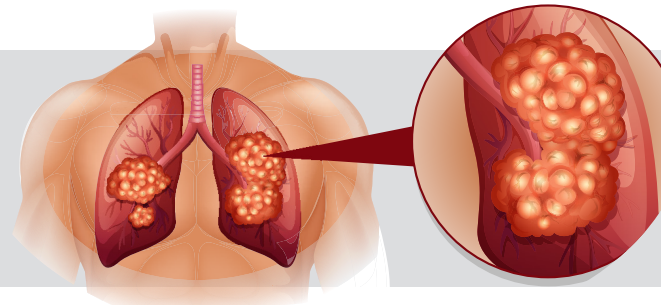


Learning Series - #37



Understanding Lung Nodules

Lung nodules, also known as **pulmonary nodules**, are small growths in lung tissue that are typically round or oval-shaped. While most are benign, some may indicate the presence of lung cancer. Given the significant role these nodules can play in identifying early-stage malignancies, it is essential to understand their **characteristics, risk factors, and diagnostic pathways**. Advances in imaging technology, particularly **low-dose CT scans**, have made it easier to detect nodules, often incidentally, and lead to earlier evaluations and diagnosis.



What Are Lung Nodules?

Lung nodules are typically less than **30 millimeters** in diameter. Nodules larger than this are classified as **masses** and carry a higher likelihood of **malignancy**. They are often discovered incidentally during imaging for unrelated medical conditions and can result from infections, inflammation, or neoplastic processes.

Nodules can be classified as either **benign** and **malignant** based on their origin and characteristics. The distinction between benign and malignant lung nodules is essential for risk assessment. Below is a table summarizing the common types of both benign and malignant lung nodules:

Table 1: Benign Lung Nodules

Category	Type	Brief Description
Infectious / Granulomatous	Healed granulomas	Prior infections (TB, histoplasmosis, coccidioidomycosis)
	Non caseating granulomas	Sarcoidosis
Benign Tumors	Hamartoma	Most common benign lung tumor (fat, cartilage)
	Other benign tumors	Lipoma, fibroma, leiomyoma, hemangioma, neurofibroma/schwannoma
Inflammatory / Autoimmune	Rheumatologic nodules	Rheumatoid nodules, granulomatosis with polyangiitis (Wegener's), Sarcoidosis nodules
Congenital / Developmental	Congenital lesions	Bronchogenic cysts, pulmonary sequestration, AVMs
Post Traumatic / Post Treatment	Injury or treatment related	Scar tissue, organizing pneumonia, hematoma, post radiation change, foreign body granuloma

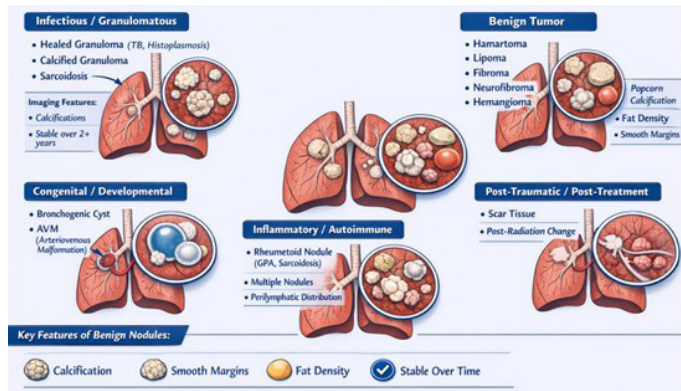
Table 2: Malignant Lung Nodules

Category	Type	Brief Description
Malignant Lung Nodules	Primary lung cancer	Cancer arising from lung tissue
	Metastatic cancer	Spread from another primary cancer site



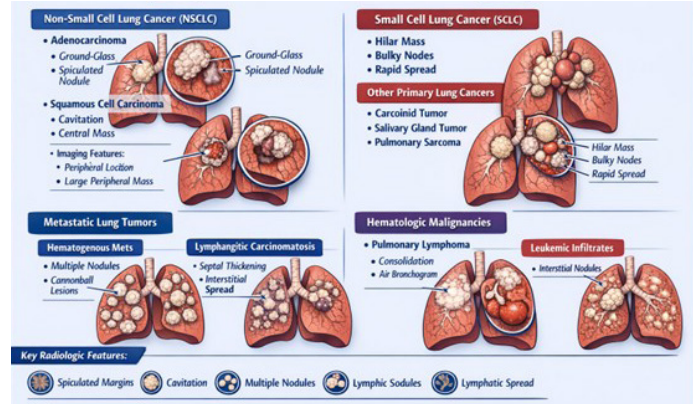


Benign Pulmonary Nodules



AI generated image

Malignant Pulmonary Tumors



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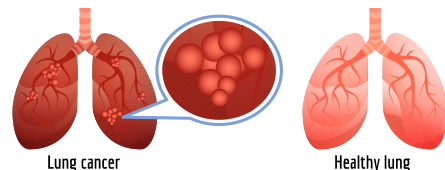
Characteristics of Benign vs. Malignant Lung Nodules

