How can we, as radiologists, ensure that the correct imaging studies are being performed as we transition to value-based care? One way is by critically looking at our recommendations for incidental findings on CT. Too often, the recommendations for an identical lesion vary widely by radiologist, practice type, and region. The purpose of this chapter is to show a case-based approach to the incidental liver lesion using the American College of Radiology (ACR) White Paper [1] as a guide.

As the use of MDCT has increased, there has been a concomitant increase in the frequency of detecting incidental findings [2–5]. These incidental findings are defined as findings that are unrelated to the clinical indication for the imaging examination. Although it can be helpful to detect these findings, detection of these lesions can also potentially confound physicians and patients with regard to the optimal means by which to manage them [1]. One major issue is that the workup of these incidental lesions can lead to increased utilization of cross-sectional imaging and, subsequently, increased health care costs [1]. Given that workup and follow-up recommendations for these lesions can vary widely by physician, hospital, and region, some potential advantages of standardizing the approach would be to attempt to limit costs and reduce risk to patients from unnecessary imaging [1, 6]. A full discussion of costs and the conundrum associated with reducing costs while maintaining quality is beyond the scope of this chapter, but the ACR White Paper [1] does begin to address this issue.

It is difficult to quantify how often incidental liver lesions are encountered in clinical practice, but some estimates suggest that more than 50% of patients without a history of malignancy had benign hepatic lesions at autopsy [7, 8] and that up to 15% of CT studies show incidental findings in the liver [8]. The ACR White Paper on Incidental Findings [1] has provided an outstanding evidence- and expert consensus–based approach for incidental lesions that are commonly encountered in practice. This document is comprehensive in that it deals with incidental findings in the kidneys, adrenal glands, pancreas, liver, and so on. This chapter will be a case-based approach to the incidental liver lesion with a focus on pertinent management and important lessons learned in clinical practice.

First Things First

When an incidental focal liver lesion is identified, the ACR Incidental Findings Committee [1] suggests that there are three key questions that should be asked to determine the next best steps. First, does the incidental liver lesion put the patient at risk for an adverse outcome? Next, is it possible to differentiate a benign cause from a malignant cause with confidence? Finally, if the lesion is benign, are there any potential complications that could arise from it (e.g., bleeding or hemorrhage from hepatic adenoma) [1]? To ascertain the importance of the incidental liver lesion, one must be able to separate individual patients with these findings into clinical risk categories. There are three risk categories as defined in the ACR White Paper [1]: low risk, average risk, and high risk. Low-risk individuals are 40 years old or younger with no history of malignancy, no risk factors, and no symptoms attributable to hepatic disease. Average-risk individuals are differentiated from low-risk individuals by age alone (> 40 years old). Finally, high-risk individuals are those who have a known primary malignancy that can metastasize to the liver, hepatic risk factors (detailed in the ACR White Paper), or a known hepatic disease such as cirrhosis.

Establishing the clinical risk category helps to determine the next steps in management—that is, additional imaging, biopsy, or no further workup [1]. Although biopsy of focal liver lesions is generally a safe procedure, it is not without risk, morbidity, or controversy [9]. The postprocedural morbidity of percutaneous liver biopsy is estimated to range from 2.0% to 4.8% with a mortality of 0.05% [10–12]. In clinical practice, my colleagues and I use percutaneous liver lesion biopsy as the final step if we are unable to reach a conclusion about the cause of an incidental liver lesion with noninvasive cross-sectional modalities; therefore, we believe that biopsy remains an important part of the workup of a small number of incidental liver lesions similar to the way in which it is used by other authors [13].
The Flowchart

You have now identified an incidental liver lesion, measured its size, and have placed the patient in a risk category, so what’s next? The ACR White Paper [1] has a flowchart with color coding to lead you through the next steps (Fig. 1). The key numbers that you need to know are 0.5 and 1.5 cm because these values are the key size thresholds that the ACR White Paper uses in the flowchart. The yellow boxes identify the imaging features and risk category needed to lead you to pink boxes, indicating that the workup can stop because the finding is likely to be benign and does not require additional follow-up, or to green boxes, indicating the need to pursue further diagnostic testing, biopsy, or follow-up [1]. With this flowchart in mind, I will discuss some case examples.

Case Examples

Case 1

Low-attenuation lesions between 0.5 and 1.5 cm are commonly encountered on MDCT. The key factor that determines how to follow these lesions is whether the lesion shows benign or suspicious imaging features. This delineation is critical because the risk category does not impact recommendations.

Benign imaging features include well-circumscribed margins, attenuation values of less than about 20 HU, homogeneous appearance, and findings suggestive of typical hemangiomas [1]. In contrast, suspicious imaging features include ill-defined margins, enhancement with attenuation values of greater than 20 HU, heterogeneous appearance, and enlargement [1] (Fig. 2).

