

# **PULMONARY NODULE GUIDELINES: PURE GROUND GLASS AND PART SOLID NODULES**

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# GUIDELINES

2005: Fleischner Society Guidelines - solid noncalcified nodules detected incidentally on CT

2013: Fleischner Society Guidelines – ground glass and part solid nodules detected  
incidentally on CT

2015: LUNG-RADS: LDCT lung screening recommendations

## FLEISCHNER SOCIETY SOLID PULMONARY NODULE GUIDELINES (2005)

Nodule Size (mm)*	Low-Risk Patient†	High-Risk Patient‡
≤4	No follow-up needed§	Follow-up CT at 12 mo; if unchanged, no further follow-up
>4–6	Follow-up CT at 12 mo; if unchanged, no further follow-up	Initial follow-up CT at 6–12 mo then at 18–24 mo if no change
>6–8	Initial follow-up CT at 6–12 mo then at 18–24 mo if no change	Initial follow-up CT at 3–6 mo then at 9–12 and 24 mo if no change
>8	Follow-up CT at around 3, 9, and 24 mo, dynamic contrast-enhanced CT, PET, and/or biopsy	Same as for low-risk patient

# Fleischner Society Guidelines for Ground Glass and Subsolid Pulmonary Nodules 2013

Nodule Type	Management Recommendations	Additional Remarks
<b>Solitary pure GGNs</b>		
≤5 mm	No CT follow-up required	Obtain contiguous 1-mm-thick sections to confirm that nodule is truly a pure GGN
>5 mm	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Solitary part-solid nodules	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component <5 mm, then yearly surveillance CT for a minimum of 3 years. If persistent and solid component ≥5 mm, then biopsy or surgical resection	Consider PET/CT for part-solid nodules >10 mm
<b>Multiple subsolid nodules</b>		
Pure GGNs ≤5 mm	Obtain follow-up CT at 2 and 4 years	Consider alternate causes for multiple GGNs ≤5 mm
Pure GGNs >5 mm without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with >5 mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer

# LUNG-RADS

Lung-RADS™ Version 1.0 Assessment Categories Release date: April 28, 2014

Category	Category Descriptor	Category	Findings	Management	Probability of Malignancy	Estimated Population Prevalence
Incomplete	-	0	prior chest CT examination(s) being located for comparison part or all of lungs cannot be evaluated	Additional lung cancer screening CT image and/or comparison to prior chest CT examinations is needed	n/a	1%
Negative	No nodules and definitely benign nodules	1	no lung nodules nodules with specific calcifications: complete, central, popcorn, concentric rings and fat containing nodules	Continue annual screening with LDCT in 12 months	< 1%	90%
Benign Appearance or Behavior	Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth	2	solid nodule(s): < 6 mm new < 4 mm			
			part solid nodule(s): < 6 mm total diameter on baseline screening non solid nodule(s) (GGN): < 20 mm OR ≥ 20 mm and unchanged or slowly growing category 3 or 4 nodules unchanged for ≥ 3 months			
Probably Benign	Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer	3	solid nodule(s): ≥ 6 to < 8 mm at baseline OR new 6 mm to < 6 mm part solid nodule(s): ≥ 6 mm total diameter with solid component < 6 mm OR new < 6 mm total diameter non solid nodule(s) (GGN) ≥ 20 mm on baseline CT or new	6 month LDCT	1-2%	5%
Suspicious	Findings for which additional diagnostic testing and/or tissue sampling is recommended	4A	solid nodule(s): ≥ 8 to < 15 mm at baseline OR growing < 8 mm OR new 6 to < 8 mm part solid nodule(s): ≥ 6 mm with solid component ≥ 6 mm to < 8 mm OR with a new or growing < 4 mm solid component endobronchial nodule	3 month LDCT; PET/CT may be used when there is a ≥ 8 mm solid component	5-15%	2%
			4B			
		4X	Category 3 or 4 nodules with additional features or imaging findings that increase the suspicion of malignancy	chest CT with or without contrast, PET/CT and/or tissue sampling depending on the "probability of malignancy and comorbidities. PET/CT may be used when there is a ≥ 8 mm solid component.	> 15%	2%
Other	Clinically Significant or Potentially Clinically Significant Findings (non lung cancer)	5	modifier - may add on to category 0-4 coding	As appropriate to the specific finding	n/a	10%
Prior Lung Cancer	Modifier for patients with a prior diagnosis of lung cancer who return to screening	C	modifier - may add on to category 0-4 coding	-	-	-

#### IMPORTANT NOTES FOR USE:

- Negative screen: does not mean that an individual does not have lung cancer
- Size: nodules should be measured on lung windows and reported as the average diameter rounded to the nearest whole number; for round nodules only a single diameter measurement is necessary
- Size Thresholds: apply to nodules at first detection, and that grow and reach a higher size category
- Growth: an increase in size of > 1.5 mm
- Exam Category: each exam should be coded 0-4 based on the nodule(s) with the highest degree of suspicion
- Exam Modifiers: 5 and C modifiers may be added to the 0-4 category
- Lung Cancer Diagnosis: Once a patient is diagnosed with lung cancer, further management (including additional imaging such as PET/CT) may be performed for purposes of lung cancer staging; this is no longer screening
- Practice audit definitions: a negative screen is defined as categories 1 and 2; a positive screen is defined as categories 3 and 4
- Category 4B Management: this is predicated on the probability of malignancy based on patient evaluation, patient preference and risk of malignancy; radiologists are encouraged to use the McWilliams et al assessment tool when making recommendations
- Category 4X: nodules with additional imaging findings that increase the suspicion of lung cancer, such as spiculation, GGN that doubles in size in 1 year, enlarged lymph nodes etc
- Nodules with features of an intrapulmonary lymph node should be managed by mean diameter and the 0-4 numerical category classification
- Category 3 and 4A nodules that are unchanged on interval CT should be coded as category 2, and individuals returned to screening in 12 months
- LDCT: low dose chest CT

\*Link to McWilliams Lung Cancer Risk Calculator

Upon request from the authors at: <http://www.brooks.ca/lung-cancer-risk-calculator>

At UpToDate <http://www.upToDate.com/contents/calculator-solitary-pulmonary-nodule-malignancy-risk-brook-university-cancer-prediction-equation>

# Fleischner Society Guidelines for Ground Glass and Subsolid Pulmonary Nodules (2013)

Nodule Type	Management Recommendations	Additional Remarks
<b>Solitary pure GGNs</b>		
≤5 mm	No CT follow-up required	Obtain contiguous 1-mm-thick sections to confirm that nodule is truly a pure GGN
>5 mm	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Solitary part-solid nodules	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component <5 mm, then yearly surveillance CT for a minimum of 3 years. If persistent and solid component ≥5 mm, then biopsy or surgical resection	Consider PET/CT for part-solid nodules >10 mm
<b>Multiple subsolid nodules</b>		
Pure GGNs ≤5 mm	Obtain follow-up CT at 2 and 4 years	Consider alternate causes for multiple GGNs ≤5 mm
Pure GGNs >5 mm without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with >5 mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer

# International Association for the Study of Lung Cancer/American Thoracic Society/European Respiratory Society Classification of Lung Adenocarcinoma in Resection Specimens