Features	Benign	Malignant
Size	Generally small (<30 mm)	Often larger (>30 mm)
Growth Rate	Slow or stable over time	Rapid growth (weeks to months)
Appearance	Smooth, well-defined edges	Irregular, spiculated edges
Calcification	Common, central or diffuse	Rare, often eccentric or stippled

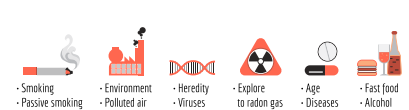
Risk Factors for Lung Nodules & Probability of Malignancy

Risk Factor	Low Risk (≤5%)	High Risk (>65%)
Smoking	Non-smoker	Current or former smoker
Age	Younger (< 40 years)	Older (> 50 years)
Exposure to Carcinogens	No exposure	Exposed to carcinogens (e.g., asbestos, radon)
History of Cancer	No history of cancer	Personal history of cancer
Chronic Lung Diseases	No chronic lung diseases	Presence of chronic lung diseases (e.g., COPD, emphysema)
Family History	No family history of lung cancer	Family history of lung cancer
Sex	Male	Female
Marginal Spiculation	Smooth, well-defined edges	Irregular, spiculated edges
Location	Lower lobe location	Upper lobe location
Nodule Multiplicity	Single nodule	Multiple nodules

Symptoms



Risk Factors





Diagnostic tools

Effective screening is essential, particularly for high-risk individuals. Diagnostic tools include:

Method	Details
Low-Dose CT (LDCT)	Gold standard for detection, especially in high-risk individuals aged 50–80 with significant smoking history.
Chest X-Ray	Can incidentally detect nodules but is less sensitive than LDCT.
PET/CT Scans	Evaluates metabolic activity, helping distinguish between benign and malignant nodules.
Biopsy	Performed via bronchoscopy, needle aspiration, or surgery for histological analysis.
Sputum Cytology	Examines sputum for malignant cells; less commonly used for nodule evaluation.

Imaging Findings and Risk Stratification for Lung Nodules

Feature	Description	High-Risk Indicators	Low-Risk Indicators
Nodule Size	The size of the nodule, measured in millimeters.	> 8 mm	< 5 mm
Nodule Margins	The edges of the nodule, which can be smooth or irregular.	Irregular or spiculated	Smooth, well-defined
Attenuation	The density of the nodule (solid, subsolid, or ground-glass).	Ground-glass opacity	Solid or subsolid with uniform attenuation
Calcification	The presence of calcium deposits within the nodule.	Absent or atypical calcification	Popcorn or central calcification patterns
Nodule Location	The anatomical position of the nodule within the lungs.	Upper lobe or near the hilum	Lower lobe or peripheral lung fields
Other Findings	Additional lung features such as fibrosis, atelectasis, or emphysema.	Presence of fibrosis, atelectasis, or emphysema with other risk factors	Presence of these findings alone without suspicious features

Risk Assessment and Management Tools

Accurate evaluation of lung nodules is essential for distinguishing between benign and malignant lesions. The **Lung Imaging Reporting and Data System (Lung-RADS)** and the **2017 Fleischner Society Guidelines** are key frameworks in this process.

- **Lung-RADS** is a standardized classification system by the American College of Radiology (ACR) for interpreting LDCT scans in lung cancer screening. It categorizes lung nodules based on features like size and shape to estimate malignancy risk and recommend follow-ups.
- **Fleischner Guidelines 2017** guidelines help determine follow-up recommendations for incidentally found pulmonary nodules based on their size, appearance, and patient risk factors. These guidelines are primarily used for individuals aged 35 and older, as they are at a higher risk for lung cancer, while younger patients typically have a lower risk of malignancy.

Both guidelines work together to improve lung nodule management, supporting early cancer detection and reduced mortality.

The chart below highlights the key differences between these two approaches.

Aspect	Lung-RADS	Fleischner Guidelines (2017)
Primary Use	Lung cancer screening in high-risk populations.	Incidental findings in any clinical setting.
Target Population	Smokers/former smokers aged 55-80 with a significant smoking history.	Broad population, including those aged 35 and older, and those without cancer screening intent.
Imaging Modality	Low-dose CT (LDCT).	Any thoracic imaging modality (CT, chest X-ray).
Risk Stratification	Focuses on high-risk patients.	Individualized risk assessment for all patients.
Reporting	Standardized categories for screening follow-up.	Detailed recommendations tailored to nodule size and type.





The following tables present standardized criteria for assessing pulmonary nodules on CT imaging, including Lung RADS for LDCT lung cancer screening and the Fleischner Society Guidelines.

