2017 Version of LI-RADS for CT and MR Imaging: An Update
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Doctors Elsayes, Kielar and Sirlin welcome to the podcast.

Thank you.

Thank you.

J.S.K. Khaled we’re gonna begin with you. Your paper in the current issue is an important one and it provides our readers with an updated pictorial on the revised LI-RADS which was released this year in 2017. Can you please describe how LI-RADS began and how it’s evolved over the years?

Khaled Elsayes, MD So good morning first Jeff and thank you very much for inviting us for this podcast. It’s our pleasure to be here and it’s my pleasure also to be with Dr. Sirlin and Dr. Kielar great colleagues and we’ll have (inaudible) and Claude is chair of the Steering Committee for LI-RADS and myself and Ania Kielar are co-chairs of that (inaudible) and each committee of LI-RADS in the American College of Radiology. So as we all know hepatocellular carcinoma is the most common primary malignancy of the liver and it’s the second leading cause of cancer related to deaths in the world. That’s why HCC is very important and HCC that develops asymptomatic patients is treated with five years of (inaudible). However, if it can be treated early with transplantation or resection, the five years survival rate greatly improves and that’s why it’s very important to detect hepatocellular carcinoma at an early stage by means of screening which is very important for an optimal outcome after screening and detection of the lesion then comes the role of contrast enhanced CT and MRI and potentially now contrast enhanced ultrasound after the FDA approval. In most current clinical practice guidelines, CT and MR have replaced biopsy. So if you have a lesion with imaging features that are characteristic for hepatocellular carcinoma then it’s imaging diagnosis will make diagnosis we don’t need biopsy. In North America, the American Association for the Study of Liver Diseases and the United Network for Organ Sharing and Organ Procurement Transplantation Network (UNOS-OPTN) have provided diagnostic guidelines for patients at a high risk for hepatocellular carcinoma and liver transplantation candidates. These organizations provided criteria for diagnosis of hepatocellular carcinoma these are based on imaging features such as arterial phase hyper enhancement, washout, capsule, appearance, lesion size and tumor growth. So our proposal our LI-RADS, this is contemporary to UNOS-OPTN and it’s building on AASLD for the American Association for the Study of Liver Disease. The LI-RADS was developed by diagnostic radiologists with the support of the American College of Radiology by providing the connections to these features and it also has created lexicons, algorithms, schematic, and addressing gaps in these systems. So LI-RADS, LI-RADS is intended, what is the aim of LI-RADS it’s intended to use variability and interpretation of imaging findings. It’s also intended to improve communication through standardizing and reporting and (inaudible) therapeutic decision making and outcome monitoring. It was designed for use by community and academic practice radiologists as well as radiologists (inaudible), researchers, and any healthcare professional involved in providing care to patients at a high risk of HCC. We’re dealing now Jeff with the third update of LI-RADS. So LI-RADS was initially released in 2011 and there were two updates in 2013 and 2014 and now we’re releasing the third update of LI-RADS this is version 2017.

J.S.K. Terrific. Thank you very much for that. Khaled following the introduction in your paper you begin with an overview of the new LI-RADS version 2017 which focuses obviously on the use of CT and MR in the LI-RADS version. Can we look at Figure 1 and discuss the new additions and clarifications that appear in the new LI-RADS version 2017?

K.E. Absolutely let me pull up Figure 1. So in 2017 there were brand new categories that were created and others that were expanded all using evidence based data and expert consensus. This included a new algorithm for LI-RADS characterization and the context for ultrasound surveillance and screening for patients at a high risk for HCC. There was also a separate algorithm was developed before liver lesions being evaluated using contrast enhanced ultrasound given its increased use in North America after the recent FDA approval of microbubble contrast agents. Also in the area of treatment response, there was significant work done to expand this area and to include the standardized terms such non-viable, equivocal, viable or even non-evaluable based on the three
observations. So number one here we have some new
algorithms, okay and we have also some new and modi-
cified categories. Such as LI-RADS M so LI-RADS M is malignan-
cy and so I think LI-RADS NC which is non-categorizable, and
LI-RADS tumor in vein, this was a category that was
modified in LI-RADS version 2017. Also for LI-RADS M
I was gonna say that there was explicit new criteria for LI-
RADS M which is malignancy specific for definite features or
probable features of a malignancy other than hepatocellular
carcinoma. In addition to that ancillary features have been
also expanded and built upon. But at the same time, it’s very
important to note that we changed this in LI-RADS 2017,
this is no longer mandatory for the version of 2017. It’s op-
tional due to lack of sufficient evidence in the (inaudible) in-
corporation of these features. There was also modified infor-
mation for tumor growth so that’s mainly the new additions