## Premalignant

### Preinvasive lesions

**Atypical adenomatous hyperplasia → AAH**

**Adenocarcinoma *in situ* (≤ 3 cm formerly BAC) → AIS**

Nonmucinous

Mucinous

Mixed mucinous/nonmucinous

## Malignant lesions

**Minimally invasive adenocarcinoma (≤ 3 cm lepidic predominant tumor with ≤ 5 mm invasion) → MIA**

Nonmucinous

Mucinous

Mixed mucinous/nonmucinous

### Invasive adenocarcinoma IA

Lepidic predominant (formerly nonmucinous BAC pattern, with > 5 mm invasion)

Acinar predominant

Papillary predominant

Micropapillary predominant

Solid predominant with mucin production

### Variants of invasive adenocarcinoma

Invasive mucinous adenocarcinoma (formerly mucinous BAC)

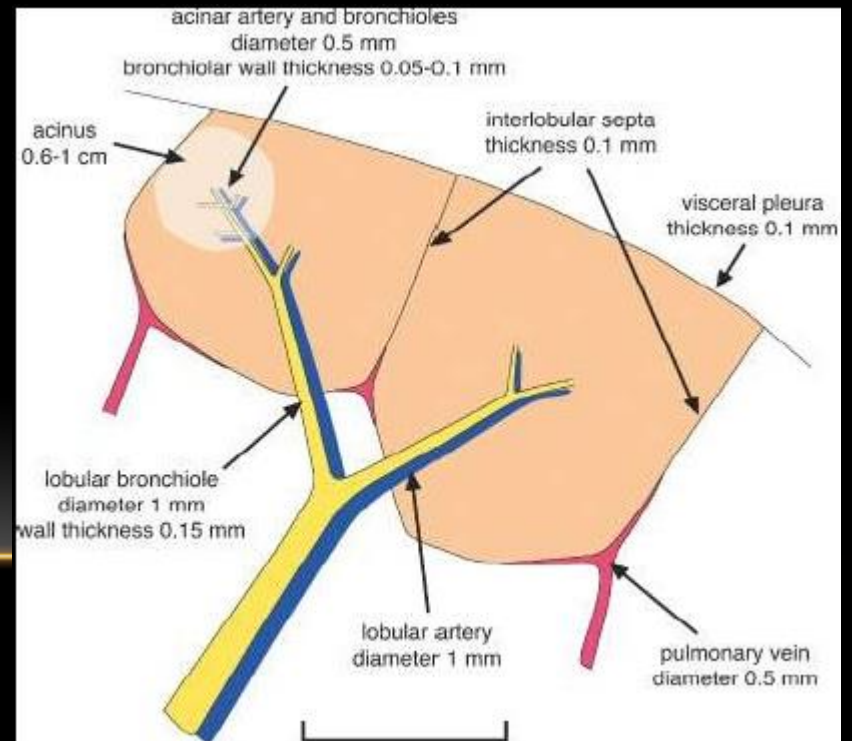
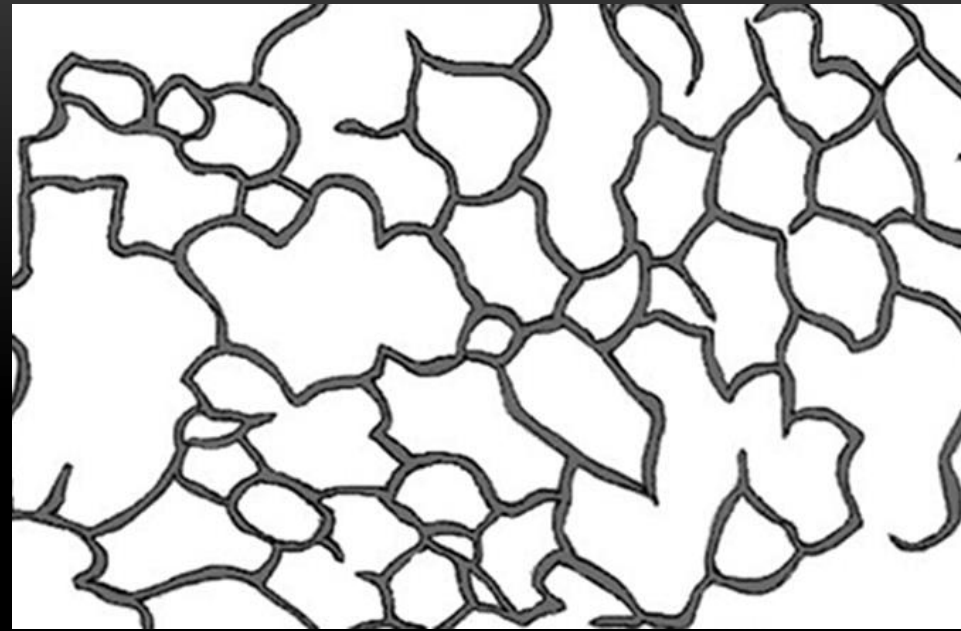
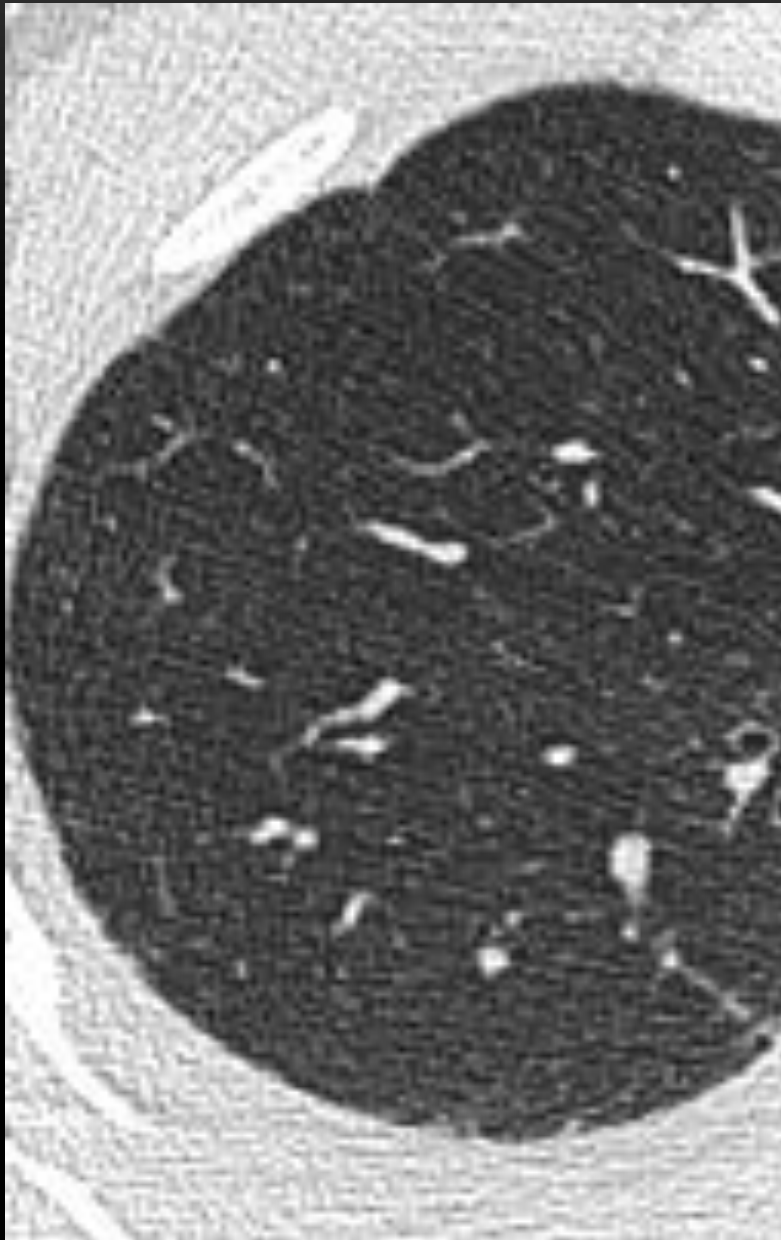
Colloid

Fetal (low and high grade)

TRAVIS WD. 2011PROC AMER THOR SOC VOL 8, 381-385.

