CEUS LI-RADS® v2017 ESSENTIALS

(For CEUS with Pure Blood Pool Agents)

Untreated observation visible on precontrast US and without pathologic proof in patient at high risk for HCC

- If cannot be categorized due to image degradation or omission → CEUS LR-NC
- If definite tumor in vein (TIV) → CEUS LR-TIV
- If definitely benign → CEUS LR-1
- If probably benign → CEUS LR-2
- If probably or definitely malignant but not HCC specific (i.e., if meets CEUS LR-M criteria [a]) → CEUS LR-M

Otherwise, use CEUS diagnostic table below

- If intermediate malignancy probability → CEUS LR-3
- If probably HCC → CEUS LR-4
- If definitely HCC → CEUS LR-5

CEUS Diagnostic Table

Arterial phase hyperenhancement (APHE)	No APHE		APHE (not rim [b], not peripheral discontinuous globular [c])	
Nodule size (mm)	< 20	≥ 20	< 10	≥ 10
No washout of any type	CEUS LR-3	CEUS LR-3	CEUS LR-3	CEUS LR-4
Late and mild washout	CEUS LR-3	CEUS LR-4	CEUS LR-4	CEUS LR-5

a. CEUS LR-M criteria – any of following:
- rim APHE **OR**
- early (<60s) washout **OR**
- marked washout

b. rim APHE indicates CEUS LR-M

c. peripheral discontinuous globular indicates hemangioma (CEUS LR-1)

If unsure about the presence of any major feature: characterize that feature as absent

What is CEUS?

Contrast-Enhanced Ultrasound (CEUS):

- Advanced form of ultrasound (US) in which images are acquired
  - using intravenously injected microbubble contrast agents
  - with technology optimized for visualizing those agents
- Similar to CT and MRI, permits dynamic characterization of lesion and liver blood flow
- Allows characterization with high temporal resolution of limited number of observations
- Most suitable for problem solving
- Not optimal for staging entire liver
- Although it may be used with caution by expert practitioners in these contexts or for these purposes, it is not currently recommended by CEUS LI-RADS to
  - characterize nodules occult on precontrast gray-scale images
  - assess treatment response

CEUS LI-RADS is being developed for precontrast occult nodules and for treatment response.

Key differences compared to CT and MRI are that CEUS:

- Permits real-time imaging, which
  - Virtually eliminates possibility of arterial phase mistiming.
  - May allow detection of APHE missed on CT or MRI.
- Uses purely intravascular microbubble contrast agents, which affects washout and “capsule” characterization.
  - CEUS washout is true washout. Hence, CEUS uses the term washout, not the terms “washout” or washout appearance.
  - CEUS characterization of washout requires assessment of its onset (late vs. early) and degree (mild vs. marked), not just its presence.
  - CEUS does not depict “capsule”; “capsule” is not a CEUS major feature.
- Is safer; microbubble agents have virtually no known adverse reactions.
- Allows multiple injections of microbubble contrast agents in same examination, permitting more complete characterization of the same observation and/or assessment of additional observations.
- Does not depict vascular pseudolesions such as arterioportal shunts, a frequent cause of diagnostic confusion on CT and MRI.
  - Any CEUS enhancing observation is a true lesion.
- Has fewer ancillary features (AFs).
- Permits characterization of limited number of targeted observations per examination; hence, not usually suitable for staging.
- Requires higher level of expertise for optimal performance.
- Is new in the United States, hence, not yet fully adopted or widely available

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Indications for CEUS in patients at risk for HCC:

- Assess nodules ≥ 10 mm detected on surveillance US
- Assess LR-3, LR-4, and LR-M observations detected on prior CT or MRI
- Detect APHE when mistiming is suspected as the reason for its absence on prior CT or MRI
- Assess biopsied observations with inconclusive histology
- Guide biopsy or treatment of observations difficult to visualize with precontrast US
- Help select appropriate observation(s) or observation component(s) for biopsy
- Monitor changes in enhancement pattern over time for selected CEUS LR-3 or CEUS LR-4 observations
- Differentiate tumor in vein (“tumor thrombus”) from bland thrombus

CEUS LI-RADS® 2017

Apply in patients at high risk for HCC, namely those with:

- Cirrhosis **OR**
- Chronic hepatitis B viral infection **OR**
- Current or prior HCC

Including adult liver transplant candidates and recipients posttransplant

Do not apply in patients:

- Without the above risk factors
- < 18 years old
- With cirrhosis due to congenital hepatic fibrosis
- With cirrhosis due to a vascular disorder such as hereditary hemorrhagic telangiectasia, Budd-Chiari syndrome, chronic portal vein occlusion, cardiac congestion, or diffuse nodular regenerative hyperplasia