Lung-RADS for interpreting LDCT scans with Nodule Size and Malignancy Risk

Lung-RADS Category	Nodule Description	Nodule Size (mm)	Malignancy Risk (%)	Management Recommendations
1	Negative	No nodules or definitely benign	<1%	Annual screening with low-dose CT in 12 months.
2	Benign Appearance/ Behavior	Solid nodule <6 mm or GGNs <30 mm	<1%	Annual screening with low-dose CT in 12 months.
3	Probably Benign	Solid nodule 6-8 mm or part-solid nodules <6 mm solid component	1-2%	Follow-up with low-dose CT in 6 months.
4A	Suspicious	Solid nodule 8-15 mm or part-solid nodule ≥6 mm solid component, or new nodule 4-6 mm	5-15%	Follow-up with low-dose CT in 3 months, PET/CT, or tissue sampling depending on the clinical scenario.
4B	Very Suspicious	Solid nodule >15 mm or new nodule >8 mm, or part-solid nodule with solid component >8 mm	>15%	Consider PET/CT or tissue sampling.
4X	Suspicious With Additional Features or Growth	Additional imaging features that increase suspicion	>15%	Consider more urgent evaluation and management with PET/CT or tissue sampling.

Fleischner Guidelines (2017) Guidelines for Solid and Subsolid Nodules:

SOLID NODULES			
Type	Size	Follow-Up Recommendations	Cancer Probability (2-4 years)
LOW RISK			
Single Nodule	<6 mm	No routine follow-up	<1%
	6-8 mm	CT after 6-12 months, then consider CT after 18-24 months	<7%
	>8 mm	Consider CT at 3 months, PET-CT, or biopsy	>40%
Multiple Nodules	<6 mm	No routine follow-up	<1%
	6-8 mm	CT after 3-6 months, then consider CT after 18-24 months	<6%
	>8 mm	CT after 3 months, PET-CT, or biopsy	<7%
HIGH RISK			
Single Nodule	<6 mm	Optionally, CT after 12 months	<7.5%
	6-8 mm	CT after 6-12 months, then after 18-24 months	>20%
	>8 mm	CT after 6-12 months, then after 18-24 months	>40%
Multiple Nodules	<6 mm	Optionally, CT after 12 months	<7%
	6-8 mm	CT after 3-6 months, then after 18-24 months	20%
	>8 mm	CT after 3-6 months, then after 18-24 months	30%





Fleischner Guidelines (2017) Guidelines for Solid and Subsolid Nodules (cont'd):

SUBSOLID NODULES			
Type	Size	Follow-Up	Cancer Probability (2–4 years)
Ground-glass	< 6mm	No Routine Follow Up	1-7%
	>= 6mm	CT at 6-12 months to confirm persistence, then CT at 3 and 5 years	20%
Part-Solid	< 6 mm	No Routine Follow Up	<10 %
	>= 6mm	CT at 3-6 months, then annually for 5 years	>30%
Multiple	< 6mm	CT at 3-6 months. If stable CT at 2 and 4 years	20%
	>= 6mm	CT at 3-6 months. Subsequent management based on most suspicious nodule	10%

Tools for Estimating Malignancy Risk

To further assist in evaluating malignancy risk, there are some reputable online calculators designed to assess the malignancy risk of solitary pulmonary nodules:

Tool	Description
Mayo Clinic Solitary Pulmonary Nodule Malignancy Risk Score	Estimates malignancy risk based on clinical and radiologic characteristics.
Brock University Lung Cancer Risk Calculator	Calculates the likelihood of lung cancer diagnosis within 2–4 years of follow-up.





Underwriting considerations:

Lung nodules pose a significant challenge in life underwriting due to their potential for malignancy, but advancements in imaging technology and standardized guidelines have improved risk assessment. Life underwriters can utilize tools such as Lung-RADS and the Fleischner Guidelines to more accurately evaluate the risk of malignancy. By combining these tools with a thorough understanding of the nodule's characteristics, the applicant's medical history, and relevant diagnostic findings, underwriters can make more informed risk assessment.



Key Considerations for Underwriting Lung Nodules:

1. Nodule Characteristics:

- Nodules >8 mm with irregular margins or in the upper lobes are concerning and may indicate a higher risk of malignancy.

2. Risk Stratification Guidelines:

- **Lung-RADS and Fleischner Guidelines:** These tools help underwriters determine if a nodule requires immediate follow-up, further diagnostic testing, or routine screening based on its size, appearance, and risk profile.

3. Applicant's History:

- **Smoking History:** A history of smoking increases the likelihood of lung cancer and other pulmonary diseases, often placing the applicant in a higher-risk category.
- **Family History of Lung Cancer:** A family history of lung cancer increases the risk of malignancy.
- **Age and Other Comorbidities:** Age, occupational exposures (e.g., asbestos), and other comorbid conditions (e.g., COPD, previous cancers) should be considered when assessing the risk.

4. Diagnostic Findings and Follow-up:

- **Follow-up Imaging:** Follow-up imaging (e.g., CT or PET scans) is essential to track changes in the nodule's size and characteristics, which can help make a more accurate risk assessment.

5. Using Risk Models:

- **Brock University and Mayo Clinic Models:** By combining these tools and considerations, life underwriters can make more informed and accurate decisions regarding applicants with lung nodules, balancing the risks of malignancy with the individual's overall health history and diagnostic findings.

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