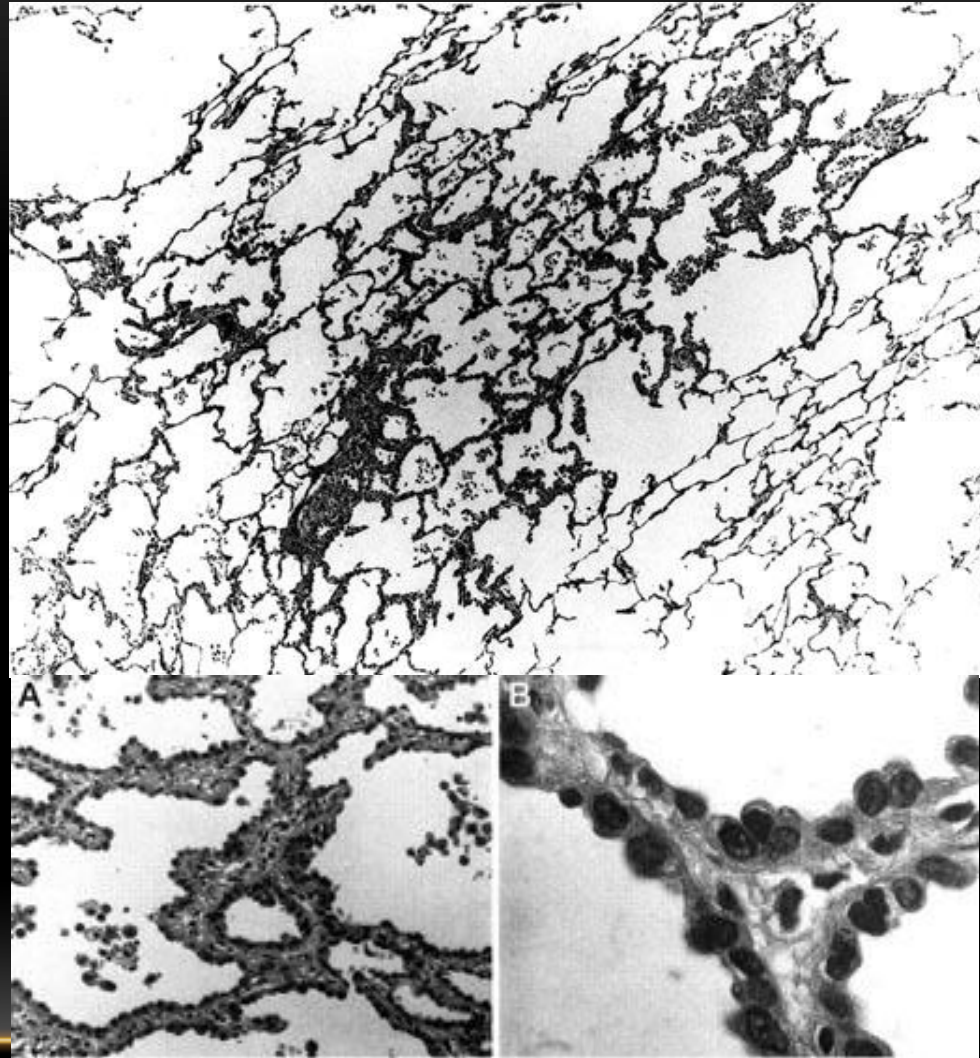
Patients with AIS or MIA who undergo complete resection should have a 100% or near 100% 5-year disease free survival, respectively. Travis WD et al. 2009. J Thorac Oncol 4(9):S86.

# Normal lung on HRCT

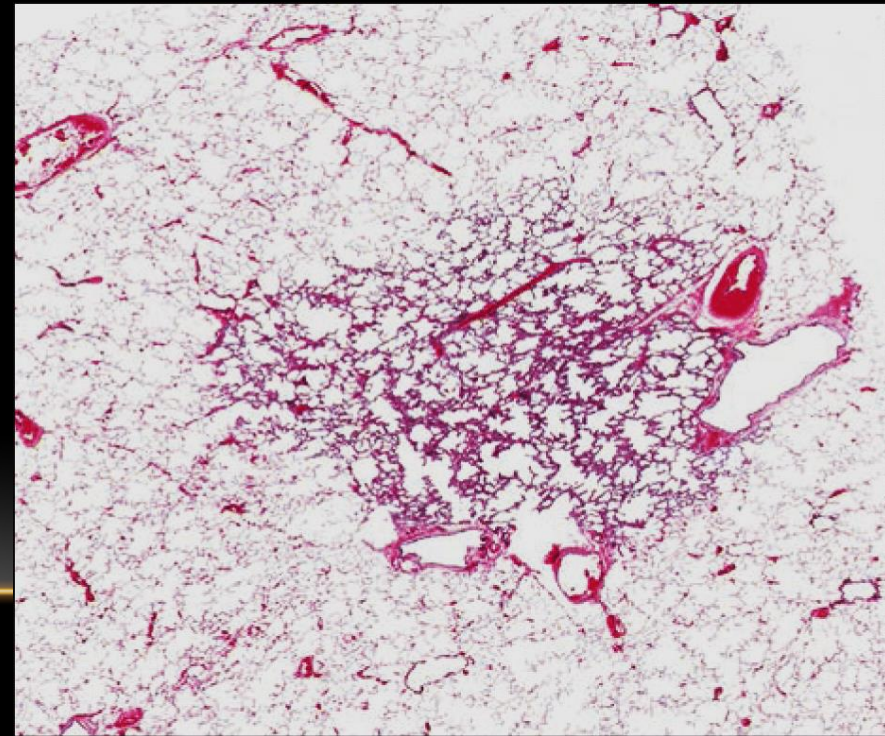
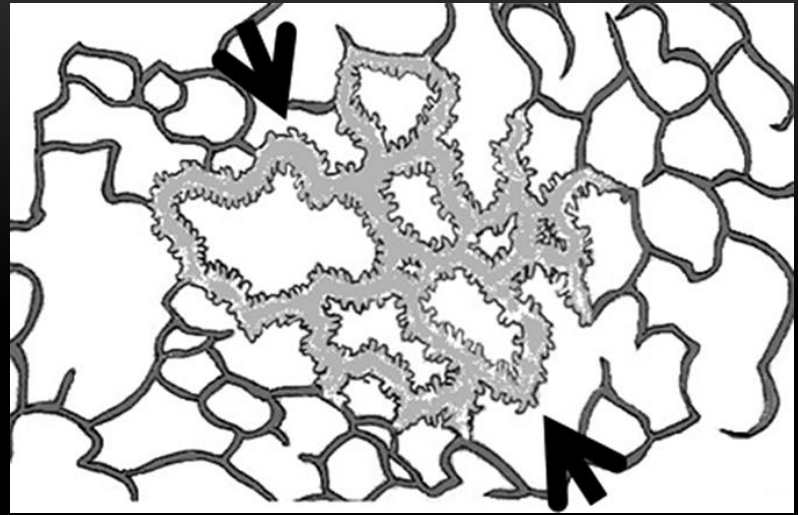
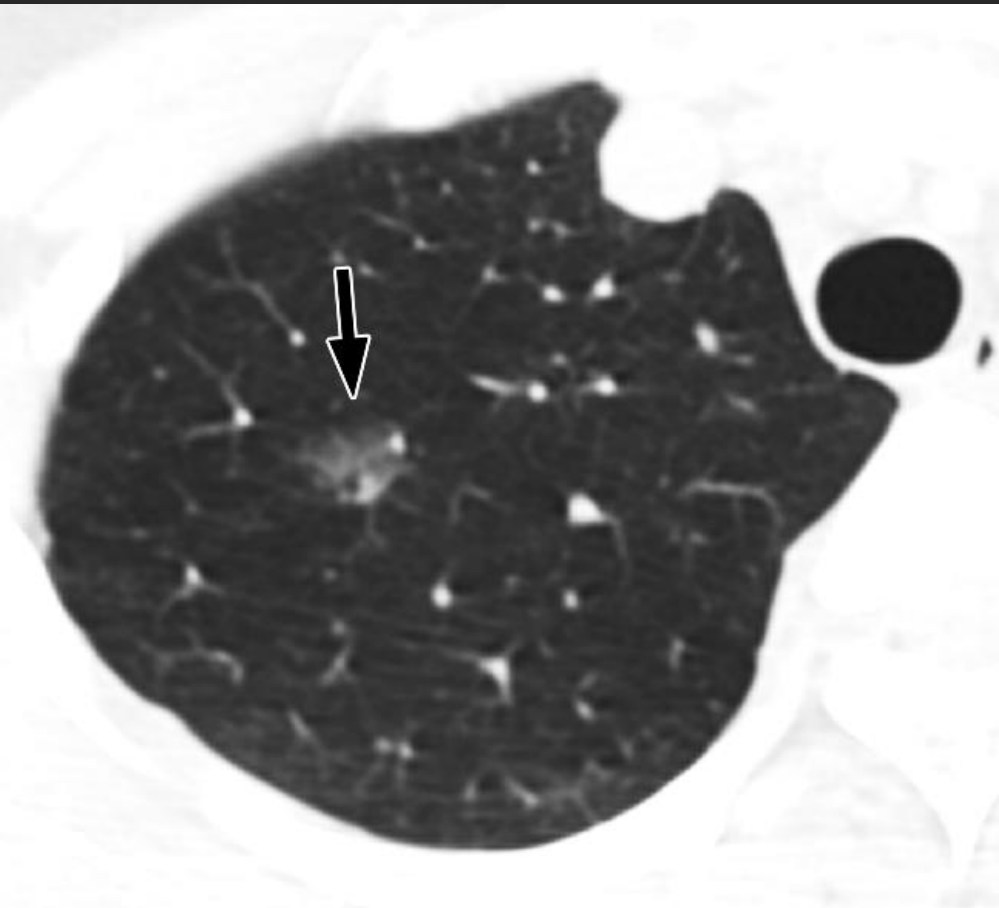