J.S.K. Terrific Khaled. Thank you for that. Claude we’re
gonna turn to you. The paper in this issue is obviously a very
important one and it really provides our readers with an up-
dated pictorial on this revised LI-RADS which was just re-
leased. What motivated the updates and why should radiolo-
gists and the allied specialists who are caring for patients with
known or suspected hepatocellular carcinoma use LI-RADS?

Claude Sirlin, MD Thanks for that question. Khaled al-
ready outlined some of the updates, but very briefly what
motivated the various updates were to address gaps in the
previous versions as well continuously attempting to further
simplify the algorithms. So for example in version 2013 we
added the category LI-RADS M to recognize the fact that
not all cancers in the cirrhotic liver are HCC so this was an
important category to alert the refer and the patient that there
may be a cancer other than HCC in the liver. We also created
an algorithmic display to facilitate the interpretation and use
of LI-RADS and we added an atlas of controlled terminology
schematic drawings and illustrative examples. That was 2013.
2014 we added hepatobiliary agents such as gadoxetate diso-
dium and we simplified the algorithm. In 2017 we added ul-
trasound, we added contrast enhanced ultrasound, we added
treatment response and we further simplified the algorithm.
So in summary the updates are intended to address gaps and
further simplify. Now why should radiologists and allied spe-
cialists use LI-RADS? We believe that LI-RADS is currently
the leading and most comprehensive system for imaging liver
cancer in patients with cirrhosis. It provides rigorous stan-
dardization of imaging not only for clinical care, but also we
believe equally importantly for research and for education.
LI-RADS is a dynamic document so unlike other guidelines
which can be updated only very five to ten years, LI-RADS
can be updated as evidence accrues, as new knowledge is
formed, and very importantly in response to user feedback.
LI-RADS also has an international perspective. We now have
over 250 contributors to LI-RADS from every continent ex-
cept for Antarctica so there’s a broad international perspec-
tive that is helping to make sure that LI-RADS is relevant,
not just in the United States, but ideally to the whole world.

J.S.K. Terrific. Thanks. Claude let’s look specifically at one
new diagnostic category, this is the LRNC which was added
to LI-RADS in the most recent version. Can you detail this
category, when it’s to be used by radiologists, and what the
recommended follow-up would be for these patients with this
particular designation?

C.S. Now that’s a great question. So LI-RADS non-cate-
gorizable or LI-RADS NC is to be used rarely and only in the
situation where the radiologists cannot decide whether an ob-
servation is more likely benign or more likely malignant due
to image degradation or image omission. So for example, if a
lesion is challenging because it has unusual imaging features,
but the actual imaging is fine, all the phases were obtained
and were good quality, do not apply LI-RADS non-catego-
rizable, do your very best to apply the best category you can.
Also even if images are omitted or degraded but you can nar-
row the list of categories to be more likely benign or more
likely malignant then don’t apply this category. For example
if I know something is a LI-RADS 4, 5 or M, but I’m not sure
exactly which one of those it is, I would not use LI-RADS
non-categorizable I would say the imaging is limited, I believe
this is a malignant mass somewhere in the LR 4, 5 or M cat-
egory and I would recommend further follow-up which then
leads me to your next question what is the follow-up? And I
would say that depends on several factors and so the radiol-
ogist will need to use his or her judgement if – it depends
mainly on what the cause of the non-categorizability was as
well as the size of the observation and the urgency to figure
out based on clinical factors. So for example, if the reason
that something was non-categorizable was because someone
was breathing during the arterial phase, then it may be as
simple as bringing the patient back with better breathing in-
suctions if the radiologist thinks that might work. Similarly
if the arterial phase images were just not acquired it would
be as simple as bringing the patient back and acquiring the
missing images. Sometimes it might require more judgment.
Sometimes it might require a different contrast agent or a
different modality. We don’t have rules that can outline every
possible scenario so we leave it to the radiologist’s judgment.
The last thing I’d like to emphasize though is that if in the
radiologist’s judgment no imaging alternative is likely to be
helpful, then at that point we would recommend multi-disci-
plinary discussion between the radiologist, the hepatologist,
and possible other healthcare providers with consideration of
biopsy or other diagnostic workup.

