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Liver imaging: it is time to adopt standardized terminology

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Liver imaging: it is time to adopt standardized terminology

ABSTRACT

Liver imaging plays a vital role in the management of patients at risk for hepatocellular carcinoma (HCC); however, progress in the field is challenged by nonuniform and inconsistent terminology in the published literature. The Steering Committee of the American College of Radiology (ACR)'s Liver Imaging Reporting And Data System (LI-RADS), in conjunction with the LI-RADS Lexicon Writing Group and the LI-RADS International Working Group, present this consensus document to establish a single universal liver imaging lexicon. The lexicon is intended for use in research, education, and clinical care of patients at risk for HCC (i.e., the LI-RADS population) and in the general population (i.e, even when LI-RADS algorithms are not applicable). We anticipate that the universal adoption of this lexicon will provide research, educational, and clinical benefits.

Medical Subject Headings (MeSH) Keywords:

Liver Neoplasms; Carcinoma, Hepatocellular; Radiology; Consensus; Writing

KEY POINTS:

- To standardize terminology, we encourage authors of research and educational materials on liver imaging to use the standardized LI-RADS Lexicon.
- We encourage reviewers to promote the use of the standardized LI-RADS Lexicon for publications on liver imaging.
- We encourage radiologists to use the standardized LI-RADS Lexicon for liver imaging in clinical care.

Abbreviations:

AASLD	American Association for the Study of Liver Diseases
ACR	American College of Radiology
APHE	arterial phase hyperenhancement
CEUS	contrast-enhanced ultrasound
COU	context of use
CT	computed tomography
HCC	hepatocellular carcinoma
LI-RADS	Liver Imaging Reporting And Data System
MRI	magnetic resonance imaging
US	ultrasound

Introduction

The literature on the imaging of primary liver cancer is vast, with more than 10,000 peer-reviewed manuscripts published since 1970 (**Supplemental Material 1**). The use of nonstandard terminology has challenged the synthesis of this literature, slowed advances in knowledge, impeded progress in research and education, and introduced ambiguity in communication between radiologists and clinicians. While most scientific papers, review articles, and imaging guidelines agree on the use of some imaging features to noninvasively diagnose hepatocellular carcinoma (HCC) (e.g., arterial phase hyperenhancement (APHE) and washout), the actual terms used in these manuscripts are variable, leading to uncertainty as to whether the same imaging phenomena are being described. For example, at least eleven different terms have been used in scientific papers and imaging guidelines to describe APHE (**Supplemental Table 1**) [1-9]. Likewise, diverse terms have been used for washout (**Supplemental Table 2)**, capsule, growth, and other key imaging features of liver cancer. Further adding to this challenge, terms may not be defined or are vaguely or variably defined in different manuscripts. Similar problems exist for imaging of lesions other than HCC, including other primary liver cancers, metastases, and benign neoplasms.

Inconsistencies and ambiguities in the literature, such as those described above, create confusion, introduce uncertainty [10-12], and impede progress. In particular, inconsistent terminology and definitions complicate the extraction and pooling of data from the published literature, the conduct of structured reviews and meta-analyses, the replication of research results, and the translation of research findings into clinical practice. They also cause inefficiency, as papers must devote space to providing terms and their definitions, and readers must comprehend potentially unfamiliar or inconsistent content. Similarly, nonstandard terminology in clinical care can create barriers to effective communication, as it

leads to ambiguity and potential misunderstanding of the results by the referrers [10; 12-15] and unnecessary confusion for patients who are reading their reports.

To overcome the challenges imposed by inconsistent terminology, a worldwide standardized lexicon is needed for liver imaging. Accordingly, the Steering Committee of the American College of Radiology (ACR)'s Liver Imaging Reporting and Data System (LI-RADS) has overseen the development of such a standardized lexicon. The lexicon is intended for use for research, education, and clinical care in patients at risk for HCC (i.e., the LI-RADS population) and in the general population (i.e, even when LI-RADS algorithms are not applicable). Ultimately, we believe that the adoption of the LI-RADS lexicon will help improve patient care by reducing variability between reports. Herein we explain how the lexicon was developed, refined, and approved, provide examples of its current terms and definitions, describe how the lexicon will be expanded and maintained in the future, and discuss remaining controversies and future directions. The LI-RADS Steering Committee, in conjunction with the LI-RADS Lexicon Writing Group and the International Working Group, presents a consensus statement that proposes the LI-RADS Lexicon serves as a universal lexicon for liver imaging in research, education, and clinical care.

LI-RADS Lexicon

What is the LI-RADS Lexicon

The LI-RADS Lexicon is a standardized dictionary of terms relevant to liver imaging. For each term, there is a definition, its context of use (see below), the applicable imaging modalities, explanatory comments, and synonyms. The Lexicon is published by the ACR and is freely available through the ACR website at https://www.acr.org/Clinical-Resources/Reporting-and-Data-Systems/LI-RADS.

Tables 1 to 4 list the terms and their definitions as of 6/1/2021, organized thematically. General terminology is provided in **Table 1**, US terminology in **Table 2**, contrast-enhanced ultrasound (CEUS) terminology in **Table 3**, and CT/MRI terminology in **Table 4**. Due to space constraints, the accompanying comments, synonyms, dates of approval, and additional fields are not provided in these tables, although they are provided in **Supplemental Table 3** and on the referenced website.

Context of use of the LI-RADS Lexicon

The LI-RADS Lexicon proposes two distinct contexts:

LI-RADS specific context of use: Some of the terms in the LI-RADS Lexicon apply narrowly to patients with or at risk for HCC, as their applicability in the general population has not been established. According to the American Association for the Study of Liver Diseases (AASLD) and LI-RADS, patients at risk for HCC include those with cirrhosis, chronic hepatitis B viral infection even in the absence of cirrhosis, and current or prior HCC [16; 17]. Examples of LI-RADS-specific terms include capsule, threshold growth, subthreshold growth, and size stability ≥ 2 years.

Broad context of use: Most of the terms in the LI-RADS Lexicon apply broadly to the general population of patients undergoing liver imaging with US, CEUS, CT or MRI for a variety of indications. Examples of broadly applicable terms include observation, pseudolesion, growth, and imaging phase. These include patients not at risk for HCC, in whom the LI-RADS algorithms are not applicable currently.

How the LI-RADS Lexicon relates to the LI-RADS algorithms, Core Documents, Manual, and radiology ontologies

The LI-RADS Lexicon and the LI-RADS screening/surveillance, diagnostic and treatment response algorithms [16; 18; 19] are distinct in purpose and function. The algorithms are intended to function in the LI-RADS specific context of use with the purpose of detecting or diagnosing HCC or assessing response to therapy of HCC, respectively. The purpose of the Lexicon is to provide a common vocabulary for describing liver imaging findings that is functional both in the LI-RADS specific context and in a broad context of use, even when LI-RADS algorithms are not applicable.

Terms defined in the LI-RADS Core Documents [16; 18; 19] and select additional terms defined in the LI-RADS Manual [20] are included in the the LI-RADS Lexicon. Since the definitions in the Lexicon have undergone additional layers of scrutiny, refinement, and editing, the exact wording may differ, but the meaning is preserved. The Lexicon also includes some new terms that have not yet been integrated into the Core or Manual as of this publication, e.g., spoke wheel, centrifugal APHE (CEUS term).

The Lexicon will be integrated into the Radiological Society of North American (RSNA)'s RadLex®, «a comprehensive set of radiology terms for use in radiology reporting, decision support, data mining, data registries, education and research» [21]. Its terms also will be included in RadElement

(radelement.org), a joint RSNA and ACR initiative to standardize the names and attributes of common data elements.

How the LI-RADS Lexicon was developed and refined

The Lexicon was developed over many years through a multistep process. Details are provided in the **Supplement**. Briefly, from 2008 to 2019, several LI-RADS working groups developed provisional terms and definitions. These were published in the 2017 and 2018 LI-RADS Core Documents [16; 18; 19] and/or the LI-RADS Manual [20]. Subsequently, essential terms from these Documents were iteratively refined by a Lexicon and Writing Group (LWG; current roster listed in **Supplemental Table 4**) that convened in 2019 for lexicon development and refinement. Term definitions, context of use, accompanying comments, and synonyms were developed and refined by the LWG. The terms' names, definitions and contexts of use were evaluated by the entire 34-member Steering Committee, with approval for each term requiring > 90% vote. Ultimately, 83 terms were approved and included in the most recent version of the Lexicon, released in June 2021.

How the LI-RADS Lexicon will be updated

The LI-RADS Lexicon is dynamic and will be updated periodically by the LI-RADS Lexicon and Writing Group, under the oversight of the Steering Committee, in response to advances in knowledge, technical developments, and user input (**Figure**). Each update will be assigned a new version with a version date. We anticipate that the current terms and definitions will be relatively stable, with substantive changes occurring infrequently and only as needed.

To be inclusive of broad and diverse perspectives, we welcome feedback from all stakeholders, including academic and community radiologists, hepatologists, surgeons, pathologists, other individuals who contribute to the medical management of patients with liver diseases, and trainees, as

well as allied scientific societies and clinical organizations. Users are encouraged to contact the LI-RADS Lexicon and Writing Group through the ACR by email (rads@acr.org) to indicate errors or ambiguities in existing terms or to suggest new terms, better names for existing terms, or clearer definitions. Updates will have version identifiers and include the addition of new terms and refinement of existing terms with the Steering Committee's approval. The ACR website will maintain updated and archived versions of the Lexicon. When citing the Lexicon, authors are encouraged to reference it by version number.

Translation of the LI-RADS Lexicon

To facilitate adoption, we plan to translate the Lexicon into other languages, as we have done with the LI-RADS Core Documents, with translations and their updates verified by guarantors of translation integrity.

Implementation of the LI-RADS Lexicon

Given the need for standardization, the systematic methodology with which the LI-RADS Lexicon was developed and vetted over many years, and the infrastructure that has been developed for its maintenance and translation, the LI-RADS Steering Committee (roster listed in **Supplemental Table 5**), in conjunction with the LI-RADS Lexicon & Writing Group and the LI-RADS International Working Group (roster listed in **Supplemental Table 6**), issue the following consensus recommendation:

Consensus Recommendation

To standardize terminology, we encourage:

- authors of all research and educational materials on liver imaging to use the standardized LI-RADS Lexicon;

- journal editors and reviewers to promote the use of the standardized LI-RADS Lexicon for publications on liver imaging;
- radiologists to use the standardized LI-RADS Lexicon for liver imaging in clinical care.

Voting results and voter qualifications are summarized in **Supplemental Material 3**.

Implications of a consensus statement for publications on liver imaging

Authors submitting manuscripts that include liver imaging should use the terminology provided in the LI-RADS Lexicon https://www.acr.org/Clinical-Resources/Reporting-and-Data-Systems/LI-RADS. Journal editors and reviewers receiving such manuscripts should encourage the use of the proposed terminology unless authors can justify the use of alternate terminology.

Authors submitting manuscripts that include liver imaging should cite the LI-RADS version and access date of the ACR website.

If authors choose to use alternate terminology, they should define their terminology clearly. If appropriate, they should explain the rationale for using alternate terminology and specify how their terminology differs from corresponding LI-RADS Lexicon terms or definitions.

Anticipated benefits of adopting the LI-RADS Lexicon

We anticipate that adoption of the LI-RADS Lexicon into research, education, and clinical care will provide the following benefits:

- Facilitate communication of research results by providing a consistent, controlled, and clear language for describing imaging findings in scientific papers;
- Improve education by providing uniform, understandable, and unambiguous terminology for learning;
- Simplify interpretation of study results;
- Facilitate replication of study results;
- Ease the pooling of data and meta-analysis;
- Permit the extraction of imaging data from research studies to inform evidence-based refinement of LI-RADS and other diagnostic systems;
- Accelerate the translation of advances in knowledge into clinical practice;
- Facilitate the identification of knowledge gaps to inform the design of future studies;
- Enhance the clarity and consistency of clinical communication;
- Facilitate the creation of imaging registries.
- Reduce confusion for patients reading their reports.

Areas of controversy and future directions

Despite its development over many years, the LI-RADS Lexicon continues to have limitations that require additional research and/or refinement. A few are highlighted below:

Arbitrary decisions: Due to the lack of controlled terminology in the precedent literature, it was not possible to simply adopt uniformly accepted terms and definitions. The creation of the LI-RADS Lexicon required some arbitrary decisions. For example, size is defined as the “largest outer-edge-to-

outer-edge dimension of an observation." The decision to use outer to outer measurement as the size was arbitrary. Research is needed to validate arbitrary decisions or inform their refinement.

Inconsistency between modalities and contrast agents: Definitions and criteria may differ between imaging modalities and contrast agents. For example, the distinction between early and late washout applies to CEUS, as it is relevant for differentiating HCC from non-HCC malignancy with this modality, but not to CT or MRI [22]. Future efforts will be directed to harmonizing definitions across modalities and contrast agents if supported by forthcoming scientific evidence.

Imprecise definitions: The definitions for some imaging phases are imprecise. For example, there is no clear temporal demarcation between the portal venous and late or delayed phases on CEUS, CT or MRI. Further clarifications in these definitions may be necessary to improve standardization.

Balance between brevity and completeness: For many terms, clarifying information is provided as a comment (see Supplementary Table 3) rather than as part of the definition. This was done to keep defintions short. For example, the definition of nodule ("spherical or oval mass") does not include a size threshold. Instead, size information is provided as a comment: "the term "nodule" is often reserved for small masses, generally ≤ 2 cm." In the future, it may be necessary to make some of the definitions longer by adding clarifying information.

Inherent subjectivity: Most terms are inherently subjective and, despite their carefully crafted definitions, may be prone to differences in interpretation. The development of objective definitions is an important future direction.

Gaps: Some terms remain undefined. For example, hepatobiliary phase-hypointense nodule without APHE is a new term approved by the LI-RADS Steering Committee in 2018 and introduced by Motosugi and other members of the LI-RADS Hepatobiliary Agent Working Group [23]. This term has yet to be formally defined. As another example, the Lexicon uses and defines the term "rim arterial phase hyperenhancement". One component of this term ("arterial phase hyperenhancement") is defined, but the other component ("rim") is not.

Universal consensus: We recognize that complete consensus by every user for every term and definition is not possible. Nevertheless, we encourage users to adopt the Lexicon, even if they disagee with some terms or their definitions, given the benefits of standardization outlined above. In parallel, we welcome feedback from users to guide refinement and improvements.