# 3.5 mm PURE GROUND GLASS NODULE ATYPICAL ADENOMATOUS HYPERPLASIA - AAH

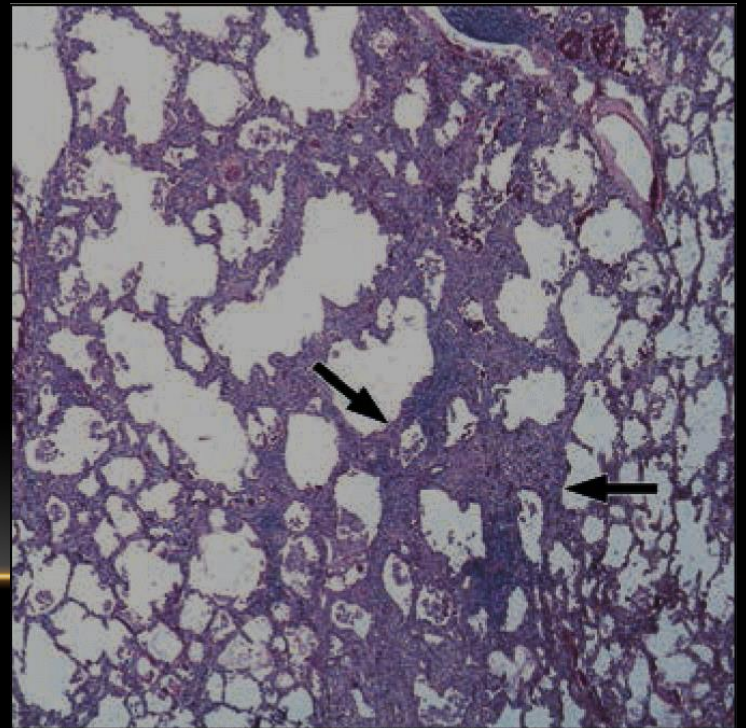
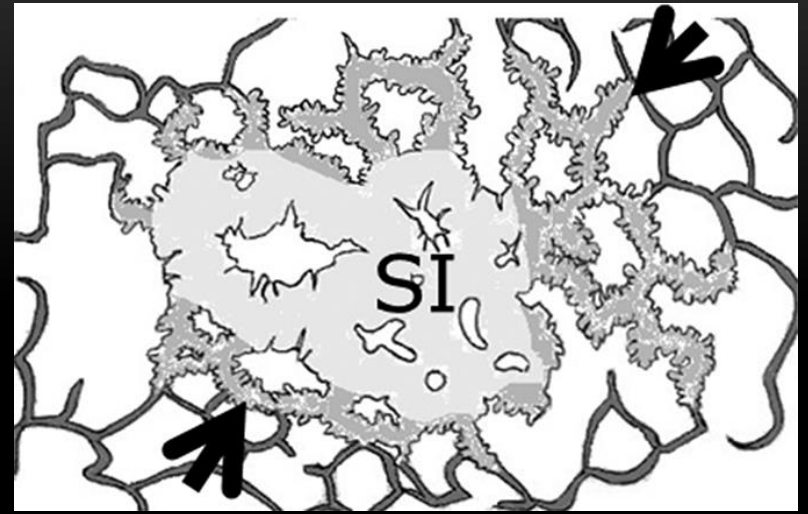
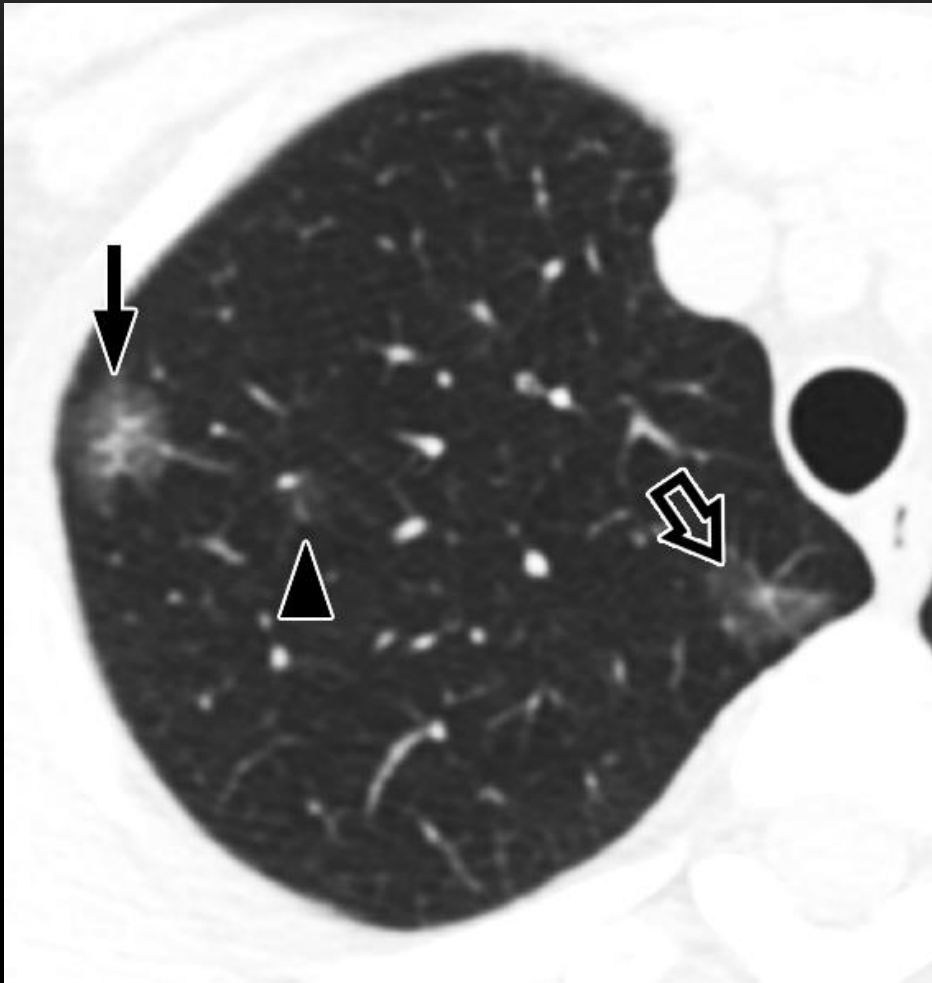


