Chronic liver disease. Previous diagnosis of HCC. Post-treatment monitoring for HCC.

Treatment options for patients with HCC may include liver transplantation, surgical resection, external beam radiation therapy, chemotherapy, and locoregional treatments, including percutaneous ablative and embolic modalities. After liver transplantation and surgical resection with negative margins, the goal of post-treatment monitoring is surveillance for new foci of HCC. After treatments in which the HCC is not actually removed, both monitoring of the treatment site as well as surveillance for distant foci of HCC must be accomplished. Thus, whole-liver surveillance remains an important goal after treatment.

CT Abdomen
CT of the abdomen without and with IV contrast is an accurate method for detecting recurrence of HCC following locoregional therapy, resection, or transplantation. After locoregional therapy, including a precontrast phase, CT is strongly recommended because treatment can render a lesion or perilesional treatment zone high in attenuation (particularly when ethiodized oil is used in embolization), which can confound the interpretation of the hepatic arterial phase [72,73]. Noncontrast CT has a limited role because the detection of recurrent HCC relies primarily on detecting abnormal tumor perfusion. Dual-energy CT can be utilized to derive virtual unenhanced images and/or iodine maps for the same purpose as a dedicated precontrast acquisition. [74]. The National Comprehensive Cancer Network guidelines recommend CT or MRI every 3 to 6 months for 2 years and then every 6 to 12 months after HCC resection, whereas the European Association for the Study of the Liver recommends multiphase CT or MRI to assess response 1 month after resection or locoregional or systemic therapies, followed by one imaging technique every 3 months to complete at least 2 years, and then regular US every 6 months thereafter [75].

FDG-PET/CT Skull Base to Mid-Thigh
The utility of FDG-PET/CT in HCC patients has primarily been investigated in the pretreatment setting; little data are available regarding post-treatment monitoring [76]. Because of the need for multiple repeated examinations and efficacy of multiphase contrast-enhanced CT and MRI, FDG-PET/CT is infrequently used for monitoring for HCC recurrence.

MR Elastography Abdomen
MR elastography has been investigated for the assessment of focal liver lesions with modest success [50]. However, limited spatial resolution and coverage of MR elastography renders it of limited utility for screening and surveillance.

MRI Abdomen
MRI of the abdomen without and with IV contrast is highly sensitive for detecting HCC recurrence. Multiple contrast mechanisms (perfusion, diffusion, hepatobiliary agent uptake, intrinsic T1- and T2-weighted signal intensity) can be used for assessment; however, arterial phase hyperperfusion remains the mainstay for detection of HCC recurrence. Both the National Comprehensive Cancer Network and the European Association for the Study of the Liver recommend CT or MRI at regular intervals for at least 2 years for follow-up of patients with treated HCC [77]. The role of hepatobiliary MRI in this setting remains controversial. It has been shown to increase sensitivity for detection of small lesions, but may overdiagnose premalignant lesions [78]. In addition, imaging artifacts are more common with gadoxetate disodium, the primary agent used for hepatobiliary imaging, and use of hepatobiliary agents may reduce the yield of the early perfusion assessment of lesions [57].

Because the detection and characterization of HCC relies mainly on the perfusional features of liver lesions, MRI without IV contrast is not typically performed for this purpose. However, noncontrast MRI may be a reasonable modality for surveillance, because it offers the best differentiation between types of soft tissues of the available noncontrast modalities.

US Abdomen

Because of the importance of vascular perfusion and the absence of morphological changes in early HCC recurrence, US is not typically utilized as the only surveillance modality for assessing for recurrent HCC following treatment. The European Association for the Study of the Liver recommends multiphase CT or MRI to assess response 1 month after resection or locoregional or systemic therapies, followed by one imaging technique every 3 months to complete at least 2 years, and then regular US every 6 months thereafter [77].

US Abdomen with IV Contrast

CEUS has been shown to be highly sensitive for the diagnosis of HCC at centers of excellence [14,67,68]. CEUS requires focused observation of a single region of interest during contrast injection, and although the ability to reinject after a period of washout allows for more than one region to be evaluated in a single examination, this method may not be well-suited for whole-liver assessment as is needed for screening and surveillance [69]. Early clinical data suggest that CEUS could have utility in monitoring both for local recurrence of HCC after locoregional therapy and for secondary surveillance, particularly given that most recurrence occurs in the same segment as the originally treated nodule [79,80]. In addition, CEUS may be an effective alternative when MRI or CT results are inconclusive [81].

US Shear Wave Elastography Abdomen

The use of SWE has been described for assessment of focal liver lesions in a limited number of small studies [70,71,82]. However, SWE assessments are typically performed slice by slice; thus, the technique is poorly suited to whole-liver surveillance. There is also a paucity of data regarding assessment of lesions that have undergone prior locoregional therapy. To date, most reported investigations on the application of SWE in the liver have focused on liver fibrosis assessment and, to a lesser extent on differentiating benign from malignant focal lesions.

US Duplex Doppler Abdomen

There is no relevant literature to support the use of US duplex Doppler in this clinical scenario.

Summary of Recommendations

- **Variant 1:** US SWE abdomen or MR elastography abdomen is usually appropriate as the initial imaging for diagnosis and staging of liver fibrosis in chronic liver disease patients. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care).
- **Variant 2:** US abdomen, MRI abdomen without and with IV contrast, or MRI abdomen without and with hepatobiliary contrast is usually appropriate for the screening and surveillance of HCC in chronic liver disease patients with no prior diagnosis of HCC. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care). The panel did not agree on recommending CT abdomen with IV contrast multiphase and US duplex Doppler abdomen for the screening and surveillance of HCC in chronic liver disease patients. There is insufficient medical literature to conclude whether or not these patients would benefit from these procedures. These procedures are controversial but may be appropriate.
- **Variant 3:** MRI abdomen without and with IV contrast, CT abdomen with IV contrast multiphase, CT abdomen without and with IV contrast, or MRI abdomen without and with hepatobiliary contrast is usually appropriate for the post-treatment monitoring for HCC in chronic liver disease patients with a prior diagnosis of HCC. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care).

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 go to www.acr.org/ac.

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 [83].

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 (eg, 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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