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# Imaging in Practice

## A small pulmonary nodule, found incidentally

**A** 62-YEAR-OLD MAN presents to the emergency department with chest pain. He says the pain is severe and developed rapidly. He says he does not smoke. On physical examination, he appears to be in no acute distress and has normal vital signs. His blood count, electrolyte and troponin concentrations, and electrocardiogram are normal. Chest radiography reveals no abnormality.

The patient continues to report chest pain, so computed tomography (CT) of the chest is performed to look for a pulmonary embolus. CT shows no evidence of a pulmonary embolus but does reveal a 7-mm solitary pulmonary nodule in the right lower lobe (FIGURE 1). The patient's pain gradually subsides.

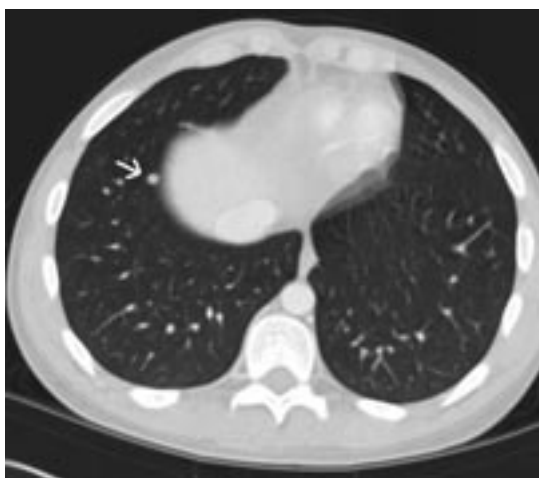
Which is the best way to evaluate and monitor this incidentally found, small pulmonary nodule?

### ■ MOST SMALL, INCIDENTAL NODULES ARE BENIGN

A solitary pulmonary nodule is defined as a single pulmonary lesion with normal surrounding lung parenchyma. In radiology, a nodule is defined as a rounded opacity measuring less than 3 cm in diameter. If the opacity is larger than 3 cm, it is termed a mass.

Solitary pulmonary nodules have both benign and malignant causes (TABLE 1).

The widespread use of multidetector CT scanners has led to an increase in the number of small lung nodules found incidentally. This trend is highlighted by cohort studies that used CT to screen for lung cancer, in which up to 51% of people screened were found to have at least one lung nodule.<sup>1-2</sup>



**FIGURE 1.** Computed tomography of the chest without contrast enhancement shows a well-defined nodule in the right lower lobe (arrow).

**Most very small nodules are benign, but once found, they need to be followed**

Most of these nodules are very small and are not malignant. However, once they are found, they need to be addressed. Traditional criteria that have been used to predict malignancy in pulmonary nodules (eg, calcification, edge characteristics, growth rate) are difficult to apply when the nodules are so small. Adjuvant imaging and biopsy techniques are inaccurate. Thus, follow-up with serial CT imaging is often recommended, although given the low likelihood of malignancy in these small nodules, nobody really knows the correct frequency of follow-up imaging.

In the rest of this article, we outline an approach to serial follow-up of small, incidental lung nodules as recommended in a report from the Fleischner Society for Thoracic Imaging and Diagnosis.<sup>2</sup>

TABLE 1

### Most common causes of solitary pulmonary nodules

#### Benign nodules (60%)

Infection (granuloma, lung abscess, round pneumonia, hydatid cyst)  
 Inflammation (sarcoidosis, Wegener granulomatosis, rheumatoid arthritis)  
 Congenital sequestration, arteriovenous malformation, cyst  
 Other causes (rounded atelectasis, mucoid impaction)

#### Malignant nodules (40%)

Bronchogenic carcinoma  
 Metastasis  
 Lymphoma  
 Carcinoid  
 Sarcoma  
 Neurofibroma

### ■ FOLLOW-UP DEPENDS ON SIZE, RISK FACTORS

When a small pulmonary nodule is found in a patient without symptoms of a pulmonary problem or without an underlying malignancy, surveillance of the nodule with serial chest CT imaging without contrast is usually recommended. The follow-up interval is influenced by the nodule size.

**Nodules 4 mm or smaller** have a very low risk of being malignant.<sup>1</sup> Patients who have a nodule in this size range and who have no history of malignancy or smoking do not require follow-up imaging. However, patients with risk factors for lung cancer (history of smoking or malignancy) should have another CT scan at 12 months.<sup>2</sup> If the nodule has increased in size, then biopsy or resection is recommended.

**Nodules larger than 4 mm and as large as 6 mm** have a low risk of malignancy (0.9%).<sup>2</sup> Follow-up CT is recommended at 12 months if the patient has no risk factors.<sup>2</sup> If the patient has risk factors, follow-up is recommended at 6 to 12 months and then again at 18 to 24 months.<sup>2</sup> If the nodule has not grown, it is considered benign. If it has grown, biopsy or resection is recommended.