# PREMALIGNANT--ADENOCARCINOMA IN SITU (AIS)



< 3 cm  
purely lepidic growth of cells  
along the alveolar septa with  
no/minimal invasion

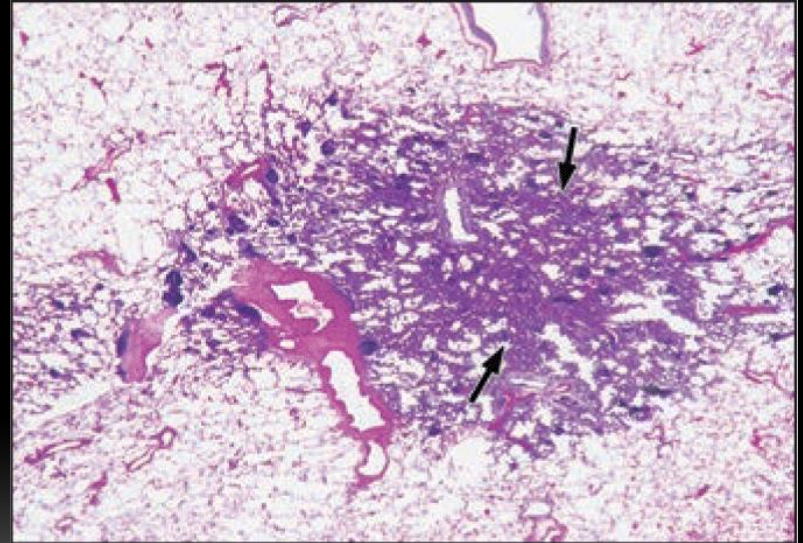
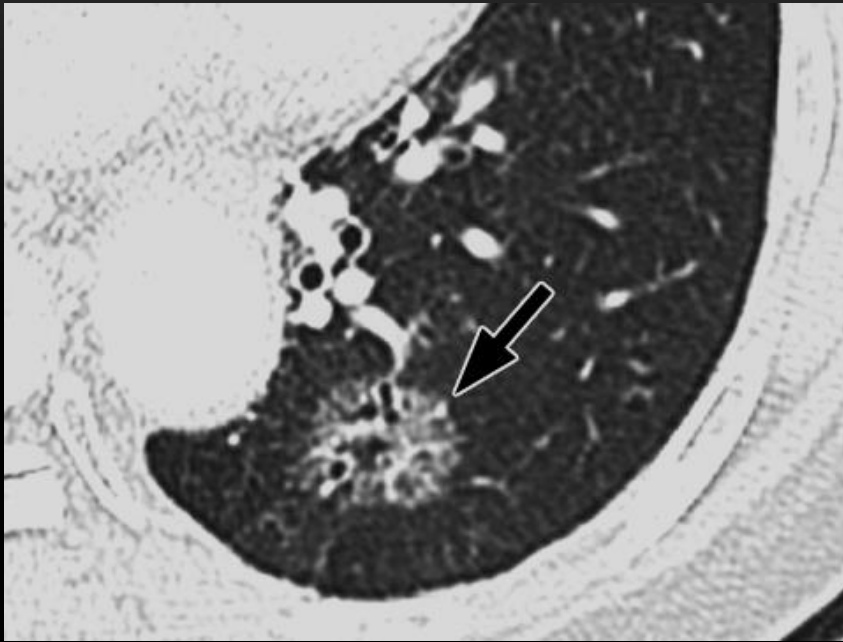
# MINIMALLY INVASIVE ADENOCARCINOMA (MIA)



Predominantly lepidic lesions  $\leq 3$  cm

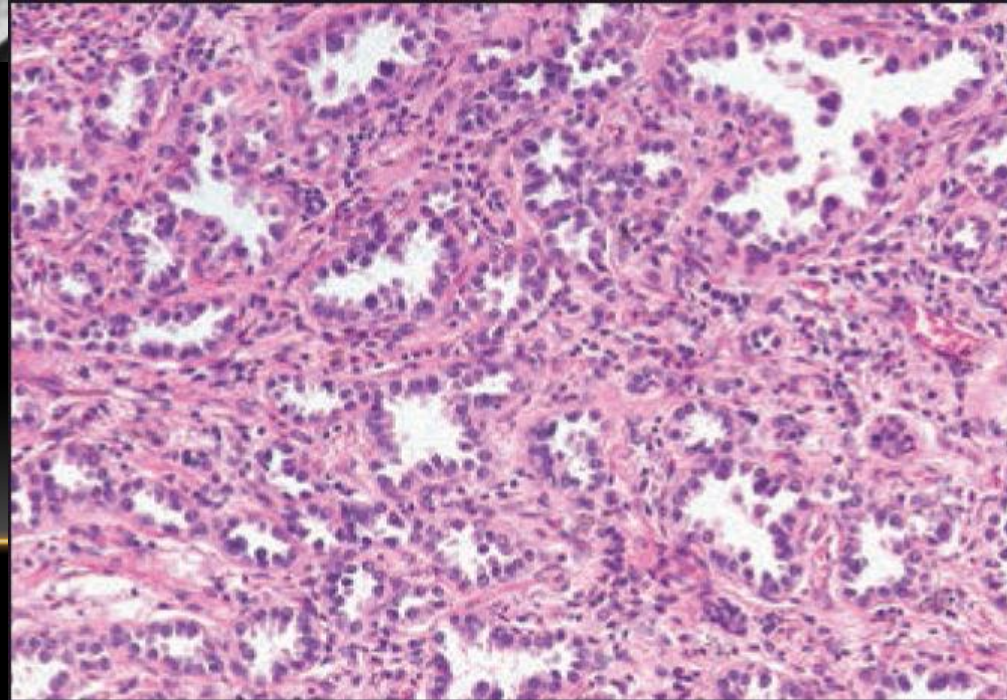
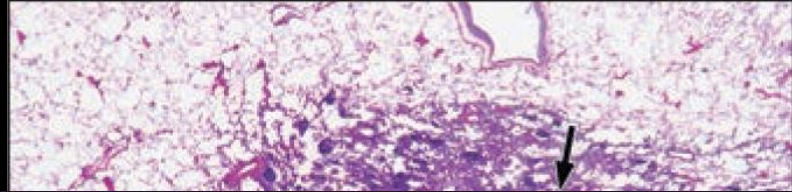
Invasive components  $\leq 5$  mm