Conclusion

There is a need for a standardized lexicon for liver imaging in research, education, and clinical care. The LI-RADS Lexicon provides standardized terms and definitions and was developed by experts in liver imaging and approved by the LI-RADS Steering Committee. We propose that the LI-RADS Lexicon be adopted for liver imaging, with some terms appropriate in the LI-RADS specific context of use and others appropriate for broad context of use irrespective of whether the LI-RADS algorithms are applicable. This recommendation was approved by 100% of the LI-RADS Steering Committee and 99% of voting members of the LI-RADS International Working Group. We anticipate that the universal adoption of the LI-RADS Lexicon will enhance the efficiency of data extraction for research, facilitate learning, accelerate advances in knowledge, and improve clinical practice. The LI-RADS Lexicon is dynamic and will be updated periodically by the LI-RADS Lexicon and Writing Group, under the oversight of the Steering Committee, in response to advances in knowledge, technical developments, and user input. We support diversity and inclusion and welcome feedback from all stakeholders.

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TABLE LEGENDS

Table 1. Modality-agnostic terminology (listed in alphabetical order).

Table 2. US Terminology (listed in alphabetical order).

Table 3. CEUS Terminology (listed in alphabetical order).

Table 4. CT/MRI terminology (listed in alphabetical order)

FIGURE LEGEND

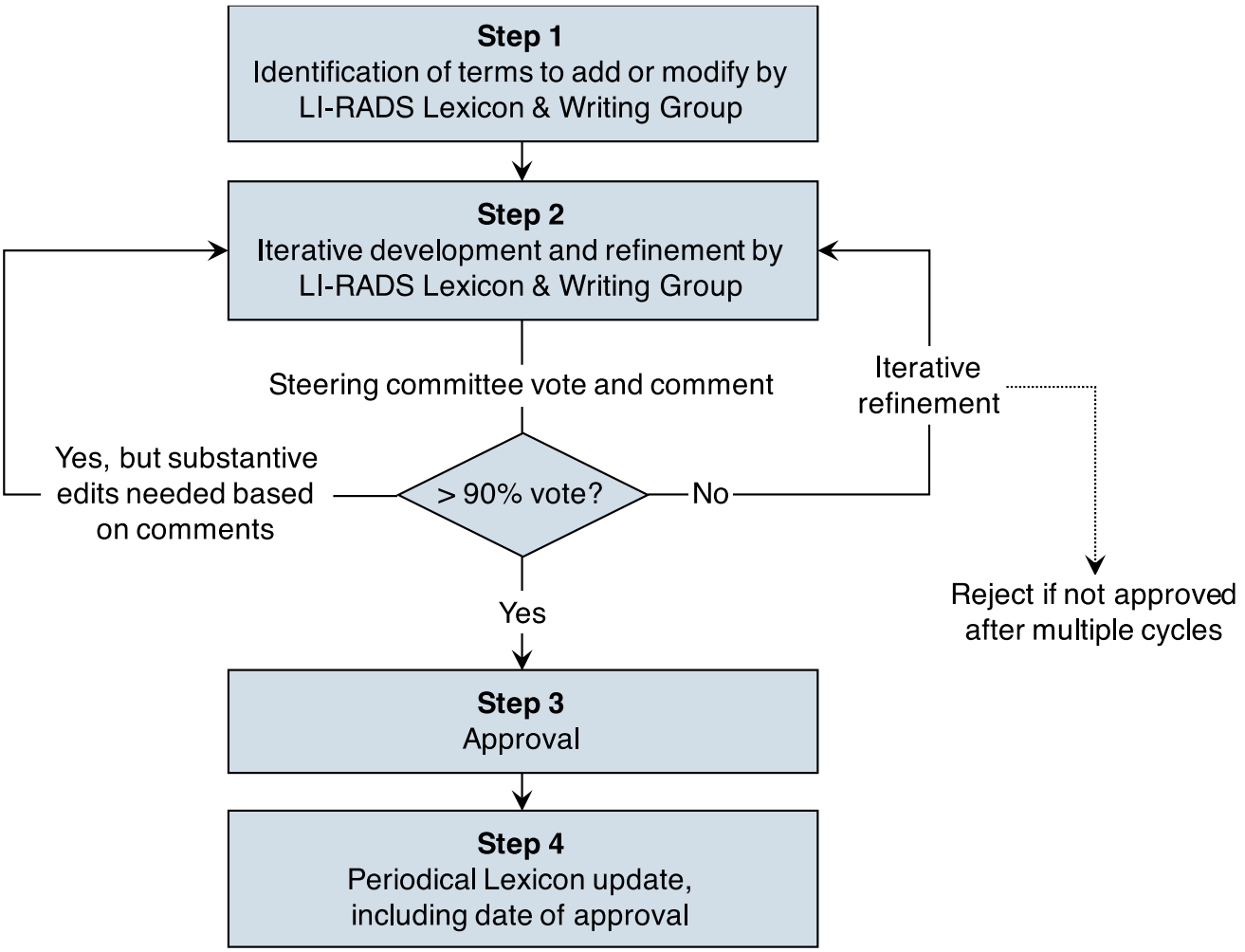

Figure. Iterative process for the addition of new terms and modification of existing terms. Sources of new terms will include terms in LI-RADS Core documents or Manuals not yet included in the Lexicon, terms from the literature recommended by members of the LI-RADS Lexicon and Writing Group, Steering Committee or other working groups, or terms from the literature recommended by the public (email recommendations to LI-RADS Lexicon and Writing Group: rads@acr.org). The Lexicon will be updated periodically to reflect new or modified terms since the prior cycle. Each update will be assigned a new version, its date documented.

TABLES

Table 1. Modality-agnostic terminology (listed in alphabetical order).

Term	Definition
Arterial phase (AP)	A postcontrast phase when: • Hepatic artery and branches are fully enhanced **AND** • Hepatic veins are not enhanced more than liver by antegrade flow.
Arterial phase hyperenhancement (APHE)	Enhancement in arterial phase more than liver, resulting in brightness higher than liver.
Blood pool agents (BPAs)	Contrast agents that distribute mainly in the vascular space after intravenous injection.
Continuous imaging	Acquisition of images without pause or interruption.
Enhancing soft tissue in vein	Presence of enhancing soft tissue in vein, regardless of visualization of parenchymal mass.
Fade	Reduction in enhancement relative to liver from hyperehancement in an earlier phase to isoenhancement or minimal hyperenhancement in all later phases. This can have one of the following patterns: • hyper (arterial phase) → iso/minimally hyper (all later phases) • hyper (portal venous phase) → iso/minimally hyper (all later phases)
Growth	Definite size increase of a mass that cannot be explained only by technique differences, artifact, measurement error, or interval hemorrhage.
Imaging phase	A time range after intravenous contrast injection with characteristic changes in enhancement of liver parenchyma, vessels, and for some agents, bile ducts.
Lesion	An observation that represents a pathologic abnormality.
LI-RADS ancillary feature*	Imaging feature used by LI-RADS to adjust category, increase diagnostic confidence, or detect observations difficult to visualize on other sequences
LI-RADS feature of TIV*	Imaging feature used by LI-RADS to assign or suggest LR-TIV category.
LI-RADS LR-M feature*	Imaging feature used by LI-RADS to assign LR-M category.
LI-RADS major feature*	Imaging feature used by LI-RADS in assigning LR-3, LR-4, and LR-5 categories, reflecting the relative probability that an observation is HCC.
Locoregional therapy	A therapy that targets a specific lesion or part of the liver without physically removing it.
Mass	Space-occupying lesion that distorts or destroys parenchyma.
Mosaic appearance	Presence of any combination of internal nodules, compartments, or septations, within a solid or mostly solid mass.
Multiphase imaging	Acquisition of images at two or more different phases after intravenous contrast injection.
Nodule	Spherical or oval mass.

Nodule-in-nodule appearance	Presence of a smaller inner nodule within a larger outer nodule.
Nonmasslike (adjective)	Not having the properties of a mass; without distorting or destroying parenchyma.
Nonperipheral washout	Subtype of washout that is NOT mainly in observation periphery.
Nonrim arterial hyperenhancement (nonrim APHE)	Subtype of APHE that is NOT mainly in observation periphery.
Observation	Area distinctive compared to liver at imaging.
Parenchymal distortion	Parenchymal area with one or more of the following characteristics: • Ill-defined area of heterogeneity • Refractive shadow on ultrasound • Loss of normal hepatic architecture
Perfusion alteration	Non-masslike change in blood supply to an area of the liver.
Peripheral discontinuous nodular enhancement	Areas of enhancement that in the early postcontrast phases are round or globular in shape and distributed discontinuously along the periphery of a lesion and that in subsequent phases expand and approximately parallel the blood pool in brightness.
Peripheral washout	Subtype of washout that is mainly in observation periphery.
Portal venous phase (PVP)	A postarterial phase acquired no more than 2 minutes after injection of a contrast agent when portal and hepatic veins are enhanced more than liver.
Postarterial phase	General term that refers to imaging after the arterial phase.
Pseudolesion	An observation that may simulate but does not represent a pathologic abnormality.
Rim arterial phase hyperenhancement (rim APHE)	Subtype of APHE that is mainly in observation periphery.
Size	Largest outer-edge-to-outer-edge dimension of an observation.
Size reduction	Spontaneous decrease in size over time, that cannot be explained only by technique differences, artifact, or measurement error.
Size stability ≥ 2 years*	No change in observation size measured on serial exams ≥ 2 years apart.
Treated lesion	Lesion treated by any therapy.
Washout	Reduction in enhancement from earlier to later phase resulting in hypoenhancement relative to liver. This can have one of the following patterns by modality: CT or MRI: • Hyperenhancing to hypoenhancing • Isoenhancing to hypoenhancing If hepatobiliary agent is given, must be assessed before the transitional phase.

	CEUS: • Hyperenhancing to hypoenhancing • Isoenhancing to hypoenhancing • Hypoenhancing to unequivocally more hypoenhancing

Note.—* These terms have LI-RADS-specific context of use

Table 2. US Terminology (listed in alphabetical order).

Term	Definition
Hyperechoic	Echogenicity higher than a reference tissue, organ, or structure.
Hypoechoic	Echogenicity lower than a reference tissue, organ, or structure.
Isoechoic	Echogenicity equal to a reference tissue, organ, or structure.
Refractive shadowing	Linear shadows from the lateral edges of an observation. Observation may be well-defined or ill-defined.

Table 3. CEUS Terminology (listed in alphabetical order).

Term	Definition
Early washout	Subtype of washout on CEUS with early onset (< 60 s) after contrast injection.
Intermittent imaging	A series of brief CEUS image acquisitions, each lasting a few seconds and repeated at intervals of about 30 to 60 seconds without any imaging in between.
Late phase (LP	A postarterial phase on CEUS images acquired after the portal venous phase when portal and hepatic veins are enhanced but less than in portal venous phase.
Late washout	Subtype of washout on CEUS with late onset (> 60 s) after contrast injection.
Marked washout	Pronounced washout on CEUS in which the observation becomes black or "punched out" within 2 minutes from contrast injection.
Mild washout	Subtype of washout on CEUS in which observation becomes less enhanced than liver, but not devoid of enhancement (i.e., some enhancement persists).
Peripheral discontinuous nodular arterial phase hyperenhancement (APHE)*	Areas of enhancement that during the arterial phase are initially round or globular in shape and distributed discontinuously along the periphery of a lesion and then rapidly expand to fill the lesion in its entirely or nearly in its entirety.
Spoke wheel, centrifugal arterial phase hyperenhancement (APHE)	Enhancement in a lesion that during the arterial phase begins as an internal focus and then rapidly expands outward in a radial, spoke-wheel pattern.

* Peripheral discontinuous nodular APHE is a temporal subtype of APHE assessable with continuous imaging during the arterial phase (AP) on CEUS.

Table 4. CT/MRI terminology (listed in alphabetical order)

Term	Definition
Blood products in mass*	Blood products in a mass, in absence of biopsy, trauma or intervention.
Capsule*	Smooth, uniform, sharp border on CT or MRI around most or all of an observation.
Corona enhancement	Periobservational enhancement in late arterial phase or early PVP. The enhancement is contiguous with and surrounds all or part of the observation.
Delayed central enhancement	Postarterial phase pattern where inner part of observation is more enhanced than periphery.
Delayed phase (DP)	A postarterial phase acquired at least 2 minutes after injection of an extracellular agent or gadobenate when portal and hepatic veins are enhanced more than liver.
Diffusion restriction	Intensity higher than liver on diffusion-weighted images not caused only by T2 shine-through.
Early arterial phase (AP)	Subtype of AP on CT or MRI when portal vein is not enhanced or is enhanced less than liver.
Enhancing capsule*	Subtype of capsule visible as an enhancing rim in portal venous phase, delayed phase, or transitional phase.
Extracellular agents (ECA)	Contrast agents with predominantly extracellular distribution after intravenous injection.
Fat in mass, more than adjacent liver	More fat in a mass than in liver.
Fat sparing in solid mass	Less fat in a solid mass than in fatty liver.
Hepatobiliary agents (HBA)	Contrast agents with sufficient hepatobiliary uptake and excretion to allow hepatobiliary phase (HBP) imaging.
Hepatobiliary phase (HBP)	Postcontrast phase acquired with an intravenous hepatobiliary agent when liver parenchyma is intended to be hyperintense to hepatic blood vessels.
Hepatobiliary phase (HBP) hypointensity	Intensity in the hepatobiliary phase lower than liver.
Hepatobiliary phase (HBP) isointensity	Uniform intensity in hepatobiliary phase identical or nearly identical to liver.
Iron in mass, more than liver	More iron in a mass than in liver.
Iron sparing in solid mass	Less iron in a solid mass than in iron-overloaded liver.
Late arterial phase (AP)	Subtype of AP on CT or MRI when portal vein is enhanced more than liver.
Marked T2 hyperintensity	Intensity on T2WI higher than non-iron-overloaded spleen and as high as or almost as high as simple fluid.