**Nodules larger than 6 mm and as large as 8 mm** are also considered to have an intermediate risk of malignancy (roughly 6%).<sup>2</sup>

Follow-up at 6 to 12 months and again at 18 to 24 months is recommended for patients at low risk.<sup>2</sup> Patients at high risk should be evaluated at 3 to 6 months, again at 9 to 12 months, and again at 24 months if there is no change in size.<sup>2</sup> Again, any increase in the size of the nodule warrants biopsy or resection.

**Nodules larger than 8 mm** are more worrisome, as roughly 18% of incidentally detected nodules of this size are malignant.<sup>2</sup> As a result, these patients should be followed aggressively for 3 months or sent for biopsy, regardless of risk factors.

### ■ CT also provides clues to diagnosis

The nodule's appearance on CT gives clues about its diagnosis. For example, it may contain a pattern of calcification that suggests it is benign, such as that seen in some granulomas or hamartomas (dense central, coarse, or popcorn appearance). Although calcification is usually a sign of benignity, a stippled or eccentric pattern of calcification has been seen in malignant nodules.<sup>3</sup> Fat in the nodule is generally not a sign of malignancy.<sup>3</sup> Vessels approaching either end of a nodule suggest a vascular anomaly, while a tail to the pleural surface suggests rounded atelectasis.

### ■ THE ROLE OF ADJUVANT IMAGING AND BIOPSY

Adjuvant imaging tests such as enhanced CT and positron-emission tomography have been shown to be useful adjuncts to chest CT in the evaluation of nodules larger than 10 mm.<sup>4,5</sup> However, these techniques are not as useful for very small nodules.

Biopsy of small nodules also has a low yield, whether via a bronchoscopic or a transthoracic needle approach. As most of these nodules are benign, one does not want to proceed to resection without a reason to be more concerned (eg, growth over time).

### ■ FUTURE ADVANCES

Technologic advances allow us to see very small nodules. Further advances should allow us to identify, characterize, and sample the nodules with greater accuracy. Computer-aided detection and diagnostic systems, volu-

**TABLE 2**

**Provisional recommendations for follow-up of small nodules**

NODULE SIZE	LOW-RISK PATIENT <sup>a</sup>	HIGH-RISK PATIENT <sup>b</sup>
≤ 4 mm	No follow-up needed <sup>c</sup>	Follow-up in 12 months If no change in size, no further follow-up <sup>d</sup>
> 4 –6 mm	Follow-up in 12 months If no change in size, no further follow-up <sup>d</sup>	Follow-up in 6–12 months If no change in size, follow-up in 18–24 months <sup>d</sup>
> 6–8 mm	Follow-up in 6–12 months If no change in size, follow-up in 18–24 months	Follow-up in 3–6 months If no change in size, follow-up in 9–12 and at 24 months
> 8 mm	CT follow-up in 3, 9, and 24 months Also consider enhanced CT, PET, or biopsy	CT follow-up in 3, 9, and 24 months Also consider enhanced CT, PET, or biopsy

CT, computed tomography; PET, positron-emission tomography

<sup>a</sup>Minimal or absent history of smoking and of other known risk factors.

<sup>b</sup>History of smoking or of other known risk factors.

<sup>c</sup>The risk of malignancy in this category (<1%) is substantially less than that in a baseline CT scan of an asymptomatic smoker.

<sup>d</sup>Nonsolid (ground-glass) or partly solid nodules may require longer follow-up to exclude indolent adenocarcinoma.

MACMAHON H, AUSTIN JHM, GAMSU G, ET AL. GUIDELINES FOR MANAGEMENT OF SMALL PULMONARY NODULES DETECTED ON CT SCANS: A STATEMENT FROM THE FLEISCHNER SOCIETY. RADIOLOGY 2005; 237:395–400..

metric measurement software, and bronchoscopic guidance systems are research tools that may soon make an impact on the clinical management of incidentally identified small pulmonary nodules.

**■ TAKE-HOME POINTS**

- Modern imaging allows us to find very small lung nodules.
- Most lung nodules 8 mm in diameter or smaller are benign.
- Traditional nodule characteristics that predict malignancy are less useful with very small nodules.
- Adjuvant imaging and biopsy are less useful

**■ REFERENCES**

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when trying to characterize very small nodules.

- Surveillance with serial chest CT is recommended for most incidentally detected, very small lung nodules.<sup>6</sup>
- Guidelines have been developed on how often to follow these small nodules, based on their size and the patient’s risk factors.

**■ OUR PATIENT**

Our patient had a 7-mm solitary pulmonary nodule and had no risk factors for cancer. He did not smoke. Based on this, we recommended a follow-up examination between 6 and 12 months later and again between 18 and 24 months. ■

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