J.S.K. Great. Thanks very much for that. Ania we’re going
to turn to you. So LI-RADS TIV or tumor in vein is a new
descriptor that replaces the LI-RADS 5V designation that
was used previously. Can we show put up Figure 3 which
illustrates a patient with this particular finding?

Ania S. Kielar, MD Absolutely. So the term LR 5 was
changed specifically to tumor in vein for the version 2017 to
address cases where tumor, not just (inaudible) is identified
at cross sectional image and this term is supposed to indicate
unequivocally enhancing soft tissue in a vein regardless of
the digitalizing associated (inaudible) mass. And as a tip, for junior radiologists’ interpretation of contract enhanced MRI use of subtraction images may be helpful for this evaluation of presence of tumor in vein. Previously published studies have shown that presence of tumor in vein is associated with worse patient prognosis which is why this term was specifically included and separated from the LR5 designation. In addition, tumor in vein is a term that is important to the American Association for the Study of Liver Disease and it affects the decisions regarding further treatment, management, as well as liver transplantation. So, based on these – when someone identifies tumor in vein the next step is multi-disciplinary discussion. And this is key because based on those discussions, biopsy may be considered for definite diagnosis as well as individualized management as informed by the final pathology. It’s also important to note that most observations categorized as LI-RADS tumor in vein are in fact HCCs but it is important to remember that there are some differential diagnoses to consider which are rare but worth you know giving a thought. One of them is the possibility of tumor in vein due to cholangiocarcinoma or in rare instances hepatocellular carcinoma and cholangiocarcinoma together. So therefore not all malignancies with tumor in vein can actually be categorized as LR tumor in vein. In those very rare instances where a radiologist thinks this may not be HCC it should be indicated specifically in your report that there may be another primary malignancy involved. On the other hand, if there has been previously pathologically proven HCC with tumor in vein then you can say path proven and if it was pathologically proven not to be an HCC then you would simply say this is a cholangiocarcinoma with tumor in vein.

J.S.K. Alright. Thank you for that. Ania let’s discuss the concept of threshold growth which is in the new LI-RADS. Can we review this concept and we’ll also show Figures 5 and 6 to illustrate this concept.

A.Z.K. Absolutely. So in order to determine growth, it’s first imperative that we all measure in a meticulous manner and adhere to standards. These standards are provided and emphasized in version 2017 of LI-RADS. So if we look at Figure 5 this is where we talk about the definition of how to measure size. The key first point is to include our edge (inaudible) of an observation. In a case where an observation has a capsule we want (inaudible) to the outer edge. If an observation is not round but is oval, then we would look at the major axis or the longest length. In the case of heterogeneous observations or nodules in nodule then we would like to include the entire observation including the areas (inaudible.) Now it is important to remember that even if an observation has an area with perfusion abnormality and we do not want to include the perfusion abnormality and that’s why currently in LI-RADS we do not recommend measuring in the arterial phase unless that’s the only phase which is where the observations can be well seen. Now once the size of an observation has been accurately determined, we can talk about growth. And in that case we have to compare to previous cross sectional imaging. So threshold growth is one of the major features in version 2017 of LI-RADS and it is now defined as a minimal 5-mm increase in lesion size and either a 50% or greater increase in size before or at 6 months or a 100% increase in size after six months. This is a little bit different than OPTN because OPTN only has one definition and that is greater than or equal to 50% increase in size in 6 months or less. So these slight differences need to be kept in mind and (inaudible) indication is that some LR5 observations may not count as OPTN 5s. So in particular this would affect observations with growth for LR5 categorization and for OPTN it’s only those that have more than 50% increase in size in 6 months or less. So the other difference between OPTN and LI-RADS is that OPTN applies to all transplant candidates whereas LI-RADS only applies (inaudible) criteria. And specifically in LI-RADS we do not currently include pediatric patients and we do not include vascular causes of cirrhosis. Now if we look at Figure 6 we’ve been given four images. One is in the earlier arterial phase then we have a mid-arterial phase and main arterial phase and hepatobiliary phase in this particular case. And we can see that the measurements if you took the long axis outer margin to outer margin would in fact vary quite significantly. (Inaudible) So in this case we would use the hepatobiliary phase which is Image D and this would be what we would use. The key feature at this point is that radiologists should use the same frame between studies and whether it’s axial or frontal and the same phase. That will maintain the most accuracy of intra movement between the two studies. And hopefully in the future with improvement with deep computer learning segmentation of observations may be easily created and accessible to radiologists for more accurate evaluation (inaudible).