Mild-moderate T2 hyperintensity	Intensity on T2WI higher than liver, similar to or lower than non-iron-overloaded spleen, and lower than simple fluid
Nonenhancing capsule*	Subtype of capsule that does not show enhancement on any image.
Nonperipheral washout	Subtype of washout in which apparent washout is NOT most pronounced in observation periphery.
Nonrim arterial hyperenhancement (nonrim APHE)	Subtype of APHE in which APHE is NOT most pronounced in periphery of observation.
Parallels blood pool enhancement	Temporal pattern in which enhancement approximates blood pool in all phases.
Peripheral washout	Subtype of washout that is mainly in observation periphery.
Postarterial extracellular phase (ECP)	Broad term referring to: • PVP and DP if an extracellular agent or gadobenate is given • PVP only if gadoxetate is given
Restricted diffusion	Intensity on DWI higher than liver **AND** ADC similar to or lower than liver.
Subthreshold growth*	Size increase of a mass, less than threshold growth. Any of the following: • Size increase < 50% over any time period • Any size increase over time interval > 6 months • A new mass of any size
Targetoid	Target-like morphology on CT or MRI. The center and periphery of a mass have different imaging characteristics.
Targetoid diffusion restriction	Subtype of restricted diffusion that is greatest in observation periphery.
Targetoid transitional phase (TP) or hepatobiliary phase (HBP) appearance	Subtype TP or HBP hypointensity where the observation periphery is more hypointense than the center.
Threshold growth*	Size increase of a mass by ≥ 50% in ≤ 6 months.
Transitional phase (TP)	Postarterial phase acquired with an intravenous hepatobiliary contrast agent when liver vessels and hepatic parenchyma are of similar signal intensity, which occurs between the portal venous and hepatobiliary phase.
Transitional phase (TP) hypointensity	Intensity in the transitional phase lower than liver.
Undistorted vessels	Vessels traversing an observation without displacement, deformation, or other alteration.
US visibility as nodule*	Unenhanced US visibility as discrete nodule or mass corresponding to CT- or MRI-detected observation.

* These terms have LI-RADS-specific context of use

SUPPLEMENTAL MATERIAL 1

Description of Search Query

Date of Search: June 30, 2021

1. Imaging of primary liver cancer

Search query

1. primary liver cancer or hepatocellular carcinoma or hcc or hepatoma (in title)

2. imaging or radiology (all)

3. 1 and 2

4. and 1970/01/01 : 3000 (date)

5. 3 and 4

Total: 13,827 results

SUPPLEMENTAL MATERIAL 2

Description of the Multi-Year Process by Which the LI-RADS Lexicon was Developed and Approved

2008-2019
The LI-RADS Steering Committee, Lexicon and Writing Group, and three other working groups (Ultrasound Surveillance, CEUS, Treatment Response) developed provisional terms, definitions, accompanying comments, and synonyms. These were published in the 2017 and 2018 LI-RADS Core Documents [16; 18; 19] or the LI-RADS Manual [20].

2019-2020
Assisted by the US, CEUS, and Treatment Response Working Group chairs, the Lexicon and Writing Group identified and extracted key provisional terms, definitions, accompanying comments, and synonyms from the 2017 and 2018 LI-RADS Core documents or from the LI-RADS Manual. Three successive teams of Steering Committee reviewers reviewed the material and made edits for brevity or clarity. After these rounds of edits, every Steering Committee member independently reviewed the lexicon and individually sent their written feedback to the two Steering Committee co-chairs. The co-chairs reviewed the feedback and made further modifications. The 79 terms that emerged from this process were sent to the Steering Committee for formal electronic vote using a commercial survey program (Survey Monkey Inc. San Mateo, CA, USA). Votes were binary ("approve" or "do not approve."). Free-text comments were allowed. Passage required 90% approval. Every Steering Committee member voted on every term. Seventy-seven terms passed. The two terms that failed (one with 88% approval, one with 89%) and all passed terms with ambiguities or inconsistencies described in the free-text comments were further discussed in an in-person meeting of the Steering Committee. As a result of that meeting, two new terms were added, two previously approved terms were removed, and one term was modified. The two new terms and the modified term were approved (100%) by a subsequent electronic vote of the Steering Committee. This lexicon was published in January 2020.

2020-2021
The LI-RADS Lexicon and Writing Group reviewed every term of the 2020 Lexicon, classified its context of use as LI-RADS specific or broad, and made additional edits for brevity or clarity. The Ultrasound, CEUS, and Treatment Response Working Groups were consulted as appropriate. Through numerous cycles of iteration, 30 of the terms in the 2020 Lexicon were modified, 3 were removed, and 3 were added, resulting in an updated provisional lexicon with 83 terms. The LI-RADS Steering Committee voted on the updated provisional lexicon in May 2021. 83 of the terms, definitions, and contexts of use were approved by >90% vote. A lexicon comprising these terms was published in July 2021.

The rosters of the LI-RADS Steering Committee and of the working groups that developed the Lexicon (Lexicon and Writing Group, Ultrasound Surveillance, CEUS, Treatment Response) are listed in **Supplementary Tables 4, 5, and 7-9**. These Tables include all members in the 2019-2020 and/or 2020-2021 periods.

SUPPLEMENTAL MATERIAL 3

Voting

This recommendation is issued jointly by the 2021 LI-RADS Steering Committee (Roster listed in **Supplemental Table 5**) and the 2021 LI-RADS International Working Group (Roster listed in **Supplemental Table 6**). The consensus statement was approved via electronic ballot by 34/34 (100%) of the Steering Committee members, with votes cast between May 4 and May 21, 2021. 97 of the 148 IWG members voted, with each of the consensus statement receiving > 97.9% approval (Statement 1: 96/97 = 99.0%, statement 2: 96/97 = 99.0%, statement 3: 95/97 = 97.9%). Votes were cast between June 5 and July 10, 2021.

Supplemental Table 1. Terms used in the scientific literature to describe arterial phase hyperenhancement.

Synonyms of "arterial phase hyperenhancement"
Arterial enhancement [1]
Contrast enhancement in arterial phase [2]
Early arterial enhancement [3]
Early contrast enhancement [4]
Arterial wash-in [5]
Arterial hypervascularity [6]
Hypervascularization [7]
Arterial-phase hypervascularity [7]
Hypervascular in arterial phase [8]
Arterial-phase enhancement [7]
Intense arterial enhancement [9]

Supplemental Table 2. Washout definitions from convenience sample of 12 scientific papers published since 2016.

	Definition
1	"Washout: intense contrast uptake during the AP followed by contrast washout in delayed phases" [24]
2	"Washout in the PVP and DP/TP: temporal reduction in nodule enhancement, resulting in hypoenhancement relative to the liver parenchyma" [25]
3	"Arterial-enhanced portion of the tumor changed to lower signal than the surrounding liver tissue seen on the portal phase" [26]
4	"Washout appearance according to type of MRI (conventional washout was defined as hypointensity on the PVP or delayed phase [DP] on ECA-MRI or hypointensity on the PVP on HBA MRI" [27]
5	"Washout was defined as hypointensity relative to background liver in the portal venous phase" [28]
6	"Washout was defined as a nodule showing lower attenuation than the background liver on portal venous to delayed phase" [29]
7	“Lesions whose signal intensities are visibly lower than the ALP [adjacent liver parenchyma] are considered positive for the washout” [30]

Supplemental Table 3. Complete Lexicon

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
Arterial phase (AP)	A postcontrast phase when: • Hepatic artery and branches are fully enhanced **AND** • Hepatic veins are not enhanced more than liver by antegrade flow.	Broad	CEUS, CT, MRI	On CEUS: the AP usually starts around 10-15 seconds after injection, and lasts for 10- 20 seconds. On CT and MRI: the AP is divided into two temporal subtypes: • Early AP: Subtype of AP in which portal vein is not enhanced or is enhanced less than liver • Late AP: Subtype of AP in which portal vein is enhanced more than liver	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to learn more about the early arterial phase.	Early phase, angiographic phase	Imaging phase	5/2021
Arterial phase hyperenhancement (APHE)	Enhancement in arterial phase more than liver, resulting in brightness higher than liver.	Broad	CEUS, CT, MRI	On MRI: assessment of APHE requires acquisiton of precontrast as well as arterial phase (AP) images. On CT: in absence of prior treatment ,APHE can usually be assessed without precontrast images. The reason is that untreated observations are rarely hyperattenuating on precontrast CT. On CEUS: assessment of APHE requires continuous imaging during the AP. APHE can be seen in the entire observation or only in part(s) of the observation. If any part of	In the LI-RADS CT/MRI diagnostic algorithms, the main APHE subtypes are classified as follows: • Rim APHE is a LR-M feature • Nonrim APHE is a major feature of HCC See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn about APHE and its subtypes. In the LI-RADS CEUS	Arterial hypervascularity, hypervascularity in arterial phase, increased contrast enhancement in hepatic arterial phase, increased contrast enhancement in late hepatic	Imaging feature, general	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				the observation has APHE, then APHE is considered to be present. Enhancement from hypo on precontrast to iso on arterial phase does not qualify as APHE. On CT and MRI: · APHE has two main subtypes: • Rim APHE • Nonrim APHE On CEUS: · APHE has four main subtypes: • Rim APHE • Nonrim APHE • Spokewheel, centrifugal APHE • Peripheral discontinuous nodular APHE • Spokewheel, centrifugal APHE is suggestive but not diagnostic of FNH. • Peripheral discontinuous nodular APHE is diagnostic of hemangioma Caveat:	diagnostic algorithm, the main APHE subtypes are classified as follows: • Rim APHE is a LR-M feature • Nonrim APHE is a major feature of HCC • Peripheral discontinuous nodular APHE, diagnostic of hemangioma	arterial phase, hypervascularity, high attenuation area in arterial phase, contrast uptake in arterial phase, wash in		

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				Peripheral discontinuous nodular enhancement is a temporal enhancement pattern that can be assessed on CT or MRI in addition to CEUS. Unlike peripheral discontinuous nodular APHE, it is not considered an APHE subtype because its assessment requires the acquisition of at least one postarterial phase and it can be assessed even if an arterial phase is not acquired. See *peripheral discontinuous nodular enhancement*.				
Blood pool agents (BPAs)	Contrast agents that distribute mainly in the vascular space after intravenous injection.	Broad	CEUS, MRI	Blood pool agents remain in the blood with little or no distribution in the extravascular space. Applies mainly to CEUS microbubble agents. Can also apply to iron-based or protein-binding Gd-based MR agents with prolonged vascular dwell times, such as gadofosveset trisodium and ferumoxytol, respectively. Neither of these MR contrast agents is approved for liver imaging in the United States.	See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf to learn more about BPAs.	Intravascular contrast agents	Type of contrast agent	5/2021
Blood products in mass	Blood products in a mass, in absence of biopsy, trauma or intervention	LI-RADS	CT, MRI		Blood products • Do not enhance • Are typically heterogeneous • Are often amorphous or geographic in shape • Have imaging characteristics that depend on their acuity: • CT	Hematoma, hemorrhage, methemoglobin, hemosiderin	Ancillary feature favoring HCC in particular	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					• Acute and subacute: hyperattenuating relative to liver • Chronic: iso or hypoattenuating. • MRI • Acute (hours to days): T1 hypo or iso, T2 hypo • Subacute (days to months): T1 hyper, T2 variable • Chronic (months to years): T1 hypo, T2 hypo. For subacute or chronic blood products: there may be signal loss on 2nd echo of dual-gradient-echo sequence or high R2* value on R2* map (if obtained) or low T2* value on T2* map (if obtained). In the context of the LI-RADS CT/MRI diagnostic algorithm, blood products in mass • Is an ancillary feature favoring malignancy in general. • Should not be applied as an ancillary feature favoring malignancy if there is history of biopsy, trauma or intervention • Should not be applied as an ancillary feature favoring malignancy in nonsolid lesions such as hemorrhagic cysts. See https://www.acr.org/-/media/ACR/Files/Clinical-			