# INVASIVE ADENOCARCINOMA (IA)

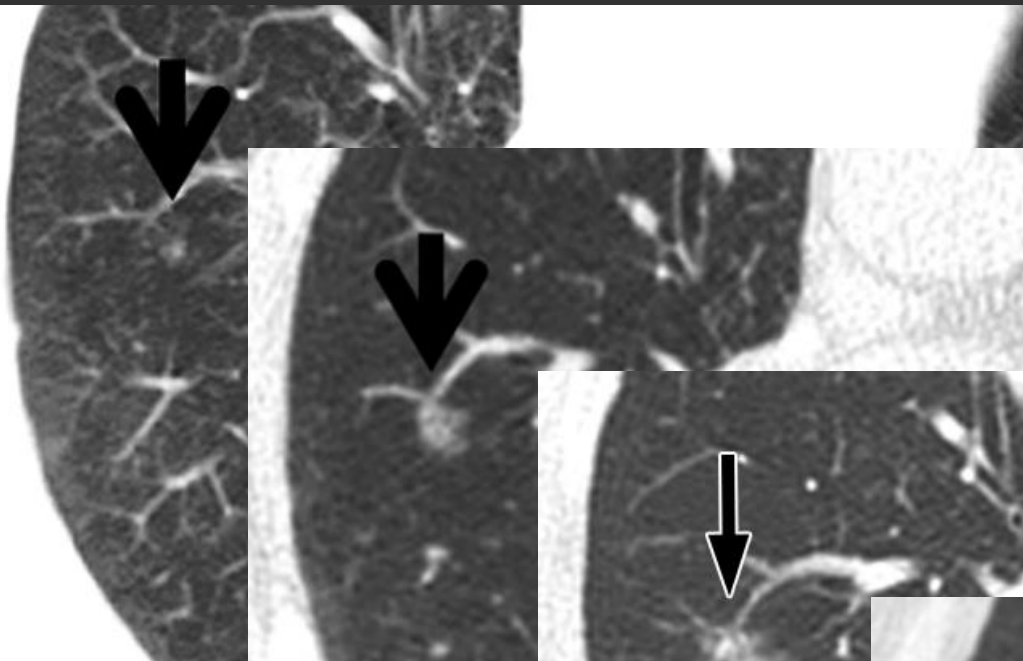


Lepidic growth and invasive components > 5 mm

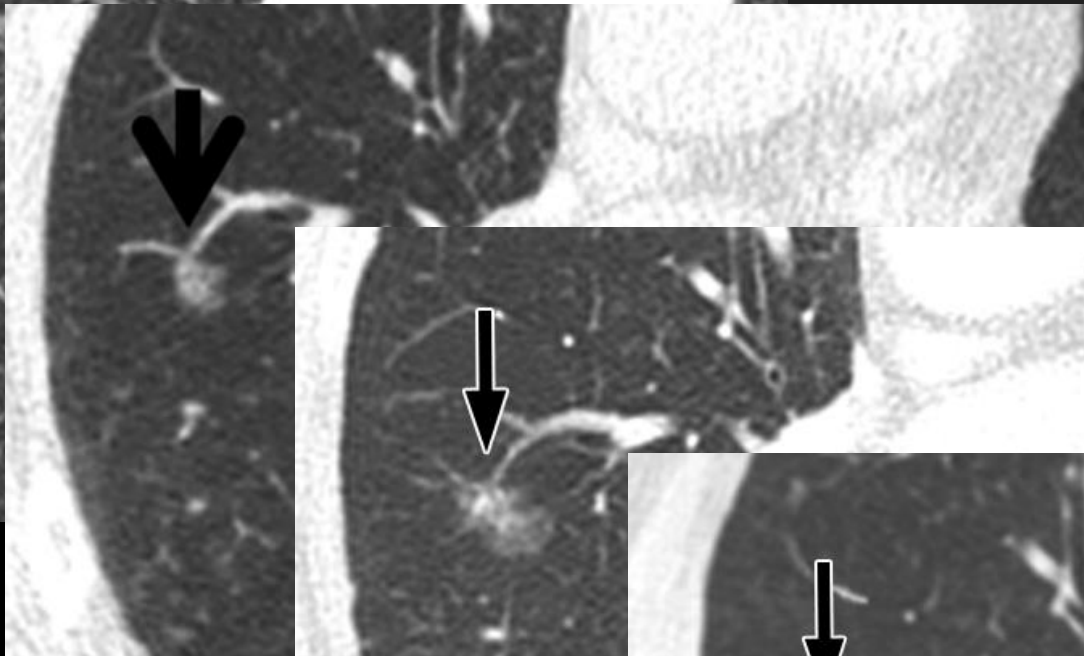
# INVASIVE ADENOCARCINOMA (IA)