Case 2

The recommendations for flash-filling lesions between 0.5 and 1.5 cm depend on the risk category of the patient. For patients who are low or average risk, these lesions are considered to be benign findings according to the ACR White Paper [1] and no further follow-up is recommended (Fig. 3). In high-risk individuals, if the lesion shows suspicious features, multiphase MRI is recommended; otherwise, follow-up CT or MRI in 6 months is advised.

Case 3

Although the flowchart in the ACR White Paper [1] is generally intended for use on incidental liver lesions identified on MDCT, it can be used at times for lesions identified on abdominal sonography. In these cases, my colleagues and I find it helpful to use lesion size and patient risk category to determine the next steps because some of the imaging features on the flowchart are not as easily assessed on sonography (Fig. 4).

Case 4

For a flash-filling lesion larger than 1.5 cm, the key factor in determining the next steps in management is the presence or absence of benign features on diagnostic imaging [1]; the patient risk category does not play a significant role in determining the next steps (Fig. 1) for these lesions. If there are benign diagnostic imaging features, the differential diagnosis for these lesions is typically focal nodular hyperplasia (FNH) or adenoma. Multiphase MRI is recommended to make this distinction. The use of hepatobiliary MRI contrast agents to assist with this distinction, especially for the diagnosis of FNH, has been well documented [14–16]. This recommendation is related to the fact that hepatobiliary MRI contrast agents have a dual route of excretion through the biliary system and kidneys, whereas conventional extracellular MRI contrast agents have a single route of excretion through the kidneys. This unique property allows hepatobiliary contrast agents to be taken up by hepatocytes during the hepatic arterial phase and to the blood pool during the hepatic venous and delayed phases [20, 21]; hemangiomas should not be isointense to the liver parenchyma in the hepatic venous and delayed phases [1]. Failure to recognize this key difference can lead to the incorrect diagnosis of hemangioma (Fig. 7) and potentially to an adverse outcome for the patient from a delay in the appropriate workup or treatment of the lesion.

Case 5

In patients with low-attenuation lesions larger than 1.5 cm and suspicious imaging features, accurate clinical risk stratification is critical to determining the next steps. Again, suspicious imaging features include ill-defined margins, enhancement with attenuation values of greater than about 20 HU, heterogeneous appearance, and enlargement [1]. For the low-risk individual, follow-up imaging with CT or MRI in 6 months is recommended. For the average-risk individual, evaluation with multiphase MRI is advised (Fig. 6). Finally, for the high-risk individual, biopsy—ideally, core biopsy—is preferred to establish the cause of the lesion. This scenario is the one in which biopsy is advised in the ACR White Paper for incidental liver lesions; the other scenario that leads to a recommendation of biopsy is a flash-filling lesion that is larger than 1.5 cm and has no benign features on diagnostic imaging.

Case 6

Appropriate workup of the incidental liver lesion requires accurate assessment of benign and suspicious imaging features. Hemangiomas are the most common benign liver tumor, with an estimated incidence of 5–20% in the general population [17, 18]. On contrast-enhanced CT, hemangiomas classically show peripheral, discontinuous, nodular enhancement; centripetal progression of lesion enhancement; and puddling of contrast material within the lesion [19]. A critical element for the accurate diagnosis of hemangiomas is to ensure that the enhancing areas of hemangiomas are isoattenuating to the aorta during the hepatic arterial phase and to the blood pool during the hepatic venous and delayed phases [20, 21]; hemangiomas should not be isointense to the liver parenchyma in the hepatic venous and delayed phases [1]. Incidental lesions in the liver are a common occurrence in clinical practice. Knowing how to deal with these lesions using an evidence- and expert consensus–based approach is a key step to standardizing the workup of these lesions.
sions across physicians, practices, and regions. This standardization is critical to minimize unnecessary diagnostic testing, decrease worry and angst felt by patients and family members, and potentially reduce costs as we move to a value-based approach to imaging. The ACR White Paper [1] is an outstanding resource to help radiologists achieve these goals.