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about blood products in mass and how it is used in LI-RADS.			
Capsule	Smooth, uniform, sharp border on CT or MRI around most or all of an observation.	LI-RADS	CT, MRI		In the LI-RADS CT/MRI diagnostic algorithm, capsule has two subtypes: • Enhancing capsule, which is a major feature of HCC • Nonenhancing capsule, which is an ancillary feature favoring HCC in particular If the capsule is enhancing, the enhancement must be most pronounced in a postarterial phase. If a capsule is visible as both an enhancing rim AND as a nonenhancing rim, it should be characterized as enhancing capsule, NOT as nonenhancing capsule. If the liver parenchyma visually consists of both nodules and fibrosis, then the capsule must be thicker or more conspicuous than the fibrotic tissue around background nodules.	Capsule appearance, pseudocapsule, tumor capsule, tumor pseudocapsule, fibrous capsule, fibrous pseudocapsule	Imaging feature, general	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					The imaging feature, capsule, refers to the imaging appearance of a capsule. Pathologically, it may represent a true tumor capsule or a pseudocapsule. Thus, an imaging capsule does not imply that there is a true capsule pathologically. The imaging appearance of capsule may represent a true tumor capsule or a pseudocapsule on pathology. The distinction between true capsule and pseudocapsule can only be made at pathology. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about capsule and its subtypes.			
Continuous imaging	Acquisition of images –without pause or interruption.	Broad	US, CEUS	On US and CEUS, typically 10-20 frames/second. CT and MRI can also acquire images without pause or interruption, but this is not commonly performed with these modalities.			Technical term	5/2021
Corona enhancement	Periobservational enhancement in late arterial phase	Broad	CT, MRI	Usually lobulated and may vary in thickness.	In the context of the LI-RADS CT/MRI diagnostic algorithm, corona enhancement is an ancillary feature favoring malignancy in general.	Corona, perilesional staining	Ancillary feature favoring	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
	or early portal venous phase. The enhancement is contiguous with and surrounds all or part of the observation.			Corona enhancement is thought to represent venous drainage from arterialized tumor.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about corona enhancement and how it is used in LI-RADS.		malignancy, not HCC in particular	
Delayed central enhancement	Postarterial phase pattern where inner part of observation is more enhanced than periphery.	Broad	CT, MRI	Delayed central enhancement is a subtype of targetoid morphology. The area of delayed enhancement in an observation may be central, eccentric, or heterogeneous, but not peripheral. The adjective “central” refers to **inner** portions of the observation but is not meant to imply that the delayed enhancement is literally in the geometric center of the observation. Delayed central enhancement: • Does not apply to central scar with delayed enhancement • Does not apply to observations that can be confidently diagnosed as hemangioma based on other features	In the context of the LI-RADS CT/MRI diagnostic algorithm, delayed central enhancement is an LR-M feature. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about delayed central enhancement.	Sustained central enhancement, concentric progressive enhancement, centripetal progressive enhancement	Imaging feature, LR-M	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
Delayed phase (DP)	A postarterial phase acquired at least 2 minutes after injection of an extracellular agent or gadobenate when portal and hepatic veins are enhanced more than liver.	Broad	CT, MRI with ECA, MRI with gadobenate dimeglumine	The DP is typically acquired 2 to 5 minutes after injection of an extracellular agent or gadobenate. The DP does not apply to MRI performed with gadoxetate (the term “transitional phase” is used for images acquired 2 to 5 minutes after injection). The portal venous phase (PVP) and DP appear similar. They can be distinguished by:	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to learn more about the delayed phase.	Interstitial phase, equilibrium phase, late dynamic phase, late venous phase	Imaging phase	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				• Timing after injection • If both phases are acquired: the liver, the portal veins, and the hepatic veins are usually less enhanced in the DP than in the PVP.				
Diffusion restriction	Intensity higher than liver on diffusion-weighted images not caused only by T2 shine-through.	Broad	MRI	Should be assessed on DW images acquired with at least moderate diffusion weighting ($b \geq 400$ s/mm^2). If an adequate ADC map is obtained or if ADC is calculated from source images, ADC is lower than or similar to liver. T2 shine-through can be seen in observations with moderate to high signal intensity on T2-weighted images. To differentiate: • Restricted diffusion: ADC (either calculated or based on the ADC map) lower or similar to liver • T2 shine-through: ADC (either calculated or based on the ADC map) higher than liver	In the context of the LI-RADS CT/MRI diagnostic algorithm, restricted diffusion is: • A nontargetoid LR-M feature, if marked in degree • A targetoid LR-M feature, if targetoid morphology • An ancillary feature favoring malignancy in general, otherwise See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about restricted diffusion.	Impeded diffusion, diffusion restriction, high DWI signal	Imaging feature, Ancillary feature favoring malignancy in general, not HCC in particular	5/2021
Early arterial phase (AP)	Subtype of AP on CT or MRI when portal vein is not enhanced or is enhanced less than liver.	Broad	CT, MRI	In the early AP: • There may be some enhancement of the portal vein. However, if the portal vein is enhanced more than liver, the early AP has passed.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to learn more about the early arterial phase.	Early phase, angiographic phase	Imaging phase	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				• There should be no enhancement of the hepatic veins by antegrade flow. If there is any enhancement of the hepatic veins by antegrade flow, the early AP has passed.				
Early washout	Subtype of washout on CEUS with early onset (< 60 s) after contrast injection.	Broad	CEUS	Early washout is usually marked in degree. Early washout usually happens earlier than 60 seconds, and late washout much later.	In the context of the LI-RADS CEUS algorithm, onset must be less than 60 seconds (< 60 s) after contrast injection. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf.		Imaging feature, LR-M	5/2021
Enhancing capsule	Subtype of capsule visible as an enhancing rim in portal venous phase, delayed phase, or transitional phase.	LI-RADS	CT, MRI		In the LI-RADS CT/MRI algorithm, enhancing capsule is: • One of two defined subtypes of capsule. • A major feature of HCC The enhancement of the capsule must be most pronounced in a postarterial phase. If there is a rim that enhances more in the arterial phase (AP) than the postarterial phases, it should be characterized as rim arterial phase hyperenhancement (APHE), not as enhancing capsule. A border visible only as an enhancing rim in the hepatobiliary phase (HBP) should not be characterized as an enhancing capsule.	Capsule, tumor capsule, pseudocapsule, fibrous capsule, capsular enhancement, delayed enhancing rim	Imaging feature, major	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about enhancing capsule.			
Enhancing soft tissue in vein	Presence of enhancing soft tissue in vein, regardless of visualization of parenchymal mass.	Broad	CEUS, CT, MRI	For terminology about vascular involvement in pediatric liver tumor imaging, refer to PRETEXT (https://www.pedrad.org/Portals/5/Subspecialties/Abdominal%20Imaging/PRETEXT%202017.pdf)	In the context of the LI-RADS CEUS and CT/MRI diagnostic algorithms, enhancing soft tissue in vein establishes the diagnosis of tumor in vein and is categorized LR-TIV. Tumor in vein and enhancing soft tissue in vein are related but not identical terms: • Tumor in vein is a LI-RADS category • Enhancing soft tissue in vein is the LI-RADS imaging criterion for tumor in vein	None	Imaging feature, LR-TIV	5/2021
Extracellular agents (ECAs)	Contrast agents with predominantly extracellular distribution after intravenous injection.	Broad	CT, MRI	For MRI, examples of FDA-approved agents (as of February, 2021, nonexhaustive list) include: gadopentetate dimeglumine, gadoteridol, gadodiamide, gadoversetamide, gadobutrol, gadoterate meglumine.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to learn more about ECAs.	Extracellular fluid contrast agents	Type of contrast agent	5/2021
Fade	Reduction in enhancement relative to liver from hyperehancement	Broad	CT, MRI, CEUS	Fade can be assessed only if at least two contrast-enhanced phases are obtained (e.g., arterial phase followed by one or more postarterial phases) so that the reduction in enhancement over time can be assessed.	In the LI-RADS CT/MRI diagnostic algorithm: If any part of the observation has washout, then washout is considered to be present, even if other or even most parts of the observation show fade.			5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
	in an earlier phase to isoenhancement or minimal hyperenhancement in all later phases. This can have one of the following patterns: • hyper (arterial phase) → iso/min hyper (all later phases) • hyper (portal venous phase) → iso/min hyper (all later phases)			Fade cannot be assessed if there is a single contrast-enhanced phase. If there is hypoenhancement relative to the liver on any postarterial phase, do not characterize as fade. While fade is similar to washout in that the area of interest appears to de-enhance relative to liver, fade and washout are not the same. See *washout* for detailed comparison.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about fade.			
Fat in mass, more than adjacent liver	More fat in a mass than in liver.	Broad	CT, MRI	Imaging criteria: • Observation is a mass AND • As follows by imaging modality: • CT: • Mass or part of mass has attenuation < -10 HU OR • If unenhanced CT is available and liver is fatty, mass has attenuation less than liver on unenhanced CT	In the context of the LI-RADS CT/MRI diagnostic algorithm, fat in mass, more than adjacent liver is an ancillary feature favoring HCC in particular. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about fat in mass, more than adjacent liver and how it is used in LI-RADS.	Steatotic nodule, intralesional fat, fatty lesion, fat deposition, fatty metamorphosis, and intralesional fatty metaplasia	Ancillary feature favoring HCC in particular	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved

				• MRI: Mass or part of mass has any of following compared to liver:
				  • More signal loss on OP compared to IP
				  • Higher fat signal on fat-only images
				  • Higher fat fraction on fat-fraction maps
				  • More signal loss on fat-suppressed compared to non-fat-suppressed images with similar or identical weighting
				
				Use caution in applying this feature if OP has a longer TE than IP; in this situation, signal loss on the longer echo may indicate either fat or iron.				

Fat sparing in solid mass	Less fat in a solid mass than in fatty liver.	Broad	CT, MRI	Imaging criteria: • Observation is solid mass AND • Liver is fatty AND • As follows by imaging modality: • CT: Mass has higher attenuation than liver on unenhanced CT • MRI: Compared to liver, mass has any of following:	In the context of the LI-RADS CT/MRI diagnostic algorithm: • Fat sparing in solid mass is an ancillary feature favoring malignancy in general • Do not apply fat sparing as an ancillary feature favoring malignancy in nonsolid lesions such as cysts or hemangiomas See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about Iron sparing in solid mass and how it is used in LI-RADS.	Lesional fat sparing	Ancillary feature favoring malignancy, not HCC in particular	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				• Less signal loss on OP compared to IP • Lower fat signal on fat-only images • Lower fat fraction on fat-fraction maps Less signal loss on fat-suppressed compared to non-fat-suppressed images with similar or identical weighting.				

Growth	Definite size increase of a mass that cannot be explained only by technique differences, artifact, measurement error, or interval hemorrhage.	Broad	US, CEUS, CT, MRI	Measure on same phase, sequence, and plane on serial exams if possible.
				
				Do not characterize as growth if size increase can be explained by technique differences, artifact, measurement error, or interval hemorrhage.
				
				There is insufficient evidence to define an absolute or percent change in size as a cut-off for establishing the presence of growth. Users should therefore use their judgement.
					In the context of all LI-RADS diagnostic algorithms, if there is doubt about the presence of growth:
					
					• Do not characterize as growth
					• Do not characterize as size stability
					
					In the context of the LI-RADS CT/MRI diagnostic algorithm, growth:
					
					• Applies *only* to masses; It does not apply to pseudolesions such as perfusion alterations or nonmasslike lesion such as focal fat deposition.
					• Should be assessed *only* if there is a prior CT or MRI exam of sufficient quality and appropriate technique to quantify the interval growth.
					• Should not be assessed by comparing to prior US or CEUS exams.
					• Has two subtypes:
					  • Threshold growth (a major feature of HCC)
					  • Subthreshold growth (an ancillary feature favoring malignancy in general)
						Interval growth, progression, size increase, diameter increase	Imaging feature, general	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about growth and its subtypes. In the context of CEUS LI-RADS diagnostic algorithm, growth: • Is an ancillary feature favoring malignancy in general • Should not be assessed by comparing to prior CT or MRI exams LI-RADS CEUS does not classify growth into subtypes.			
Hepatobiliary agents (HBAs)	Contrast agents with sufficient hepatobiliary uptake and excretion to allow hepatobiliary phase (HBP) imaging.	Broad	MRI	Applies to gadoxetate and gadobenate.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf and https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-13-HBA.pdf to learn more about HBAs.	Hepatocellular agents, biphasic agents	Type of contrast agent	5/2021
Hepatobiliary phase (HBP)	Postcontrast phase acquired with a hepatobiliary agent	Broad	MRI with gadoxetate or	The HBP is typically acquired about 20 minutes after injection of gadoxetate.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf and https://www.acr.org/-	Hepatocellular phase	Imaging phase	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
	when liver parenchyma is intended to be hyperintense to hepatic blood vessels.		gadobenate	If obtained with gadobenate, the HBP is acquired 1-3 hours after injection. Excretion of contrast into the biliary tree may or may not be present.	/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-13-HBA.pdf to learn more about HBP.			
Hepatobiliary phase (HBP) hypointensity	Intensity in the hepatobiliary phase lower than liver.	Broad	MRI with gadoxetate or gadobenate	HBP hypointensity does not qualify as washout appearance. Compare to functional areas of parenchyma (i.e., do not compare to vessels or to parts of liver that do not take up the agent).	In the context of the LI-RADS CT/MRI diagnostic algorithm: • HBP hypointensity can be seen in the entire observation or only in part(s) of the observation. If any part of the observation has HBP hypointensity, then HBP hypointensity is considered to be present. • Unless in a targetoid pattern, HBP hypointensity is an ancillary feature favoring malignancy in general • Targetoid HBP hypointensity is a subtype of HBP hypointensity. This subtype is a targetoid LR-M feature and not an ancillary feature favoring malignancy in general. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about HBP hypointensity and how it is used in LI-RADS.	Hepatobiliary phase hypoenhancement, hepatobiliary phase “defect”	Imaging feature, ancillary feature favoring malignancy, not HCC in particular	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
Hepatobiliary phase (HBP) isointensity	Uniform intensity in hepatobiliary phase identical or nearly identical to liver.	Broad	MRI with gadoxetate or gadobenate	HBP isointensity applies only to observations that are homogeneous in the HBP. Compare to functional areas of parenchyma (i.e., do not compare to vessels or to parts of liver that do not take up the agent).	In the context of the LI-RADS CT/MRI diagnostic algorithm, HBP isointensity • is an ancillary feature favoring benignity. • should not be applied as an ancillary feature favoring benignity if HBP enhancement of liver is suboptimal See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about HBP isointensity and how it is used in LI-RADS.	HBP isoenhancement, occult in HBP	Ancillary feature favoring benignity	5/2021
Hyperechoic	Echogenicity higher than a reference tissue, organ, or structure	Broad	US, CEUS		In the context of the LI-RADS US and CEUS algorithms, this definition applies to observations, which should be compared to background liver. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/LI-RADS-US-Algorithm-Portrait-2017.pdf to learn more about hyperechoic and how it is used in the US algorithm.	Echogenic	General term	5/2021
Hypoechoic	Echogenicity lower than a reference tissue, organ, or structure.	Broad	US, CEUS		In the context of the LI-RADS US and CEUS algorithms, this definition applies to observations, which should be compared to background liver. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/LI-RADS-US-Algorithm-Portrait-2017.pdf to learn more		General term [	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					about hypoechoic and how it is used in the US algorithm.			
Imaging phase	A time range after intravenous contrast injection with characteristic changes in enhancement of liver parenchyma, vessels, and for some agents, bile ducts.	Broad	CEUS, CT, MRI	The time after contrast administration is divided into discrete phases for simplicity and clinical utility. Examples for liver imaging include: • Arterial phase • Portal venous phase • Delayed phase • Late phase • Transitional phase • Hepatobiliary phase The transitional phase and hepatobiliary phase are unique to hepatobiliary agents. The delayed phase is unique to extracellular agents. The late phase is unique to blood pool agents such as those used in CEUS.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to learn more about imaging phases.		General term	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				The postarterial phase is a general term that refers to all phases after the arterial phase. The transition between the various phases is gradual, with exact timing dependent on patient-related and technical factors. Images might be acquired during a transition from one phase to the next, in which case the images might have overlapping characteristics of the two adjacent phases.				
Intermittent imaging	A series of brief CEUS image acquisitions, each lasting a few seconds and repeated at intervals of about 30 to 60 seconds without any imaging in between.	Broad	CEUS				Technical term	5/2021
Iron in mass, more than liver	More iron in a mass than in liver.	Broad	CT, MRI	Imaging criteria (MRI): • Observation is a mass AND • Mass contains iron, i.e., any of following:	In the context of the LI-RADS CT/MRI diagnostic algorithm, iron in mass, more than liver is an ancillary feature favoring benignity. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-	Siderotic nodule	Ancillary feature favoring benignity	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				• Lower signal intensity on second echo (longer TE) compared to first echo (shorter TE) on dual-echo gradient-echo sequence • Abnormally low signal intensity on T2W images • Abnormally high R2* value on R2* maps (if obtained) • Abnormally low T2* value on T2* maps (if obtained) AND • Compared to mass, liver has less iron i.e., any of following: • Less signal loss on second echo (longer TE) compared to first echo (shorter TE) on dual-echo gradient-echo sequence • Higher signal intensity on T2W images • Lower R2* value on R2* maps (if obtained) • Higher T2* value on T2* maps (if obtained) Use caution in applying this feature if OP has a longer TE than IP; in this situation, signal loss on the longer echo may indicate either fat or iron.	features.pdf to learn more about iron in mass, more than liver and how it is used in LI-RADS			
Iron sparing in solid mass	Less iron in a solid mass than in iron-overloaded liver.	Broad	MRI	Imaging criteria (MRI): • Observation is solid mass AND • Liver is iron-overloaded. Features suggesting iron overload include:	In the context of the LI-RADS CT/MRI diagnostic algorithm: • Iron sparing in solid mass is an ancillary feature favoring malignancy in general.	Lesional iron sparing, lesional iron resistance	Imaging feature, ancillary feature favoring malignancy, not	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				• Lower signal intensity on second echo (longer TE) compared to first echo (shorter TE) on dual-echo gradient-echo sequence • Abnormally low signal intensity on T2W images • Abnormally high R2* value on R2* maps (if obtained) • Abnormally low T2* value on T2* maps (if obtained) AND • Compared to liver, mass has less iron, i.e., any of following: • Less signal loss on second echo (longer TE) compared to first echo (shorter TE) on dual-echo gradient-echo sequence • Higher signal intensity on T2W images • Lower R2* value on R2* maps (if obtained) • Higher T2* value on T2* maps (if obtained) This feature cannot be reliably characterized on US or CT.	• Do not apply iron sparing as an ancillary feature favoring malignancy in nonsolid lesions such as cysts or hemangiomas See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about Iron sparing in solid mass and how it is used in LI-RADS.		HCC in particular	
Isoechoic	Echogenicity equal to a reference tissue, organ, or structure.	Broad	US, CEUS		In the context of the LI-RADS US and CEUS algorithms, this definition applies to observations, which should be compared to background liver. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/LI-RADS-US-Algorithm-Portrait-2017.pdf to learn more about isoechoic and how it is used in the US algorithm.		General term	5/2021