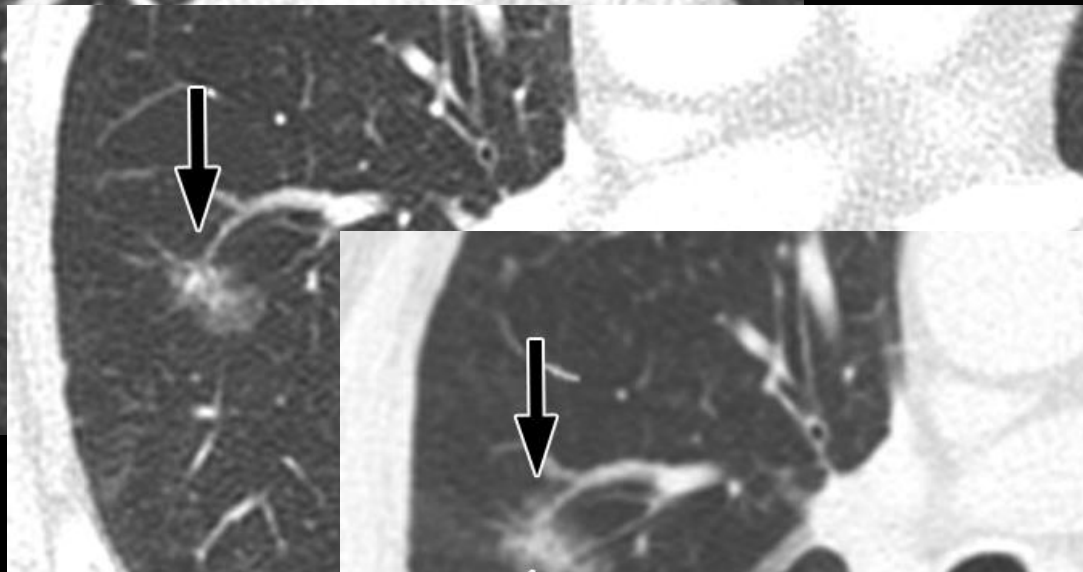
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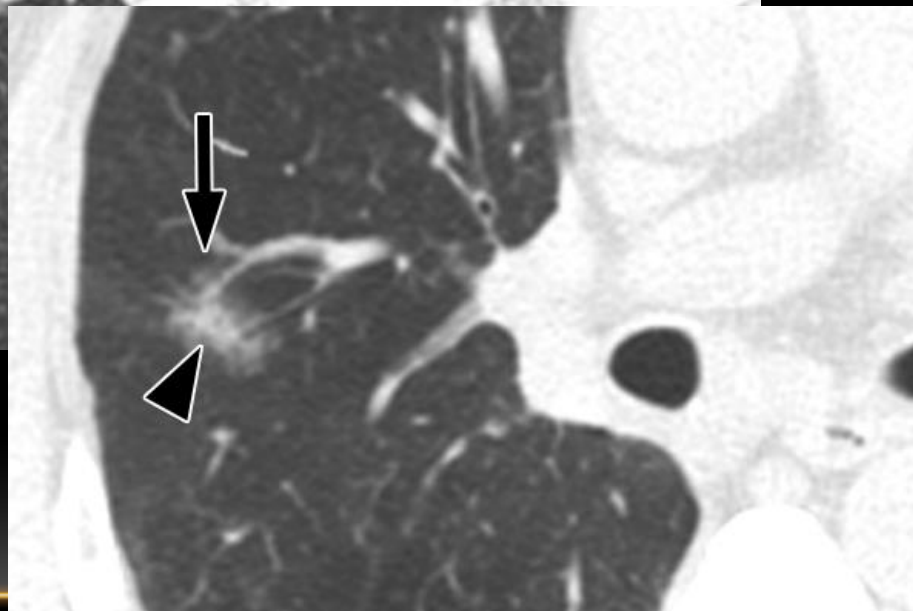
**2004**