Apply to observations:

- Visible at precontrast ultrasound

Do not assign CEUS LI-RADS categories for observations:

- That are path-proven malignancies **OR**
- That are path-proven benign lesions of non-hepatocellular origin such as hemangiomas

Apply for CEUS exams performed with:

- Pure blood-pool agents such as Lumason® (in USA)/SonoVue® (outside USA) and Definity® (in USA, Canada)/ Luminity® (outside USA, Canada)

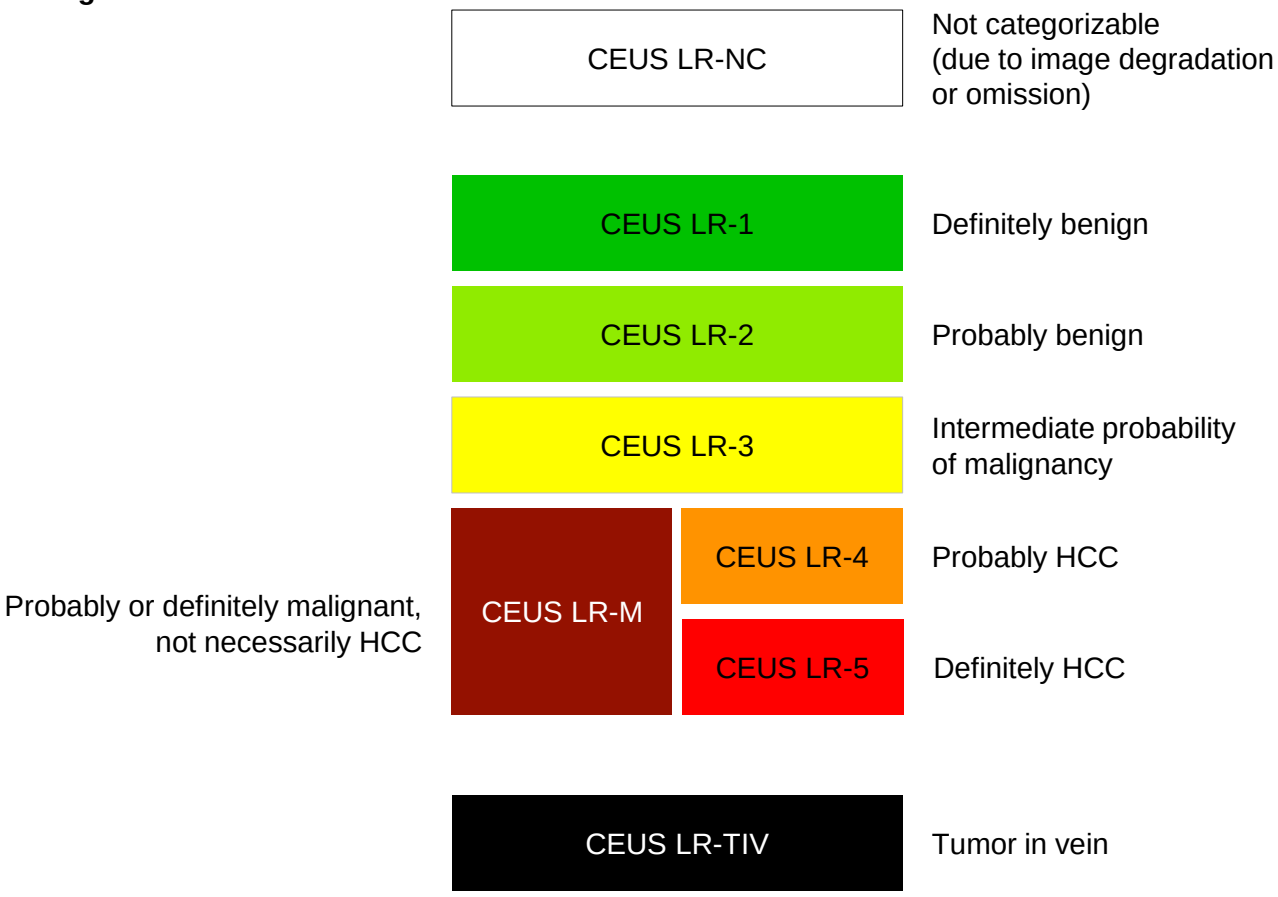
Do not apply for CEUS exams performed with:

- Combined blood-pool and Kupffer-cell agents such as Sonazoid®

  The current version of CEUS LI-RADS does not address use of Sonazoid®. Use of Sonazoid® will be addressed in the next version of CEUS LI-RADS.