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Late arterial phase (AP)	Subtype of AP on CT or MRI when portal vein is enhanced more than liver.	Broad	CT, MRI	In late AP: • Enhancement of the portal vein may or may not be homogeneous. • There may be faint enhancement of the hepatic veins by antegrade flow. However, if the hepatic veins are enhanced more than liver by antegrade flow, the late AP has passed.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to learn more about the late arterial phase.		Imaging phase	5/2021
Late phase (LP)	A postarterial phase on CEUS images acquired after the portal venous phase when portal and hepatic veins are enhanced but less than in portal venous phase.	Broad	CEUS	LP lasts from end of portal venous phase (PVP) until there is clearance of microbubbles from the circulation at about 4-6 min. Liver parenchyma is enhanced but usually less than in PVP.	See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf to learn about LP.		Imaging phase	5/2021
Late washout	Subtype of washout on CEUS with late onset (> 60 s) after contrast injection.	Broad	CEUS		In the context of the LI-RADS CEUS algorithm, onset of washout must be 60 seconds or more (≥ 60 s) after contrast injection. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf.		Imaging feature, major	5/2021
Lesion	An observation that represents a	Broad	US, CEUS, CT, MRI	May be a mass or a non-masslike lesion. See *mass* for examples of mass.	See https://www.acr.org/-/media/ACR/Files/Clinical-	FLL, focal liver lesion	General term	5/2021

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	pathologic abnormality.			Examples of nonmasslike lesions: • Nonmasslike fat deposition or sparing • Nonmasslike iron deposition or sparing The term “lesion” should not be used interchangeably with the term “observation”. A lesion is a type of observation. Although all lesions are observations, not all observations are lesions. If there is uncertainty about whether an observation represents a pathologic abnormality (i.e., a true lesion), the term “observation” is preferred over the term “lesion”.	Resources/LIRADS/Chapter-7-The-LIRADS-observation.pdf to learn more about lesion.			
LI-RADS ancillary feature	Imaging feature used by LI-RADS to adjust category, increase diagnostic confidence, or detect observations difficult to visualize on other sequences	LI-RADS	CEUS, CT, MRI		Ancillary features are divided into: • Favoring malignancy • Favoring benignity Ancillary features favoring malignancy are subdivided into: • Favoring malignancy in general • Favoring HCC in particular See https://www.acr.org/-/media/ACR/Files/Clinical-			5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about ancillary features and how they are is used in LI-RADS.			

LI-RADS feature of TIV	Imaging feature used by LI-RADS to assign or suggest LR-TIV category.	LI-RADS	CEUS, CT, MRI		In the context of the LI-RADS CT/MRI diagnostic algorithm, there are two types of TIV features:
					
					• Feature diagnostic of tumor in vein
					• Feature suggestive of tumor in vein
					
					Feature diagnostic of tumor in vein:
					• In LI-RADS, there is one feature diagnostic of tumor in vein – enhancing soft tissue in vein.
					• This feature is necessary and sufficient to establish the presence of tumor in vein and to categorize an observation as LR-TIV. Any observation with this feature should be categorized LR-TIV, regardless of the presence or absence or any other feature and regardless of visualization of a parenchymal mass.
					
					Features suggestive of tumor in vein:
					• In LI-RADS, there are four features suggestive of TIV:
					  • Occluded vein with ill-defined walls
					  • Occluded vein with restricted diffusion
					  • Occluded or obscured vein in contiguity with malignant parenchymal mass
								5/2021

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					• Heterogeneous vein appearance not attributable to artifact • These features suggest but do not establish the presence of TIV and cannot by themselves be used to categorize an observation as LR-TIV. If present, such features should prompt the radiologist to scrutinize the vein for enhancing soft tissue. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about LI-RADS features of TIV and how they are used in LI-RADS. In the context of LI-RADS CEUS diagnostic algorithm, tumor in vein is defined as unequivocal enhancing soft tissue in vein, regardless of visualization of a parenchymal mass. Tumor in vein should be differentiated from partially occlusive/recanalized bland thrombus. Arrival time of microbubble contrast agent to the vein helps in this differentiation: • Early arrival (~ same time as hepatic artery opacification): favors tumor in vein			

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					• Arrival several (~10) seconds after hepatic artery opacification: favors portal flow in patent portion of non-occlusive/recanalized bland thrombus			
LI-RADS LR-M feature	Imaging feature used by LI-RADS to assign LR-M category.	LI-RADS	CEUS, CT, MRI		LR-M features indicate a high probability of malignancy but are not specific for HCC. In context of the LI-RADS CT/MRI diagnostic algorithm, LR-M features are divided into: • Targetoid LR-M features • Nontargetoid LR-M features Targetoid LR-M features include: • Rim arterial phase hyperenhancement (APHE) • Peripheral washout • Delayed central enhancemenrt • Targetoid diffusion restriction • Targetoid transitional phase (TP) or hepatobiliary phase (HBP) appearance Nontargetoid LR-M features include: • Infiltrative appearance • Marked diffusion restriction • Necrosis or severe ischemia • Other feature that in radiologist’s judgment suggests non-HCC malignancy			5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about LR-M features and how they are used in LI-RADS. In context of the LI-RADS CEUS diagnostic algorithm, LR-M features include any one of the following: • Rim APHE followed by any washout • Early washout onset (< 1 min) • Marked washout degree (if seen before 2 min) See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf to learn more about LR-M features and how they are used in the CEUS LI-RADS diagnostic algorithm.			
LI-RADS major feature	Imaging feature used by LI-RADS in assigning LR-3, LR-4, and LR-5 categories, reflecting the relative probability that an observation is HCC.	LI-RADS	CEUS, CT, MRI		LI-RADS defines five major features on CT and MRI: • Nonrim arterial phase hyperenhancement (APHE) • Nonperipheral washout • Enhancing capsule • Size • Threshold growth			

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					LI-RADS defines three major features on CEUS: • Nonrim APHE • Late and mild washout • Size			
Locoregional therapy	A therapy that targets a specific lesion or part of the liver without physically removing it.	Broad		Examples include: • Ablative therapy • Transcatheter therapy • External beam radiation Surgical resection physically removes part of the liver and is not considered locoregional therapy. Systemic administration of chemotherapeutic or biologic agents is also not considered locoregional therapy.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-9-Treatment-response.pdf learn more about locoregional therapy.		General term	5/2021
Marked T2 hyperintensity	Intensity on T2WI higher than non-iron-overloaded spleen and as high as or almost as high as simple fluid.	Broad	MRI	Characteristic imaging feature of cysts and some hemangiomas.	In the context of the LI-RADS CT/MRI diagnostic algorithm, marked T2 hyperintensity is an ancillary feature favoring benignity. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-	T2 bright, high T2 signal intensity, fluid signal, lightbulb T2 bright	Ancillary feature favoring benignity	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					features.pdf to learn more about marked T2 hyperintensity and how it is used in LI-RADS.			
Marked washout	Subtype of washout on CEUS in which the observation becomes black or "punched out" while the background liver is still enhanced.	Broad	CEUS		In the context of the LI-RADS CEUS algorithm, the observation must become black or "punched out" within 2 minutes from contrast injection. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf.		Imaging feature, LR-M	5/2021
Mass	Space-occupying lesion that distorts or destroys parenchyma or other anatomic structures.	Broad	US, CEUS, CT, MRI	Examples include: • Malignant neoplasms • Benign neoplasms • Hemangiomas • Cysts • Confluent fibrosis • Treated lesions May be of any size or shape: • Round or oval • Geographic • Irregular • Diffuse • Confluent • "Infiltrative" or "permeative"	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-7-The-LIRADS-observation.pdf to learn more about mass.		General term	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				If a mass is either oval or round in shape, it is considered a nodule. For such observations, either the term “nodule” or “mass” may be used, depending on context, user preference, and size. If a mass is geographic or irregular in shape or has a diffuse, confluent, or infiltrative appearance, the term “nodule” does not apply.				
Mild washout	Subtype of washout on CEUS in which observation becomes less enhanced than liver, but not devoid of enhancement (i.e., some enhancement persists).	Broad	CEUS		Mild washout includes all washout appearing later than 2 minutes after contrast injection. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf.		Imaging feature, major	5/2021
Mild-moderate T2 hyperintensity	Intensity on T2WI higher than liver, similar to or lower than non-iron-overloaded spleen, and lower than simple fluid	Broad	MRI	In patients without a spleen or with an iron-overloaded spleen, intensity should be lower than simple fluid.	In the context of the LI-RADS CT/MRI diagnostic algorithm, mild-moderate T2 hyperintensity is an ancillary feature favoring malignancy in general. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-	Slightly bright T2, mild-moderate T2 signal	Imaging feature, ancillary feature favoring malignancy, not	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					features.pdf to learn more about mild-moderate T2 hyperintensity and how it is used in LI-RADS.		HCC in particular	
Mosaic appearance	Presence of any combination of internal nodules, compartments, or septations, within a solid or mostly solid mass.	Broad	CEUS, CT, MRI	The internal nodules or compartments differ in imaging features from each other. If there is a single inner nodule within a mass, the term nodule-in-nodule may be used. Components of a mass with mosaic appearance may be necrotic or cystic. The term mosaic appearance does not apply to a septated cyst.	In the context of the LI-RADS CT/MRI diagnostic algorithm, mosaic appearance is an ancillary feature favoring HCC in particular. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about mosaic appearance and how it is used in LI-RADS.	Mosaic pattern, mosaic architecture	Imaging feature, ancillary feature favoring HCC in particular	5/2021
Multiphase imaging	Acquisition of images at two or more different phases after intravenous contrast injection.	Broad	CEUS, CT, MRI	Common examples of multiphase imaging on CT and MRI include acquisition of: • AP (arterial phase), PVP (portal venous phase) • AP, PVP, and delayed phase (DP) • AP, PVP, transitional phase (TP), and hepatobiliary phase (HBP)	For diagnosis and staging of patients at risk for HCC, LI-RADS recommends acquisition of • CEUS: AP, PVP, late phase • CT: AP, PVP, and DP • MRI with extracellular agent or gadobenate: Precontrast, AP, PVP, DP • MRI with gadoxetate: Precontrast, AP, PVP, TP, and HBP See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to		Technical term	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					learn more about multiphase imaging and recommended LI-RADS technique			
Nodule	Spherical or oval mass.	Broad	US, CEUS, CT, MRI	A nodule is a type of mass that is either round or oval in shape, and not a cyst or abscess. If a mass is geographic or irregular in shape or has a diffuse, confluent, or infiltrative appearance, the term “nodule” does not apply. While there is no strict size cutoff, the term “nodule” is often reserved for small masses, generally ≤ 2 cm.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-7-The-LIRADS-observation.pdf to learn more about nodules.		General term	5/2021
Nodule-in-nodule appearance	Presence of a smaller inner nodule within a larger outer nodule.	Broad	CEUS, CT, MRI	The inner nodule differs in imaging features from the outer nodule or mass. It may be: • Peripherally or centrally located within the outer nodule • Small relative to the outer nodule or almost as large as the outer nodule • Round, oval, or lobulated in shape Nodule-in-nodule appearance is a type of mosaic appearance. The inner and outer nodules must be solid. The term nodule-in-nodule appearance does not apply to a hemangioma.	In the context of the LI-RADS CT/MRI diagnostic algorithm, nodule-in-nodule appearance is an ancillary feature favoring HCC in particular. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about nodule-in-nodule appearance and how it is used in LI-RADS.	Nodule-in-nodule pattern, nodule-in-nodule architecture	Imaging feature, ancillary feature favoring HCC in particular	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved

Nonenhancing capsule	Subtype of capsule that does not show enhancement on any image.	LI-RADS	CT, MRI		In the LI-RADS CT/MRI algorithm, nonenhancing capsule:
					
					• Is one of two defined subtypes of capsule.
					• Is an ancillary feature favoring HCC in particular.
					• May be seen as follows:
					  • Precontrast CT: hypoattenuating
					  • Precontrast T1WI: hypointense
					  • T2WI: hypo- or hyperintense
					  • DWI: hyperintense
					  • Contrast-enhanced CT or T1WI: nonenhancing
					  • Transitional phase (TP): hypointense
					  • Hepatobiliary phase (HBP): hypointense
					
					See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about nonenhancing capsule.
						Nonenhancing distinctive rim	Imaging feature, ancillary feature favoring HCC in particular	5/2021