J.S.K. Great. Thank you so much Ania. Khaled let’s turn back to you and let’s discuss the approach to assigning a LI-RADS diagnostic category 4 in four steps rather that you detail in the paper. We’ll review figures 12 through 14 as we discuss the four steps in assigning a LI-RADS category.

K.E. Okay thanks for this question again Jeff. So there are – looking at the table or Figure 12, so there are three main steps; first we evaluate observation using the imaging provided and to ensure the quality of imaging is sufficient for characterization. Then we look at the imaging, major imaging features which includes presence or absence of arterial phase hyper-enhancements, washouts, presence of a capsule, and threshold growth. Once this is done as well as of course measuring the size, once this is done a biliary category is assigned. Then it comes to table number 3, we’ll look at number 3 because after this step we’ll look at ancillary features, evaluate them and though these are not currently considered mandatory using LI-RAD version 2017. So if we look at – now we’re looking at Table 13 which describes the various ancillary features, some will upgrade initial LI-RAD category by up by one, while others may downgrade the category down by also one. Okay so you may upgrade it by one and downgrade it by one. You can’t upgrade it or downgrade it by more than one. But it’s also important to know that you know we cannot no ancillary features can lead to increase a LI-RAD category be-
yond LI-RADS 4. So we cannot assign LI-RADS 5 based on the upgrades by ancillary features. If there are more than one ancillary feature, we can cancel each other one another. So you have one that upgrade, one that downgrade. We can cancel one another and if one favors benign entity and one favors malignant features, then they can cancel each other. However, this cancellation cannot change that categorization of an observation by more than one category again reminding with value of ancillary features it want to go beyond LI-RADS 4. So it cannot go to LI-RADS 5 based on upgrade by ancillary features. And then the third step is apply tie-breaking rules if needed. So if we are unsure between two categories we should choose the one reflecting lower certainty. If we are unsure about tumor in a vein then we don’t categorize it as tumor in the vein. This is the third step and the last step we look at is a final check and this is meant to be a really confirming what we are looking at. The final check is after steps 1 and 2 and 3. What we do is we ask ourselves if the same category makes sense, seems reasonable and appropriate. So if they are reasonable then we’re done and we’re moving to the next observation if there is next observation in the image, but if no it doesn’t make sense, it’s not reasonable, it’s not appropriate, then assign LI-RADS category should be inappropriate and we should actually re-evaluate. So those are the four steps for the diagnoses for applying the category then in CT and MRI diagnostic algorithm.

J.S.K. Great. Thanks, thanks so much. Claude let’s just turn back to you. Next in the paper you detail the technical recommendations of performing CT and MR exams in patients who are at risk for hepatocellular carcinoma who are being evaluated by cross-sectional imaging and Figure 18 reviews these recommendations specifically. Are there any points you’d like to make on these recommendations?