CEUS LI-RADS® 2017 Categories

Diagnostic Categories



(Treatment response categories in development)

Step 1. Apply CEUS LI-RADS® Diagnostic Algorithm

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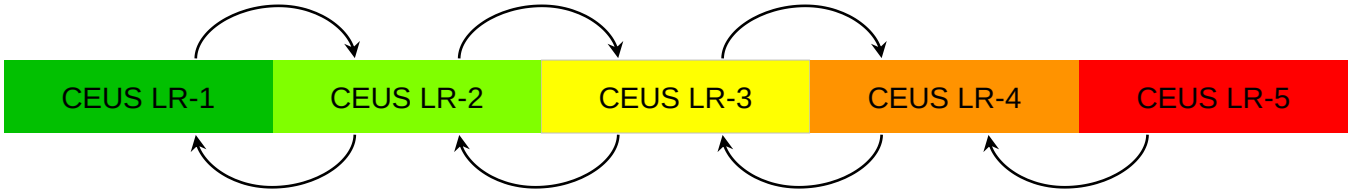
If unsure about the presence of any major feature: characterize that feature as absent

Step 2. Optional: Apply CEUS Ancillary Features (AFs)

CEUS ancillary features may be used **at interpreter's discretion** for:
Increased confidence or category adjustment

For **category adjustment** (upgrade or downgrade), apply CEUS ancillary features as follows:

One or more ancillary features favoring malignancy: upgrade by 1 category up to CEUS LR-4
(Absence of these ancillary features should not be used to downgrade)



One or more ancillary features favoring benignity: downgrade by 1 category
(Absence of these ancillary features should not be used to upgrade)

If there are conflicting AFs (i.e., one or more favoring malignancy and one or more favoring benignity):
Do not adjust category

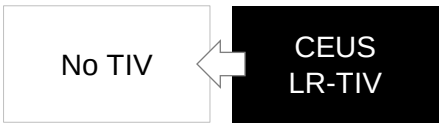
Ancillary features cannot be used to upgrade to CEUS LR-5

CEUS AFs favoring malignancy	CEUS AFs favoring benignity
Favoring malignancy in general, not HCC in particular • Definite growth **Favoring HCC in particular** • Nodule-in-nodule architecture • Mosaic architecture	• Size stability ≥ 2 years • Size reduction

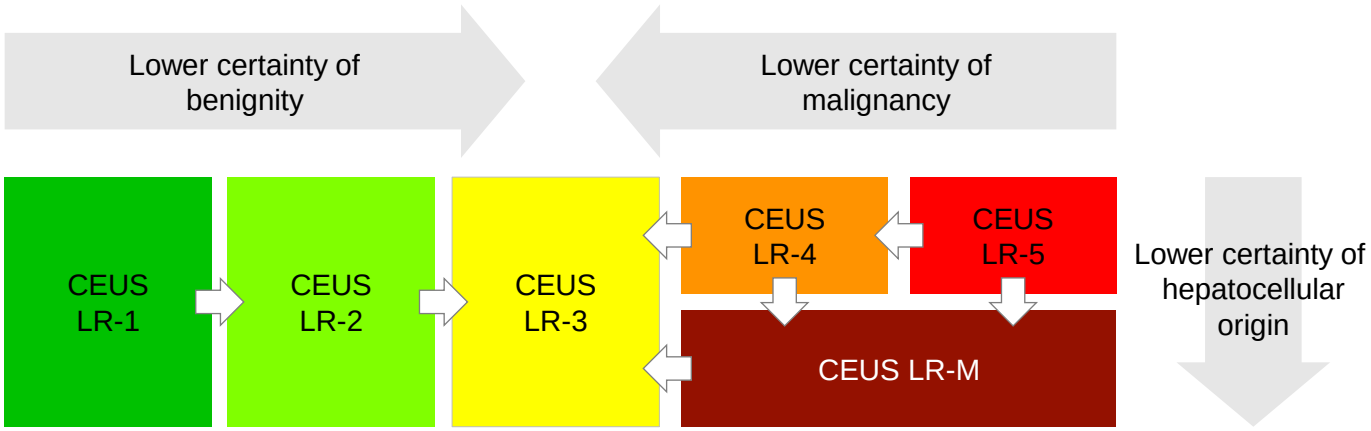
If unsure about presence of any ancillary feature: characterize that feature as absent

Step 3. Apply Tie-breaking Rules if Needed

If unsure about presence of TIV, do not categorize as CEUS LR-TIV



If unsure between two categories, choose the one reflecting lower certainty



Step 4. Final Check

After Steps 1, 2, and 3 –

Ask yourself if the assigned category seems reasonable and appropriate

If YES: You are done, move on the next observation (if any).

If NO: Assigned LI-RADS category may not be appropriate, so reevaluate.