Nonmasslike (adjective)	Not having the properties of a mass; without distorting or destroying parenchyma or other anatomic structures.	Broad	US, CEUS, CT, MRI	May apply to lesions or pseudolesions Examples include: • Nonmasslike fat deposition or sparing • Nonmasslike iron deposition or sparing • Nonmasslike arterial phase hyperenhancement (APHE)	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-7-The-LIRADS-observation.pdf to learn more about mass, nonmasslike, and related terms.		General term	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				• Nonmasslike heterogeneous enhancement				
Nonperipheral washout	Subtype of washout that is **NOT** mainly in observation periphery.	Broad	CT, MRI, CEUS	Nonperipheral washout may be homogeneous or heterogeneous; if heterogeneous, it may be focal, scattered (patchy, spotty), nodule-in-nodule, or mosaic. See *washout* for additional comments.	In the LI-RADS CT/MRI algorithm, nonperipheral washout is: • One of two defined subtypes of washout • A major feature of HCC See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about nonperipheral washout.	Washout; venous/portal venous/delayed/late phase hypoenhancement, hypoattenuation, or hypointensity; deenhancement	Imaging feature, major	5/2021
Nonrim arterial hyperenhancement (nonrim APHE)	Subtype of APHE that is **NOT** mainly in observation periphery.	Broad	CEUS, CT, MRI	Nonrim APHE is a subtype of APHE. Nonrim APHE may be homogeneous or heterogeneous. See *APHE* for additional comments.	In the context of the LI-RADS CT/MRI diagnostic algorithm, nonrim APHE is: • One of two defined subtypes of APHE • A major feature of HCC See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about APHE and its subtypes.	Arterial hypervascularity, hypervascularity in arterial phase, increased contrast enhancement in hepatic arterial phase, increased	Imaging feature, major	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
						contrast enhancement in late hepatic arterial phase, hypervascularity, high attenuation area in arterial phase, contrast uptake in arterial phase, wash in		
Observation	Area distinctive compared to liver at imaging.	Broad	US, CEUS, CT, MRI	Observation is a general term that includes lesion and pseudolesion. May be a true lesion (if it corresponds to a pathologic abnormality) or a pseudolesion (if it does not correspond to a pathologic abnormality).	The LI-RADS decision tree and algorithm use the generic term “observation” for simplicity. For clear communication in clinical practice, radiologists may use the most specific term for which there is certainty. For example, if a radiologist is certain that an observation is a solid nodule, then the term “nodule” is acceptable. On the other hand, if a radiologist is not certain if an observation is a true lesion or a pseudolesion, the term “observation” is preferred, as the terms “nodule” or “lesion” or “focal liver lesion” may be misleading. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-7-The-LIRADS-	Lesion or pseudolesion	General term	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					observation.pdf to learn more observation, lesion, pseudolesion, and related terms.			
Observation, lesion, pseudolesion, mass, nodule	N/A	Broad	US, CEUS, CT, MRI	Observation, lesion, pseudolesion, mass, and nodule are a group of related but not identical terms. The terms are related hierarchically. Observation is a general term that encompasses all the other terms in this group. Lesion and pseudolesion are types of observations. A mass is a type of lesion. A nodule is a type of mass.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-7-The-LIRADS-observation.pdf to learn more about observation, lesion, pseudolesion, mass, and nodule.		Group of terms	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				The most specific term can be used depending on context and user preference. For example, if an observation is thought to be a true lesion, then either the term “lesion” or the term “observation” may be used. If there is uncertainty about whether an observation is a true lesion or a pseudolesion, the term “observation” is preferable.				
Parallels blood pool enhancement	Temporal pattern in which enhancement approximates blood pool in all phases.	Broad	CT, MRI	In general, the following blood vessels represent the blood pool in each phase: • Arterial phase (AP): aorta or hepatic artery • Portal venous phase (PVP): portal vein • Delayed (DP), transitional (TP), and hepatobiliary (HBP) phases: portal vein or hepatic vein This enhancement pattern is characteristic but in isolation is not diagnostic of hemangiomas. Other features (i.e. marked T2-hyperintensity and peripheral discontinuous nodular enhancement) may be needed to confirm the diagnosis of hemangioma. Note that with gadoxetate the blood pool usually becomes about isointense to liver in transitional	In the context of the LI-RADS CT/MRI diagnostic algorithm, parallels blood pool enhancement is an ancillary feature favoring benignity. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about parallels blood pool enhancement and how it is used in LI-RADS.	Following signal/attenuation/brightness/enhancement of blood pool on all phases	Ancillary feature favoring benignity	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				phase and hypointense to liver in hepatobiliary phase (HBP). Therefore, care should be exercised when applying this feature with gadoxetate. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about the application of this feature with gadoxetate.				
Parenchymal distortion	Parenchymal area seen on ultrasound with one or more of the following characteristics: • Ill-defined area of heterogeneity • Refractive shadow • Loss of normal hepatic architecture	Broad	US, CEUS	Loss of normal hepatic architecture includes loss of visualization of normal portal triads or hepatic veins.	In the context of the LI-RADS US surveillance algorithm, parenchymal distortion ≥ 10 mm in size is categorized US-3 Positive. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/LI-RADS-US-Algorithm-Portrait-2017.pdf.		General term	5/2021
Perfusion alteration	Nonmasslike change in blood supply to an area of the liver.	Broad	CT, MRI, CEUS	Often seen as a nonmasslike area of hyperenhancement in the arterial phase with isoenhancemeent on postarterial phases. May be of any size. Usually geographic, occasional round or oval in shape.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-7-The-LIRADS-observation.pdf and https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-15-Benign-entities.pdf to learn more about perfusion alterations.	THID, THAD, THED, AP shunt, perfusional abnormality, perfusion anomaly,	General term	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				Often peripherally located. May be caused by or be associated with a mass. On CT and MRI, may be mistaken for a nodule, especially if round or oval in shape, or for an infiltrative mass, especially if heterogeneous.		vascular pseudolesion		
Peripheral discontinuous nodular arterial phase hyperenhancement (APHE)	Areas of enhancement that during the arterial phase are initially round or globular in shape and distributed discontinuously along the periphery of a lesion and then rapidly expand to fill the lesion in its entirely or nearly in its entirety.	Broad	CEUS	Peripheral discontinuous nodular APHE is a temporal subtype of APHE assessable with continuous imaging during the arterial phase (AP) on CEUS. Diagnostic imaging feature of nonsclerosed hemangiomas on CEUS.	In the LI-RADS CEUS algorithm, peripheral discontinuous nodular APHE is: • A subtype of APHE • Diagnostic of hemangioma See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf to learn more about peripheral discontinuous nodular APHE and how it is used in CEUS LI-RADS.		Imaging feature, general	5/2021
Peripheral discontinuous nodular enhancement	Areas of enhancement that in the early postcontrast phases are round or globular in shape	Broad	CEUS, CT, MRI	Peripheral discontinuous nodular enhancement is a temporal enhancement pattern. Strict assessment of this feature requires acquisition of two or more phases.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about peripheral discontinuous nodular hyperenhancement and how it is used in LI-RADS.	Peripheral discontinuous globular enhancement, peripheral discontinuous	Imaging feature, general	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
	and distributed discontinuously along the periphery of a lesion and that in subsequent phases expand and approximately parallel the blood pool in brightness.			As the areas of enhancement expand they may coalesce to become continuous, may fill the lesion in its entirely or nearly in its entirety, and may no longer appear round or globular. The enhancing areas approximately parallel the blood pool in brightness. If a hepatobiliary agent is given, the enhancing areas usually become iso- and then hypo-intense relative to liver in the transitional and hepatobiliary phases. Diagnostic imaging feature of nonsclerosed hemangiomas. Although strict assessment of peripheral discontinuous nodular enhancement requires acquisition of two or more phases, a diagnosis of hemangioma can be made on a single postcontrast phase if the imaging features are sufficiently characteristic. In such cases, the temporal pattern is inferred.		puddles of enhancement, peripheral discontinuous puddling		
Peripheral washout	Subtype of washout that is mainly in observation periphery.	Broad	CT, MRI	Peripheral washout is • a subtype of targetoid morphology and • a subtype of washout. See *washout* for additional comments.	In the context of the LI-RADS CT/MRI diagnostic algorithm, the presence of peripheral washout suggests intrahepatic cholangiocarcinoma (iCCA) or other non-HCC malignancy, but it does not exclude HCC. See https://www.acr.org/-/media/ACR/Files/Clinical-	Venous/portal venous/delayed/late phase peripheral hypoenhancement, peripheral hypoattenuation, or	Imaging feature, LR-M	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about peripheral washout and how it is used in LI-RADS.	hypointensity; peripheral deenhancement		
Portal venous phase (PVP)	A postarterial phase acquired no more than 2 minutes after injection of a contrast agent when portal and hepatic veins are enhanced more than liver.	Broad	CEUS, CT, MRI	On CEUS: the PVP usually starts around 30-45 seconds after injection, lasts for 90-100 seconds, and ends at around 2 minutes after injection. On CT and MRI: Typically PVP images are acquired around 60 seconds to 80 seconds after start of injection. The PVP and delayed phase (DP) appear similar. They can be distinguished by: • Timing after injection • If both phases are acquired: the liver, the portal veins, and the hepatic veins are usually more enhanced in the PVP than in the DP. In some patients, the transitional phase may begin before 2 minutes after injection of gadoxetate. If the liver is as enhanced or more enhanced than veins after injection of gadoxetate, the PVP has passed, even if the images are acquired within 2 minutes of injection.	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to learn more about the portal venous phase.	Early postarterial phase, portal dominant phase	Imaging phase	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
Postarterial extracellular phase (ECP)	A general term referring to: • PVP and DP, if an extracellular agent or gadobenate is given • PVP only, if gadoxetate is given	Broad	CT, MRI	During the postarterial extracellular phase, enhancement of the liver is mainly due to extracellular distribution of a contrast agent. Does not apply to blood pool agents.			Imaging phase	5/2021
Postarterial phase	General term that refers to imaging after the arterial phase.	Broad	CEUS, CT, MRI	On CEUS: the postarterial phase is divided into the portal venous phase and the late phase. On CT and MRI with extracellular contrast agents: the postarterial phase is divided into the portal venous phase and delayed phase. On MRI with gadoxetate: the postarterial phase is divided into the portal venous phase, transitional phase, and hepatobiliary phase. On MRI with gadobenate: the postarterial phase is divided into the portal venous phase, delayed phase, and hepatobiliary phase. A transitional phase does occur but is rarely acquired.		Venous phase, late phase	Imaging phase	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
Pseudolesion	An observation that may simulate but does not represent a pathologic abnormality.	Broad	US, CEUS, CT, MRI	May be mistaken for a true lesion. Examples include: • Round or oval perfusion alterations • Some artifacts such as ghosting artifacts from aorta	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-7-The-LIRADS-observation.pdf to learn more about pseudolesions.		General term	5/2021
Refractive shadowing	Linear shadows from the lateral edges of an observation. Observation may be well-defined or ill-defined.	Broad	US, CEUS	In some infiltrative tumors, refractive shadows may be the best sonographic finding to indicate their presence.	See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/LI-RADS-US-Algorithm-Portrait-2017.pdf.		General term	5/2021
Rim arterial phase hyperenhancement (rim APHE)	Subtype of APHE that is mainly in observation periphery.	Broad	CEUS, CT, MRI	Rim APHE is • a subtype of targetoid morphology and • a subtype of APHE. Rim APHE can be smooth or irregular. It can vary in thickness. Rim APHE should not be confused with peripheral discontinuous nodular enhancement, which is characteristic of hemangioma. See *APHE* for additional comments.	In the LI-RADS CEUS and CT/MRI algorithms, rim APHE is an LR-M feature. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf and https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf to learn more about rim APHE.	Peripheral APHE, ring APHE, targetoid APHE, APHE in target pattern, rim enhancement	Imaging feature, LR-M	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
Size	Largest outer-edge-to-outer-edge dimension of an observation.	Broad	US, CEUS, CT, MRI	Pick phase, series, and plane in which margins are clearest.	In the context of the LI-RADS CT/MRI diagnostic algorithm: • Include capsule in measurement. • Do not measure in arterial phase or DWI if margins are clearly visible on different series See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about size and how it is used in LI-RADS. The definition of “size” in LI-RADS corresponds to the definition of the “longest diameter” in RECIST. LI-RADS prefers “size” rather than “diameter” as observations may not be spherical.	Diameter, dimension, long axis	Imaging feature, general Imaging feature, major	5/2021
Size reduction	Spontaneous decrease in size over time, that cannot be explained only by technique differences, artifact, or measurement error.	Broad	CT, MRI, US, CEUS		In the context of the LI-RADS CT/MRI diagnostic algorithm, size reduction: • Is an ancillary feature favoring benignity • Should be measured on the same phase, sequence, and plane on serial exams if possible • Should be assessed *only* if there is a prior CT or MRI exam of sufficient quality and appropriate technique to reliably measure interval change in size, if any • Should not be assessed by comparing to prior US or CEUS exams	Decreased size, shrinkage, regression	Ancillary feature favoring benignity	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					• Should not be applied as an ancillary feature favoring benignity if the size reduction is due to resorption of blood products. Rationale: size reduction due to resorption of blood products can be seen in malignant tumors In the context of CEUS LI-RADS diagnostic algorithm, size reduction: • Is an ancillary feature favoring favoring benignity • Should not be assessed by comparing to prior CT or MRI exams LI-RADS CEUS does not classify growth into subtypes. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about size reduction and how it is used in LI-RADS.			
Size stability ≥ 2 years	No change in observation size measured on serial exams ≥ 2 years apart.	LI-RADS	CT, MRI, CEUS		In the context of the LI-RADS CT/MRI diagnostic algorithm, size stability ≥ 2 years: • Is an ancillary feature favoring benignity • Should be measured on the same phase, sequence, and plane on serial exams if possible	Stable size, unchanged size, stable diameter, unchanged diameter	Ancillary feature favoring benignity	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					• Should be assessed *only* if there is a prior CT or MRI exam of sufficient quality and appropriate technique to reliably measure interval change in size, if any • Should not be assessed by comparing to prior US or CEUS exams • Should not be applied as an ancillary feature favoring benignity if there is any doubt about size stability In the context of CEUS LI-RADS diagnostic algorithm, size stability ≥ 2 years: • Is an ancillary feature favoring benignity • Should not be assessed by comparing to prior CT or MRI exams See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about size stability ≥ 2 years and how it is used in LI-RADS.			
Spokewheel, centrifugal arterial phase hyperenha	Enhancement in a lesion that during the arterial phase begins as an internal focus and then rapidly expands outward in	Broad	CEUS	Spokewheel, centrifugal APHE is a temporal subtype of APHE assessable with continuous imaging during the arterial phase (AP) on CEUS. Imaging feature suggestive of FNH on CEUS.			Imaging feature, general OR	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
ncement (APHE)	a radial, spoke-wheel pattern.						Imaging feature, diagnostic of FNH	
Subthreshold growth	Size increase of a mass, less than threshold growth. Any of the following: • Size increase < 50% over any time period • Any size increase over time interval > 6 months • A new mass of any size	LI-RADS	CT, MRI		In the context of the LI-RADS CT/MRI diagnostic algorithm, subthreshold growth is a(n): • Subtype of growth • Ancillary feature favoring malignancy in general See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about subthreshold growth.	Subthreshold diameter increase, subthreshold size increase, growth less than threshold	Imaging feature, ancillary feature favoring malignancy, not HCC in particular	5/2021
Targetoid	Target-like morphology on CT or MRI. The center and periphery of a mass have different imaging characteristics.	Broad	CT, MRI		In the context of the CT/MRI LI-RADS algorithm: • Five subtypes of targetoid have been defined: • Rim arterial phase hyperenhancement (APHE) • Peripheral washout • Delayed central enhancement • Targetoid diffusion restriction	Target-like, target appearance	Imaging feature, LR-M	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
					• Targetoid transitional phase (TP) or hepatobiliary phase (HBP) appearance • The presence of any of the targetoid subtypes suggests intrahepatic cholangiocarcinoma (iCCA) or other non-HCC malignancy, but it does not exclude HCC. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about targetoid features and how they are used in LI-RADS.			
Targetoid diffusion restriction	Subtype of restricted diffusion that is greatest in observation periphery.	Broad	MRI	Targetoid diffusion restriction is • A subtype of targetoid morphology and • A subtype of diffusion restriction	In the context of the LI-RADS CT/MRI diagnostic algorithm, targetoid diffusion restriction is an LR-M feature See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about targetoid diffusion restriction and how it is used in LI-RADS.	Peripheral restriction, DWI target sign/appearance, targetoid diffusion	Imaging feature, LR-M	5/2021
Targetoid transitional phase (TP) or hepatobilia	Suptype TP or HBP hypointensity where the observation periphery is more	Broad	MRI with HBA	Targetoid TP/HBP appearance is • A subtype of targetoid morphology and • A subtype of TP/HBP hypointensity	In the context of the LI-RADS CT/MRI diagnostic algorithm, targetoid TP or HBP appearance is an LR-M feature.	HBP/TP cloud, HBP/TP target sign/appearance	Imaging feature, LR-M	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
ry phase (HBP) appearance	hypointense than the center.				See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about TP or HBP appearance and how it is used in LI-RADS.			
Threshold growth	Size increase of a mass by ≥ 50% in ≤ 6 months.	LI-RADS	CT, MRI		In the context of the LI-RADS CT/MRI diagnostic algorithm, threshold growth: • Is one of two defined subtypes of growth. • Is a major feature of HCC. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about threshold growth.	Growth by 50% or more, size increase by 50% or more	Imaging feature, major	5/2021
Transitional phase (TP)	Postarterial phase acquired with an intravenous hepatobiliary contrast agent when liver vessels and hepatic parenchyma are of similar signal intensity, which occurs between the portal venous	Broad	MRI with gadoxetate. (While the TP does occur with gadobenate, TP	During the TP, enhancement of the liver is due to both extracellular and intracellular distribution of a hepatobiliary contrast agent. The TP is typically acquired 2 to 5 minutes after injection of gadoxetate. Although TP images are typically acquired 2 to 5 minutes after injection of gadoxetate, the onset of the TP is variable. In some patients, the onset may be before 2 minutes after injection; in other	See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-12-Technique.pdf to learn more about the TP.	Interstitial phase, equilibrium phase, late dynamic phase are often misused to indicate the transitional phase but they are not true synonyms for	Imaging phase	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
	and hepatobiliary phase.		images are usually not acquired with this agent)	patients, the onset may be later than 5 minutes after injecton. This phase is acquired almost exclusively with gadoxetate. While TP exists with gadobenate, it is rarely, if ever, acquired.		the transitional phase.		
Transitional phase (TP) hypointensity	Intensity in the transitional phase lower than liver.	Broad	MRI with gadoxetate	TP hypointensity does not qualify as washout. Compare to functional areas of parenchyma (i.e., do not compare to vessels or to parts of liver that do not take up the agent).	In the context of the LI-RADS CT/MRI diagnostic algorithm: • TP hypointensity can be seen in the entire observation or only in part(s) of the observation. If any part of the observation has TP hypointensity, then TP. hypointensity is considered to be present. • Unless in a targetoid pattern, TP hypointensity is an ancillary feature favoring malignancy in general • Targetoid TP hypointensity is a subtype of TP hypointensity. This subtype is a targetoid LR-M feature and not an ancillary feature favoring malignancy in general. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about TP hypointensity and how it is used in LI-RADS.	Transitional phase hypoenhancement, late dynamic phase hypointensity, late dynamic phase hypoenhancement, equilibrium phase hypointensity, interstitial phase hypointensity	Imaging feature, ancillary feature favoring malignancy, not HCC in particular	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
Treated lesion	Lesion treated by any therapy.	Broad	CEUS, CT, MRI	Lesions can be treated by locoregional therapy, resection, systemic therapy, or a combination.	LI-RADS provides guidance on assessing treatment response or recurrence after locoregional therapy or resection. See https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/LI-RADS-2018-Core.pdf and https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-9-Treatment-response.pdf to learn more about how to assess treatment response using LI-RADS. LI-RADS does not yet provide guidance on assessing treatment response after systemic therapy.		General term	5/2021
Undistorted vessels	Vessels traversing an observation without displacement, deformation, or other alteration.	Broad	CT, MRI	Characteristic of perfusion alteration.	In the context of the LI-RADS CT/MRI diagnostic algorithm, undistorted vessels is an ancillary feature favoring benignity. See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about undistorted vessels.	Lack of mass effect on vessels	Ancillary feature favoring benignity	5/2021
US visibility as nodule	Unenhanced US visibility as discrete nodule or mass corresponding to	LI-RADS	CT, MRI		In the context of the LI-RADS CT/MRI diagnostic algorithm, US visibility as nodule is an ancillary feature favoring malignancy in general.	US detectability as discrete nodule, sonographic visibility as	Imaging feature. ancillary feature favoring	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
	CT- or MRI-detected observation.				See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf to learn more about US visibility as nodule and how it is used in LI-RADS.	discrete nodule, sonographic visibility as nodule	malignancy, not HCC in particular	
Washout	Reduction in enhancement from earlier to later phase resulting in hypoenhancement relative to liver. This can have one of the following patterns by modality: CT or MRI: • Hyperenhancing to hypoenhancing • Isoenhancing to hypoenhancing If hepatobiliary agent is given, must be assessed before the transitional phase.	Broad	CT, MRI, CEUS	Washout can be assessed only if at least two contrast-enhanced phases are obtained (e.g., arterial phase followed by one or more postarterial phases) so that the reduction in enhancement over time can be assessed. Washout cannot be assessed if there is a single contrast-enhanced phase. Washout must occur in an extracellular postarterial phase: • For extracellular contrast agents and gadobenate: hypoenhancement in portal venous phase (PVP), delayed phase (DP), or both • For gadoxetate: hypoenhancement in PVP only. Hypointensity in transitional phase (TP) or hepatobiliary phase (HBP) does not qualify as washout Washout can be assessed qualitatively (i.e., visually) relative to liver parenchyma. It does not require quantitative measurements.	In the LI-RADS CT/MRI diagnostic algorithm, the washout subtypes are classified as follows: • Peripheral washout is a LR-M feature • Nonperipheral washout is a major feature of HCC In the LI-RADS CEUS diagnostic algorithm, the washout subtypes are classified as follows: • Early or marked washout is a LR-M feature • Late and mild washout is a major feature of HCC See https://www.acr.org/-/media/ACR/Files/Clinical-Resources/LIRADS/Chapter-16-Imaging-features.pdf and https://www.acr.org/-/media/ACR/Files/RADS/LI-RADS/CEUS-LI-RADS-2017-Core.pdf_ to learn more about washout and its subtypes.	venous/portal venous/delayed/late phase hypoenhancement, hypoattenuation, or hypointensity; deenhancement	Imaging feature, general	5/2021