C.S. The most important point I’d like to make is that LI-RADS currently applies to multi-phase CT, multi-phase MRI with extracellular agents or multi-phase MRI with hepatobiliary agents such as gadoxetate disodium. I’m frequently asked whether LI-RADS applies to MRIs performed with gadoxetate and the answer is unequivocally yes. So that’s the single most important thing I’d like to emphasize. I’d also like to emphasize that the technical recommendations on this table and in LI-RADS are minimum technical recommendations. They reflect what we believe is the minimum required for appropriate imaging of liver cancer in the setting of cirrhosis. It’s based in part on evidence, in part on expert opinion, in part on a desire to minimize radiation and in part on practical considerations. So for example to minimize radiation we currently say that pre-contrast CT is optional in those patients who have had no prior treatment. We also say that diffusion weighted imaging is optional and the reason for that is that not all scanners in the United States currently can do high quality diffusion weighted imaging. So it’s a practical consideration we made DWI optional not mandatory. Now we allow users of course to add if they would like, so for example those users that have the capability of doing multi arterial phase imaging may choose to acquire multiple arterial phases. We don’t require it, we don’t recommend it, but that’s an option. Now as I mentioned a lot of this is based on expert opinion and practical considerations. Not all that is based on evidence. And so we’re hoping that with research we might be able to figure out what phases and what imaging sequences are truly incrementally valuable and which ones are redundant. So maybe with time we could reduce some of the requirements, but we need research to do that. And the last thing I’d say is that one controversial issue that I would love to see some research on is whether in fact pre-contrast you know unenhanced CT should be acquired before giving contrast. There are reasons to do it; there are reasons not to do it. I would say this is a controversial issue. In 2017 LI-RADS make this optional, but I would love to see some research to determine whether or not the incremental value of pre-contrast CT make actually outweigh the small risk of additional radiation exposure.

J.S.K. Terrific. Thanks Claude. Ania finally let’s touch on treatment response categories and the criteria for assessing recurring and residual disease which is new for LI-RADS version 2017. Let’s show Figure 24 that details the process of making this assessment. Ania would you like to review this for us?

A.Z.K. Absolutely. So before I go into the actual figure here, I just wanted to say that LI-RADS treatment response assessment was advanced for this version 2017 and it was developed by an international group of multi-disciplinary LI-RADS treatment response working group which includes radiologists, hepatologists and (inaudible) and well as interventional radiology. And it is important because there are many different local types of therapies which can occur and we need as radiologists to be familiar with the enhancement patterns of these treated tumors. So that’s the first thing to remember. (Inaudible) if we go through the way that this built by using the LI-RADS treatment response it allows radiologists to have clear communication between radiologists and specialists caring for patients who have undergone local regional therapy. It also provides standardized terminology with the terms of viable, equivocal and non-viable to facilitate data collection and as Claude mentioned in his responses, research is still an area of need in this particular treatment region and it is something that’s increasing in the literature right now. When we look at this particular response algorithm the first thing to look at is whether or not we can evaluate this. So the term non-evaluable is used for treatment response as Dr. Elsayes explained earlier. It is actually important to differentiate non-categorizable from non-evaluable. Non-evaluable is used exclusively for evaluating an observation that has undergone local, regional therapy such as radio frequency ablation, stereotactic body radiation therapy or various (inaudible) therapies. The term non-evaluable should be used when a treatment response cannot be evaluated due to image degradation or omission of various sequences. So that’s the first part. Once you’ve looked and determined that the imaging quality is acceptable, then we have three options. One is non-viable and those are instances where the interpreting radiologist feels that there’s no tumor left. Generally speaking those are areas of non-enhancement, (inaudible) tumor viable LI-RADSTR indicates that there is something leftover
after the treatment, and the one in between is equivocal that we use that term. So in equivocal the enhancement pattern may be either atypical for a treatment specific expected enhancement pattern or definitely viable.

**J.S.K.** Terrific. Well I’d like to thank doctors Elsayes, Kielar and Sirlin for joining us today to discuss their featured paper in the current November 2017 issue of *RadioGraphics* on LI-RADS version 2017 an update. Doctors, thank you very much for taking your time today.

Thank you very much.