REFERENCES


Figures begin on next page.
Incidental Liver Mass Detected on CT

- <0.5 cm
  - Low or average risk
    - Benign, no further follow-up
  - High risk
    - Flash filling (robustly enhancing)
    - Follow-up

- 0.5-1.5 cm
  - Low attenuation, benign imaging features
    - Benign, no further follow-up
  - Low attenuation, suspicious imaging features
    - Follow-up
  - Flash filling (robustly enhancing)

- >1.5 cm
  - Benign diagnostic imaging features
    - Benign, evaluate if possible FNH, adenoma
      - Biopsy, preferred
    - No benign diagnostic imaging features
      - Follow-up

Definitions of numbers in flowchart are as follows:

1. Low risk individuals: Young patient (≤ 40 years old), with no known malignancy, hepatic dysfunction, hepatic malignant risk factors, or symptoms attributable to the liver.
2. Average risk individuals: Patient >40 years old, with no known malignancy, hepatic dysfunction, abnormal liver function tests or hepatic malignant risk factors or symptoms attributable to the liver.
3. High risk individuals: Known primary malignancy with a propensity to metastasize to the liver, cirrhosis, and/or other hepatic risk factors. Hepatic risk factors include hepatitis, chronic active hepatitis, sclerosing cholangitis, primary biliary cirrhosis, hemochromatosis, hemosiderosis, oral contraceptive use, anabolic steroid use.
4. Follow-up CT or MRI in 6 months. May need more frequent follow-up in some situations, such as a cirrhotic patient who is a liver transplant candidate.
5. Benign imaging features: Typical hemangioma (see below), sharply marginated, homogeneous low attenuation (up to about 20 HU), no enhancement. May have sharp, but irregular margins.
6. Suspicious imaging features: Ill-defined margins, enhancement (more than about 20 HU), heterogeneous, enlargement. To evaluate, prefer multiphasic MRI.
7. Hemangioma features: Nodular discontinuous peripheral enhancement with progressive enlargement of enhancing foci on subsequent phases. Nodule isodense with vessels, not parenchyma.
8. Small robustly enhancing lesion in average risk, young patient: hemangioma, focal nodular hyperplasia (FNH), transient hepatic attenuation difference (THAD) flow artifact, and in average risk, older patient: hemangioma, THAD flow artifact. Other possible diagnoses: adenoma, arterio-venous malformation (AVM), nodular regenerative hyperplasia. Differentiation of FNH from adenoma important especially if larger than 4 cm and subcapsular.
9. Hepatocellular or common metastatic enhancing malignancy: islet cell, neuroendocrine, carcinoid, renal cell carcinoma, melanoma, choriocarcinoma, sarcoma, breast, some pancreatic lesions.
Incidental Liver Lesions

Fig. 2—Case 1: 50-year-old woman with remote history of melanoma who presented for contrast-enhanced CT (CECT) of abdomen and pelvis. (Courtesy of Sandrasegaran K, Indiana University School of Medicine, Indianapolis, IN)

A, CECT image reveals 0.8-cm low-attenuation lesion (asterisk) in right hepatic lobe. Based on lesion attenuation of approximately 58 HU, ill-defined margins of lesion, and high-risk category of patient, recommendation is follow-up imaging. Ideally, follow-up imaging will be with multiphase MRI. M = mean attenuation of lesion.

B, Follow-up CECT image obtained 6 months after A reveals stability of lesion in size and appearance. These findings suggest that lesion is unlikely to be metastasis from remote history of melanoma.

Fig. 3—Case 2: 21-year-old woman who presented to emergency department with abdominal pain. Contrast-enhanced CT (CECT) was performed.

A, CECT image shows 0.8-cm flash-filling lesion in posterior segment of right hepatic lobe (arrow). Patient was low risk. Therefore, no further follow-up is recommended because lesion is considered to be benign.

B, CECT image obtained for unrelated indication 5 years after A reveals interval enlargement of lesion (arrow) to 2.5 cm. Because of size of lesion on current CT image, different section of flowchart (Fig. 1) should be used to determine next steps. Lesion has generally benign-appearing features, and recommendation was made to consider multiphase MRI to ascertain if lesion is focal nodular hyperplasia or adenoma. Patient did not undergo MRI and was lost to follow-up.

Fig. 4—Case 3: 31-year-old woman who presented to primary care physician with right upper quadrant and epigastric abdominal pain and bloating. Abdominal sonography was performed.

A and B, Gray-scale (A) and color Doppler (B) sonography images of left hepatic lobe reveal isoechoic mass (≈ 6 cm) with some internal blood flow (arrows). Multiphase MRI was ordered for this low-risk individual to further evaluate lesion because lesion lacks benign features.

(Fig. 4 continues on the next page)
Fig. 4 (continued)—Case 3: 31-year-old woman who presented to primary care physician with right upper quadrant and epigastric abdominal pain and bloating. Abdominal sonography was performed.

C, Axial T2-weighted image with fat suppression reveals stealthy-appearing lesion in left hepatic lobe (arrow) that corresponds to lesion seen on sonography (A and B).

D, Axial T1-weighted image with fat suppression in arterial phase after administration of extracellular MRI contrast agent shows homogeneous hyperenhancement of lesion (arrow).