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
	CEUS: • Hyperenhancing to hypoenhancing • Isoenhancing to hypoenhancing • Hypoenhancing to unequivocally more hypoenhancing			Washout applies to observations with at least some enhancement. It does not apply to nonenhancing observations. Reduction in enhancement from arterial phase hyperenhancement (APHE) to isoenhancement does not qualify as washout. If APHE is present, the areas with APHE and washout do not need to coincide. If the liver parenchyma visually consists of both nodules and fibrosis, then compare to composite liver tissue (i.e., a visual average of the nodules and fibrosis). Washout can be seen in the entire observation or only in part(s) of the observation. If any part of the observation has washout, then washout is considered to be present. On CT or MRI: • Washout has two subtypes based on morphology: • Peripheral washout • Nonperipheral washout On CEUS:				

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved
				• Washout is divided into subtypes based on time of onset and degree: • Time of onset: • Early: < 60 seconds after contrast injection • Late: ≥ 60 seconds after contrast injection • Degree: • Mild: less enhanced than liver, but not devoid of enhancement (i.e., some enhancement persists). If mild washout becomes marked > 2 minutes after contrast injection, it is still characterized as mild. • Marked: virtually devoid of enhancement (“punched-out”) by 2 min after contrast injection. While washout is similar to fade in that the area of interest appears to de-enhance relative to liver, washout and fade are not the same: Washout: • Follows isoenhancement or hyperenhancement in an earlier phase (CT or MRI) or any degree of enhancement in an earlier phase (CEUS) • Results in hypoenhancement in a later phase relative to liver				

Term	Definition (2021)	Context of Use (COU)	Applicable modalities	General comments	LI-RADS specific comments	Synonyms (their use is generally less preferred)	Type of term (if used in context of LI-RADS)	Date approved

				• Examples (AP = arterial phase; PVP = portal venous phase; DP = delayed phase; LP = late phase):
				  • CT/MRI/CEUS:
				  • Hyper (AP) → hypo (PVP or DP/LP or both)
				  • Hyper (PVP) → hypo (DP/LP)
				  • Iso (AP) → hypo (PVP or DP/LP or both)
				  • Iso (PVP) → hypo (DP/LP)
				  • CEUS only
				  • Hypo (AP) → more hypo (PVP or LP or both)
				  • Hypo (PVP) → more hypo (LP)
				
				Fade:
				
				• Follows hyperenhancement in an earlier phase
				• Results in iso- or minimal hyperenhancement in all later phases relative to liver
				• Examples:
				  • CT/MRI/CEUS
				  • Hyper (AP) → iso/min hyper (all later phases)
				  • Hyper (PVP) → iso/min hyper (all later phases)				

Supplemental Table 4. Roster of the LI-RADS Lexicon and Writing Group (2019-2020 and/or 2020-2021).

Name	Role	Affiliation (as of August 2021)
Mustafa R. Bashir	Member	Duke University Medical Center
Victoria Chernyak	Co-Chair	Beth Israel Deaconess Medical Center
Guilherme Moura Cunha	Member	University of Washington
David Fetzer	Member	UT Southwestern Medical Center
Kathryn J. Fowler	Member	University of California San Diego
Alessandro Furlan	Member	University of Pittsburgh Medical Center
Aya Kamaya	Ex-officio	Stanford University Medical Center
Avinash Kambadakone	Member	Massachusetts General Hospital
Ania Kielar	Member	University of Toronto
Yuko Kono	Ex-officio	University of California San Diego
James T. Lee	Member	University of Kentucky
Mishal Mendiratta-Lala	Member	University of Michigan
Amit Singal	Member	Southwestern Medical Center
Claude B. Sirlin	Co-Chair	University of California San Diego
An Tang	Member	Université de Montréal

Supplemental Table 5. Roster of the LI-RADS Steering Committee (2019-2020 and/or 2020-2021)

Name	Role	Affiliation (as of August 2021)
Mustafa R. Bashir	Member	Duke University Medical Center
Jason Birnbaum	Member in training	Montefiore Medical Center
Julius Chapiro	Member	Yale New Haven Hospital
Victoria Chernyak	Chair	Beth Israel Deaconess Medical Center
Guilherme Moura Cunha	Member	University of Washington
Richard KG Do	Member	Memorial Sloan Kettering Cancer Center,
Eric Ehman	Member	Mayo Clinic Rochester
Khaled Elsayes	Member	The University of Texas MD Anderson Cancer Center
Soudabeh Fazeli	Member in training	University of California, San Diego
David Fetzer	Member	UT Southwestern Medical Center
Kathryn J. Fowler	Member	University of California, San Diego
Alice Fung	Member	Oregon Health & Science University
Alessandro Furlan	Member	University of Pittsburgh Medical Center
Elizabeth Hecht	Member	Columbia University Medical Center
Jay Heiken	Member	Mayo Clinic Rochester
Cheng "William" Hong	Member in training	Stanford University Medical Center
Reena Jha	Member	Georgetown University Hospital
Aya Kamaya	Member	Stanford University Medical Center
Avinash Kambadakone	Member	Massachusetts General Hospital
Ania Kielar	Member	University of Toronto
Marc Kohli	Member	University of California, San Francisco
Yuko Kono	Member	University of California, San Diego
Andrej Lyshchik	Member	Thomas Jefferson University
Adrija Mamidipalli	Member in training	University of California, San Diego
Robert Marks	Member	Naval Medical Center San Diego
Matthew McInnes	Member	The Ottawa Hospital
Mishal Mendiratta-Lala	Member	University of Michigan
Donald Mitchell	Member	Thomas Jefferson University
Utaroh Motosugi	Member	University of Yamanashi
Chetan Potu	Member in training	Renaissance School of Medicine at Stony Brook University
Shuchi Rodgers	Member	Einstein Healthcare Network
Maxime Ronot	Member	Beaujon University Hospital
Alexandra "Sasha" Roudenko	Member	Mount Sinai Hospital
Anthony Samir	Member	Massachusetts General Hospital
Cynthia Santillan	Member	University of California, San Diego
Amit Singal	Member	UT Southwestern Medical Center

Claude B. Sirlin	Former Chair, Member	University of California, San Diego
An Tang	Member	Université de Montréal
Bachir Taouli	Member	Mount Sinai Hospital
Alexander Towbin	Member	Cincinnati Children’s Hospital
Sudhakar K. Venkatesh	Member	Mayo Clinic, Rochester
Jeffrey Weinreb	Member	Yale New Haven Hospital

Supplemental Table 6. Members of the LI-RADS International Working Group

Name	Role	Affiliation (as of August 2021)
Jorge Andres Abreu	Member	University of Ottawa
Diego Aguirre	Regional coordinator Guarantor of translation integrity to Spanish	Fundacion Santa Fe de Bogota
Chansik Ahn	Member	Yonsei University College of Medicine
Jorge Ahualli	Member	Centro Radiológico Mendez Collado
Luis Felipe Alva	Member	Profesor Radiologia UNAM, Universidad La Salle, Jefe de Servicio Imagen Medica Sur Mexico DF, Mexico
Michal Amitai	Member	Sackler Faculty of Medicine, Tel Aviv University
Marcony Andrade	Member	Delfin Medicina Diagnóstica, Hospital Aliança S.A.
Potthoff Andrej	Member	Dept. of Gastroenterology, Hepatology and Endocrinology, Hannover Medical School.
Farid Azmoudeh Ardalan	Member	Tehran University of Medical Sciences
Christophe Aubé	Member	Centre hospitalier universitaire Angers
Carmen Ayuso	Member	University of Barcelona
Adrian Balasingam	Member	Canterbury District Health Board & Pacific Radiology Group
Wolf C. Bartholomä	Member	Linköping University Hospital
Rodrigo Bazaes	Member	Clinica Santa Maria, Santiago
Ofer Benjaminov	Member	Chair Diagnostic imaging department Shaare Zedek Medical Center, Jerusalem Affiliated to Hebrew University, Jerusalem
Cecilia Besa	Member	Universidad Catolica, Santiago
Claudio Bonini	Member	Clínica De Diagnóstico Médico Oroño
Giuseppe Brancatelli	Guarantor of translation integrity to Italian	University of Palermo
David Breen	Member	University Hospital Southampton
Linda Brown	Member	Advanced Imaging Center, Ramathibodi Hospital Bangkok
Flavia Nunes Cabral	Member	Hospital Sirio-Libanês Brasilia
Pablo Rodriguez Carnero	Member	Université complutense de Madrid
Jeremy Carpio*	Member	Resocentro
Filipe Caseiro Alves	Member	University Centre Hospitals of Coimbra (CHUC)

Arvind K. Chaturvedi	Member	Rajiv Gandhi Cancer Institute & Research Center
Victoria Chernyak	Ex-officio Member (LI-RADS SC Chair)	Beth Israel Deaconess Medical Center
Jin-Young Choi	Guarantor of translation integrity to Korean	Yonsei University College of Medicine
Sang Hyun Choi	Member	University of Ulsan College of Medicine, Asan Medical Center
Paul Chou	Member	Mater Hospital Brisbane
John Cockburn	Member	Australian National University / Canberra Hospital
Massimo Colombo	Member	University of Milan
Laurian Copel	Member	Sackler Faculty of Medicine, Tel Aviv University
David Cosgrove	Member	Imperial College London
Eduardo Almeida Cunha Costa	Member	Cedrul - Centro de Diagnóstico por Imagem, João Pessoa, Paraíba
Guilherme Moura Cunha	Guarantor of translation integrity to Portuguese version of LI-RADS	University of Washington
Christoph F. Dietrich	Guarantor of translation integrity to German	Caritas Krankenhaus Bad Mergentheim
Isabelle Durot	Member	Kantonsspital Aarau, Institut für Radiologie
Roy S. Dwarkasing	Member	Erasmus University Medical Center
Antonio Eiras-Araujo	Member	Federal University of Rio de Janeiro
Khaled M. Elsayes	Ex-officio member (O&E WG)	MD Anderson
Nasir Fakhar	Member	Imam Khomeini Hospital Complex, Tehran University of Medical Sciences
Joe Feltham	Member	1. Pacific Radiology Group; 2. Wellington Public Hospital
Maryam Fotouhi	Member	Iran University of Medical Sciences; QMISG group Researcher, Liver Group
Mireen Friedrich-Rust	Member	Goethe-University Hospital
Juan Alberto Garay Mora	Member	Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán
Vanessa Garcia	Member	Hospital Pablo Tobon Uribe, Medellin
Robert Gish	Member	Stanford
Rita Golfieri	Member	University of Bologna, Policlinico S. Orsola
Fernando Gonzalez	Member	Clinica Alemana - Hosp. San Juan de Dios, Santiago

Mark Goodwin	Regional coordinator, Oceania	Melbourne Interventional Radiology Group
Satoshi Goshima	Member	Gifu University
Luigi Grazioli	Member	Radiologia ASST Spedali Civili Brescia-University of Brescia
Boris Guiu	Member	Montpellier
Sonja Gustafson	Member	Princess Alexandra Hospital & Royal Brisbane & Women's Hospitals
Ashley Guthrie	Member	Leeds Hospital
Saeed Hamid	Member	Aga Khan University
Matthias Hammon	Member	University of Erlangen
Justin Hegarty	Member	Christchurch
Thomas Helmberger		Institut für Diagnostische und Interventionelle Radiologie, Neuroradiologie und Nuklearmedizin Klinikum Bogenhausen
Andrew Holden	Member	Auckland
Natally Horvat	Member in training	Hospital das Clinicas da Faculdade de Medicina da Universidade de Sao Paulo / Hospital Sirio-Libanes
Pintong Huang	Member	The Second Affiliated Hospital of Zhejiang University School of Medicine
Claudia Huertas	Member	Instituto Neurologico de Colombia Dinamica IPS Escanografía Neurologica Medellin-Colombia
Alvaro Huete*	Member	Universidad Catolica Santiago
Ali Jafarian	Member	Imam Khomeini Hospital Complex, Tehran University of Medical Sciences
Richa D Jain	Member	Aster CMI Hospital
Christian Jenssen	Member	University of Krankenhaus Märkisch Oderland
Wang Jin	Member	Radiology Department, the 3rd Affiliated Hospital of Sun Yat-sen University, Guangzhou, China.
Naveen Kalra	Member	Postgraduate Institute of Medical Education and Research
Musturay Karcaaltincaba	Member	Hacettepe University
Ania Kielar	Ex-officio member (O&E WG)	University of Ottawa
Andrea Siobhan Kierans	Vice-Chair, 2021-present	Weill Cornell Medicine
Myeong-Jin Kim	Member	Yonsei University College of Medicine
So Yeon Kim	Member	Asan Medical Center
Yu Xuan Kitzing	Member	Sydney
Satoshi Kobayashi	Member	Kanazawa University Graduate School of Medical Sciences
Yuko Kono	Member	University of California, San Diego

Sonal Krishan	Member	Body Imaging Medanta Hospital Gurgaon India
Yu-Ting Kuo	Member	Chi Mei Hospital
Tuan Linh Le	Guarantor of translation integrity to Vietnamese	Hanoi medical university hospital
Hilton Muniz Leao	Member	Hospital das Clinicas da Faculdade de Medicina da Universidade de Sao Paulo
Jeong Min Lee	Member	Seoul National University Hospital
David Lisle	Member	University of Queensland
Alain Luciani	Member	Hôpitaux Universitaires Henri Mondor, Créteil
Olivier Lucidarme	Member	Faculté de Médecine Pierre et Marie Curie - Pitié Salpétrière
Sergio Lucino	Member	Instituto Oulton, Córdoba
Elizabeth M. Hecht	Co-Chair, 2021-present	Weill Cornell Medicine
Arnon Makori	Member	Director of Imaging Informatics Clalit Health Services
Ignacio Maldonado	Member	Clinica Davila, Santiago
Alberto Marangoni	Member	Sanatorio Allende, Córdoba
Raul Marquina	Member	Clinica Internacional
Luis Marti-Bonmati	Member	Quirón Hospital, Valencia
Julio Martín	Member	Radiology Dept, Hospital Parc Taulí, Sabadell-Barcelona
Osamu Matsui	Member	Kanazawa University
Stephen Merrilees	Member	Auckland
Lucy Modahl	Member	Auckland
Utaroh Motosugi	Member	University of Yamanashi, Yamanashi, Japan
Takamichi Murakami	Member	Kindai University
Abdul Nadir	Member	Pakistani Kidney and Liver Institute
Parm Naidoo	Member	Monash University
Parm Naidoo	Member	Monash University
Christian Pállson Nolsøe	Member	University of Copenhagen Denmark
Hugo José Paladini	Member	Hospital Universitario Fundacion Favaloro
Daniella B. Parente	Member	Federal University of Rio de Janeiro
Kirsten Pearce	Member	Waitemata District Health Board
Vittorio Pedicini	Member	Humanitas Research Hospital
Ángela García Pérez	Member	Hospital Universitario Gregorio Marañón
Fabio Piscaglia	Member	University of Bologna
Dario Poretti	Member	Humanitas Research Hospital
Hamidreza Saligheh Rad	Member	Tehran University of Medical Sciences
Amir Reza Radmard	Member	Shariati Hospital, Tehran University of Medical Sciences
Gustavo Raichholz*	Member	Diagnóstico por Imágenes Junin
Jordi Rimola	Member	University of Barcelona

Jan Ringers	Member	Aga Khan University
Manoel Rocha	Member	Hospital das Clinicas da Faculdade de Medicina da Universidade de Sao Paulo
Javier Romero	Member	Fundacion Santa Fe de Bogota
Sebastian Rossini	Member	Instituto Radiológico
Daniela Said	Member	Clínica Dávila-Universidad de los Andes
Faeze Salahshour	Member	Tehran University of Medical Sciences
Basit Salam	Member	Aga Khan University
Shiv Kumar Sarin	Member (Hepatologist)	Institute of Liver and Biliary Sciences
Sebastian Schindera	Member	Kantonsspital Aarau, Institut für Radiologie
James Seow	Member	Royal Perth Hospital
Raju Sharma	Member	All India Institute of Medical Sciences
Claude B. Sirlin	Co-Chair, 2021-present	University of California, San Diego
Bin Song	Guarantor of translation integrity to Chinese (simplified)	West China Hospital, Sichuan University
Juan Carlos Spina	Member	Hospital Italiano de Buenos Aires
Deike Strobel	Member	University of Erlangen
Shlomit Tamir	Member	Sackler Faculty of Medicine, Tel Aviv University
An Tang	Chair, 2016-2021	University of Montreal
Cher Heng Tan	Member	Lee Kong Chian School of Medicine
Eleonora Terzi	Member	University of Bologna
Asunción Torregrosa	Member	Hospital Universitario y Politécnico La Fe
Jonathan Tibballs	Member	Sir Charles Gairdner Hospital
Mohssen Nassiri Toosi	Member	Imam Khomeini Hospital Complex, Tehran University of Medical Sciences
Viet Hung Tran	Member	Hanoi medical university hospital
Kazuhiko Ueda	Guarantor of translation integrity to Japanese version of LI-RADS	The Cancer Institute Hospital of Japanese Foundation for Cancer Research
Daniel Upegui	Member	Sanitas, Bogota
Angelo Vanzulli	Member	University of Milano
Valérie Vilgrain	Member	Hôpital Beaujon
Thu Ha Vuong	Member	Hanoi medical university hospital
Mathilde Wagner	Guarantor of translation integrity to French	Hôpital Pitié Salpétrière - UPMC
Andrew Wai	Guarantor of translation integrity to Chinese (traditional)	The University of Hong Kong, Hong Kong, China

Xiao-Ying Wang	Member	Peking University First Hospital
Jessica Yang	Member	Concord Hospital
Niloofar Ayoobi Yazdi	Guarantor of translation integrity to Farsi	Imam Khomeini Hospital Complex, Tehran University of Medical Sciences
Hadi Rokni Yazdi	Member	Imam Khomeini Hospital Complex, Tehran University of Medical Sciences
Norihide Yoneda	Member	Kanazawa University Graduate School of Medical Sciences
Islam Hamza Zaki	Member	Duke University
Elizabeth Zamora	Member	Hospital Metropolitano, Quito
Mengsu Zeng	Member	Zhongshan Hospital, FuDan University in Shanghai
Marc Zins	Member	Hôpital Paris Saint Joseph

Supplemental Table 7. Roster of the Ultrasound Working Group (listed in alphabetical order) (2019-2020 and/or 2020-2021).

Name	Role	Affiliation (as of August 2021)
Aya Kamaya	Co-Chair	Stanford University
Shuchi Rodgers	Co-Chair	Thomas Jefferson University
Linda Che	Member	VA Northern California
Hailey Choi	Member	UC San Francisco
Nirvikar Dahiya	Member	Mayo Scottsdale
Adrian Dawkins	Member	University of Kentucky
David Fetzer	Member	UT Southwestern
Helena Gabriel	Member	Northwestern University
Alison Harris	Member	Vancouver MC
Cheng William Hong	Member in training	Stanford University Medical Center
Yuko Kono	Member	UC San Diego
John Millet	Member	University of Michigan
Tara Morgan	Member	UC San Francisco
Mary O'Boyle	Member	UC San Diego
James Seow	Member	Royal Perth Hospital, Australia
Claude B. Sirlin	Ex-officio	UC San Diego
Noushin Vahdat	Member	VA San Diego
Ashish Wasnik	Member	University of Michigan

Supplemental Table 8. Roster of the CEUS Working Group (listed in alphabetical order) (2019-2020 and/or 2020-2021).

Name	Role	Affiliation (as of August 2021)
Farid Abushamat	Member-in-Training	University of California San Diego
Dirk-Andre Clevert	Member	Munich University Hospital, Munich
David Cosgrove	Member	Hammersmith Hospital, King's College Hospital, London
Christoph F. Dietrich	Member	Kliniken Hirslanden Beau Site, Salem und Permanence, Bern, Switzerland
David T. Fetzer	Co-Chair	UT Southwestern Medical Center
Meloni Franca	Member	Ospedale Valduce-Como, Italy University of Wisconsin, Madison WI
Hyun-Jung Jang	Member	University of Toronto
Tae Kim	Member	University of Toronto
Yuko Kono	Former Chair, Member	University of California San Diego
Jeong Min Lee	Member	Seoul National University Hospital, South Korea
Andrej Lyshchik	Co-Chair	Thomas Jefferson University Hospital
Kudo Masatoshi	Member	Kindai University, Japan
Fabio Piscaglia	Member	University of Bologna, Italy
Shuchi Rodgers	Member	Thomas Jefferson University Hospital
Claude Sirlin	Ex-officio	University of California San Diego
Hisham Tchelepi	Member	University of Southern California
Alex Vezeridis	Member	Stanford University
Juergen Willmann	Member	Stanford University
Stephanie Wilson	Member	University of Calgary
Minami Yasunori	Member	Kindai University, Japan

Supplemental Table 9. Roster of the Treatment Response Working Group (listed in alphabetical order) (2019-2020 and/or 2020-2021).

Name	Role	Affiliation (as of August 2021)
Chernyak, Victoria	Member	Beth Israel Deaconess Medical Center
Do, Richard	Member	Memorial Sloan Kettering
Foltz, Gretchen	Member	Washington University
Fowler, Katie	Member	UC San Diego
Geschwind, Jeff	Member	USA Vascular Centers
Kambadakone, Avinash	Member	Massachusetts General Hospital
Kielar, Ania	Member	University of Toronto
Kim, Charles Y.	Member	Duke
Kim, Edward	Member	Icahn School of Medicine at Mount Sinai
Kono, Yuko	Member	UC San Diego
Lewis, Sara	Member	Icahn School of Medicine at Mount Sinai
Mendiratta-Lala, Mishal	Chair	University of Michigan Health System
Miller, Frank	Member	Northwestern
Newton, Isabel	Member	UC San Diego
Rimola, Jordi	Member	Institut Marqués, Spain, Barcelona
Salem, Riad	Member	Northwestern
Shenoy Bhangle, Anuradha	Member	Beth Israel Deaconess Medical Center
Sirlin, Claude	Member	UC San Diego
Tang, An	Member	Université de Montréal
Yaghmai, Vahid	Member	UC Irvine
Yarmohammadi, Hooman	Member	Memorial Sloan Kettering
Yokoo, Takeshi	Member	UTSW