E, Axial T1-weighted image with fat suppression in equilibrium phase after administration of extracellular MRI contrast agent shows lesion (arrow) is similar in appearance to remainder of liver. There is suggestion of increased signal intensity in central portion of lesion, presumably within central scar. Diagnosis was focal nodular hyperplasia. This diagnosis was confirmed at surgical pathology. Patient underwent resection of lesion because she was deemed to be symptomatic from lesion by her surgeon.

Fig. 5—Case 4: 24-year-old woman who presented to emergency department with complaints of palpitations and abdominal pain. Contrast-enhanced CT (CECT) of abdomen and pelvis was performed.

A, CECT image reveals homogeneously hyperenhancing mass (≈ 6 cm) (arrow) in lateral segment of left hepatic lobe. There is suggestion of low attenuation centrally, possibly related to central scar. Based on benign findings on diagnostic imaging, recommendation was multiphase MRI with hepatobiliary MRI contrast agent (gadoxetate disodium [Eovist, Bayer Pharma]) to attempt to differentiate focal nodular hyperplasia (FNH) from adenoma.

B, Axial T2-weighted image with fat suppression reveals stealthy to slightly hyperintense lesion in left hepatic lobe (arrow) that corresponds to mass seen on CECT (A).

C, Axial T1-weighted image with fat suppression in arterial phase obtained after administration of hepatobiliary MRI contrast agent shows homogeneous hyperenhancement of lesion (arrow).

D, Axial T1-weighted image with fat suppression in hepatocyte phase obtained 20 minutes after administration of hepatobiliary MRI contrast agent shows lesion (arrow) to be heterogeneously hyperintense to remainder of liver. There is suggestion of decreased signal intensity in central portion of lesion, presumably within central scar. Diagnosis of FNH was made with confidence.
Incidental Liver Lesions

Fig. 6—Case 5: 66-year-old average-risk woman with no cirrhosis risk factors who presented with complaints of left lower quadrant pain. Contrast-enhanced CT (CECT) of abdomen and pelvis was performed.

A, CECT image reveals two low-attenuation lesions measuring approximately 2 cm in right hepatic lobe. Both medial (black arrow) and lateral (white arrow) lesions show suspicious imaging features: relatively ill-defined margins, enhancement with attenuation values greater than about 20 HU, and heterogeneous appearance. Based on these findings and average-risk category of patient, recommendation is evaluation with multiphase MRI.

B, Axial T2-weighted image with fat suppression reveals that two lesions have different signal intensities on T2-weighted imaging. Medial lesion (black arrow) is hyperintense to background liver, and lateral lesion (white arrow) is more intermediate bright to background liver. These findings suggest that differential diagnosis for medial lesion includes hemangioma and differential diagnosis for lateral lesion includes malignancy such as hepatocellular carcinoma (HCC) or solitary liver metastasis.

C–E, Axial T1-weighted images with fat suppression obtained in arterial (C), portal venous (D), and late venous (E) phases show classic centripetal nodular enhancement with puddling in medial lesion (black arrows); these findings are compatible with hemangioma. Lateral lesion (white arrows) shows rapid wash-in and rapid washout with capsule. Based on this appearance, presumptive diagnosis of HCC was made. Because of high suspicion of malignancy, α-fetoprotein (AFP) level was checked. AFP value was more than 1480 ng/mL; based on imaging and laboratory results, recommendation was partial liver resection.

F, Photograph of gross pathologic specimen reveals lateral lesion (arrow) is moderately differentiated HCC. Medial lesion was not resected, but its appearance during surgical exploration was compatible with benign hemangioma. (Courtesy of Zani SC, Duke University Medical Center, Durham, NC)
Fig. 7—Case 6: 58-year-old average-risk man who presented with abdominal pain 3 years after initial contrast-enhanced CT (CECT) at outside institution showed a liver lesion. 

A and B, CECT images of abdomen and pelvis obtained in portal venous (A) and delayed (B) phases at outside institution reveal 4-cm enhancing lesion (arrows) in posterior segment of right hepatic lobe. Lesion is heterogeneously enhancing on portal venous phase image and is isodense to hypodense to liver parenchyma on delayed phase image. Note that the attenuation of lesion does not follow the attenuation of blood pool. This lesion was interpreted to be hemangioma on initial study performed at outside institution.

C–E, Multiphase MRI performed 3 years after CECT (A and B). T2-weighted image with fat suppression (C) and T1-weighted images in arterial (D) and portal venous (E) phases reveal marked interval enlargement of lesion (arrows) in right hepatic lobe. Lesion is heterogeneously hyperintense on T2-weighted image, shows rapid wash-in with hypervascularity on arterial phase image, and shows concomitant washout on portal venous phase image. This lesion was pathologically proven to be hepatocellular carcinoma. Key teaching point of this case is that hemangioma must prove itself to be hemangioma—that is, diagnosis of hemangioma cannot be diagnosis of exclusion.