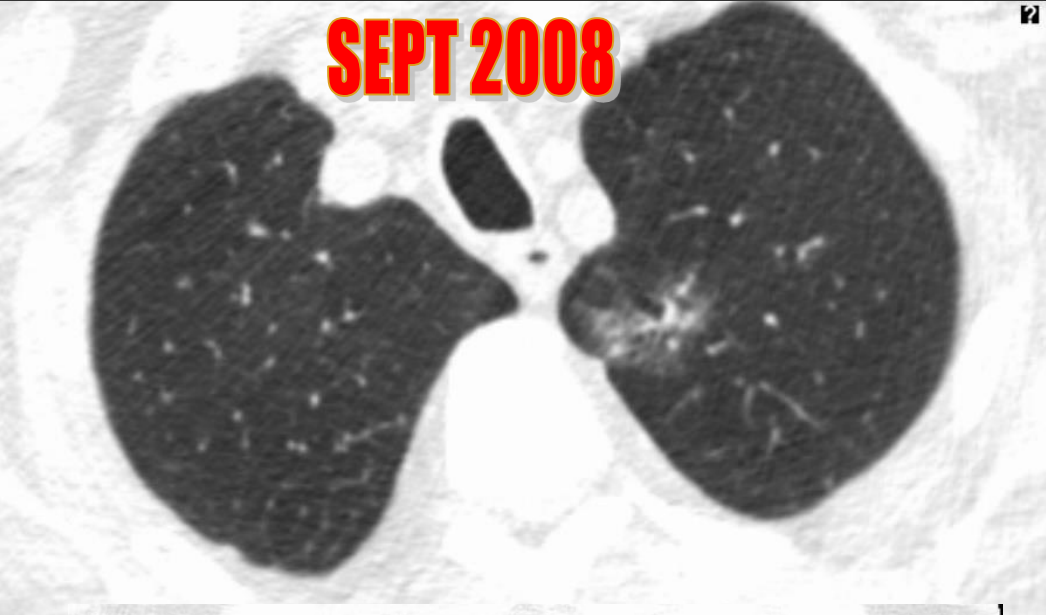
**2008**



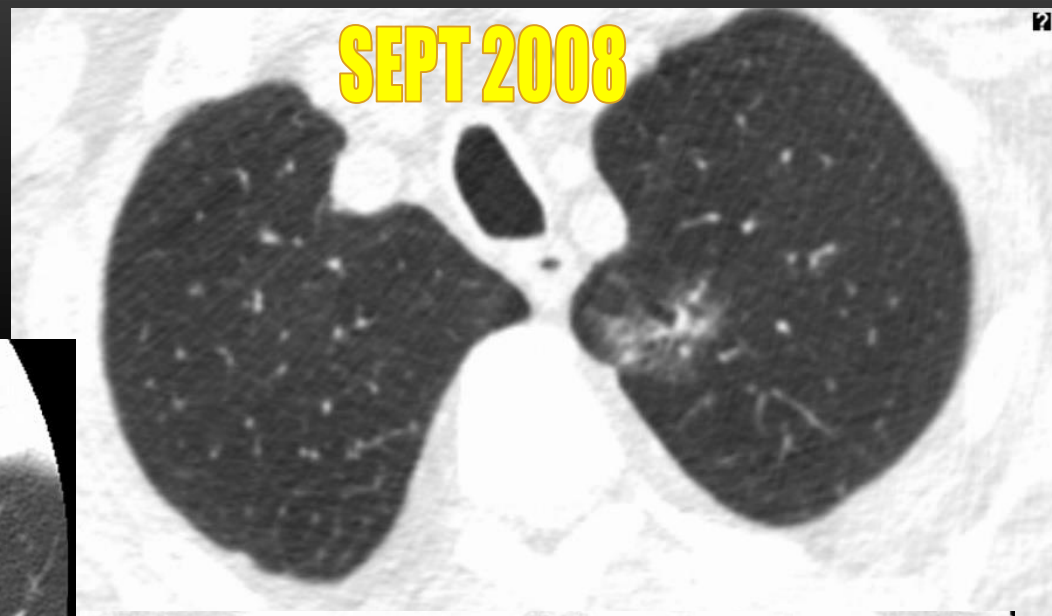
**2011**



**2013**

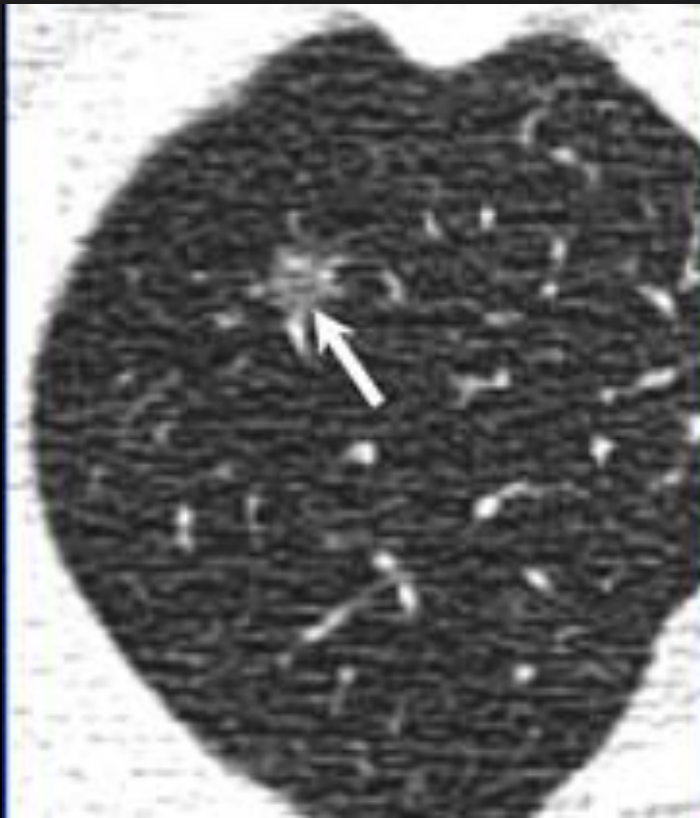


**SEPT 2008**

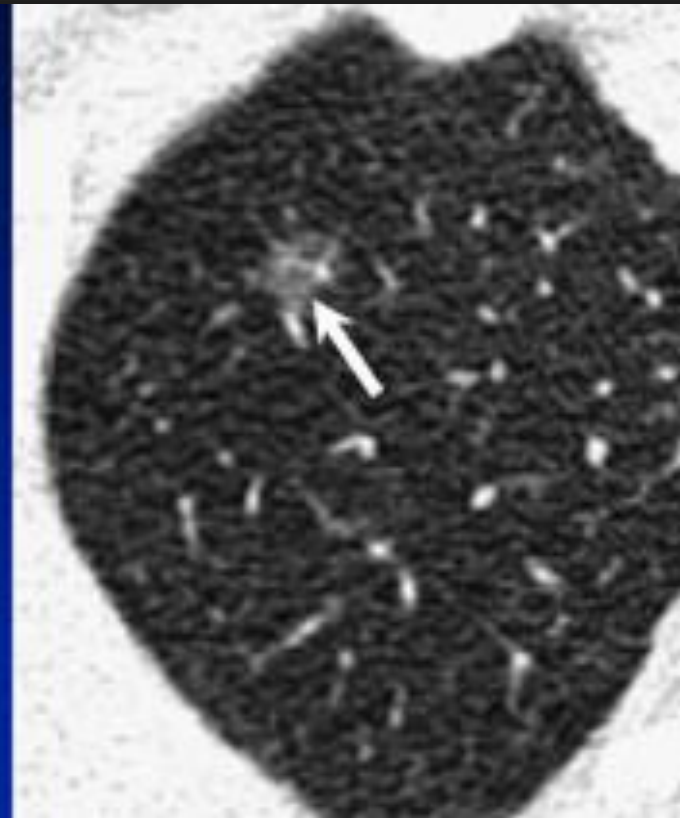




# PURE GROUND GLASS NODULE



2001



2007

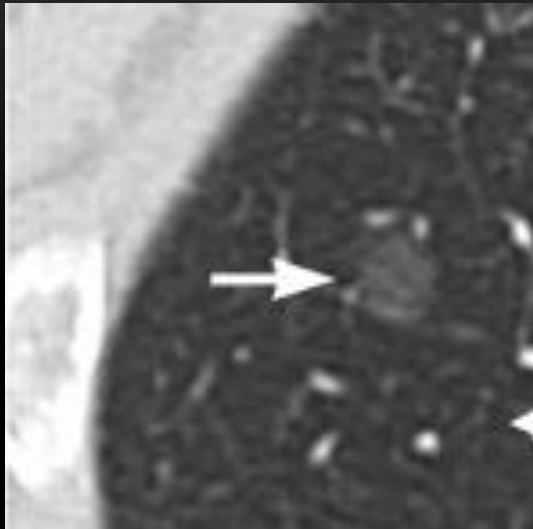
BIOPSY PROVEN FOCAL INTERSTITIAL FIBROSIS

## Key distinction from original Fleischner Society recommendation for solid incidental nodules:

Individuals with a history of smoking are not consistently differentiated from ex-smokers or from nonsmokers due to the concerns of an increasing incidence of adenocarcinoma in younger and nonsmoking individuals.

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Pure GGNs ≤5 mm	Obtain follow-up CT at 2 and 4 years	Consider alternate causes for multiple GGNs ≤5 mm
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Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with >5 mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer

# Recommendation 1: Solitary Pure Ground Glass Nodule (GGN) < 5 mm



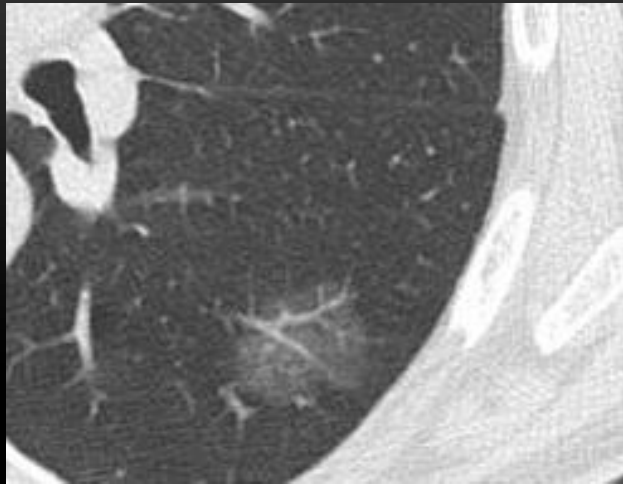
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Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with >5 mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer

## Management/Recommendation: No CT follow-up is required

- \*unknown how often AAH progresses to invasive adenocarcinoma
- \*average doubling time of pure GGN is 3 to 5 years
- \*present day measurements techniques not sensitive to detect growth year by year
- \*inconclusive studies, healthcare cost and radiation exposure
- \*must evaluate pure ground glass nodule(s) on 1 mm thick slices (not to miss small subsolid component)

Grade 1C: Strong Recommendation, Low or Very Low Quality Evidence

# Recommendation 2: Solitary Pure Ground Glass Nodule (GGN) > 5 mm



Nodule Type	Management Recommendations	Additional Remarks
<b>Solitary pure GGNs</b>		
≤5 mm	No CT follow-up required	Obtain contiguous 1-mm-thick sections to confirm that nodule is truly a pure GGN
>5 mm	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
<b>Solitary part-solid nodules</b>		
	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component <5 mm, then yearly surveillance CT for a minimum of 3 years. If persistent and solid component ≥5 mm, then biopsy or surgical resection	Consider PET/CT for part-solid nodules >10 mm
<b>Multiple subsolid nodules</b>		
Pure GGNs ≤5 mm	Obtain follow-up CT at 2 and 4 years	Consider alternate causes for multiple GGNs ≤5 mm
Pure GGNs >5 mm without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with >5 mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer

## Management/Recommendation:

Initial CT follow-up in 3 months to document resolution → infectious/inflammatory etiology; alleviates patient uncertainty and anxiety

If lesion persists, follow-up annually for a minimum of 3 years if persistent and unchanged.

No imaging test to differentiate neoplasm from benign lesion

Few reports suggest VATS wedge resection for pure GGN ≥ 8 mm

Persistent pure GGN: 20% benign and 80% premalignant/malignant (AAH, MIA, AIS)

Close interval follow-up to detect subtle internal lesion changes to avoid unnecessary surgery and over-diagnosis

Factors that predispose to interval growth:

1. pure GGN > 10 mm
2. history of lung cancer

**DO NOT EVALUATE WITH CT-PET!!!**

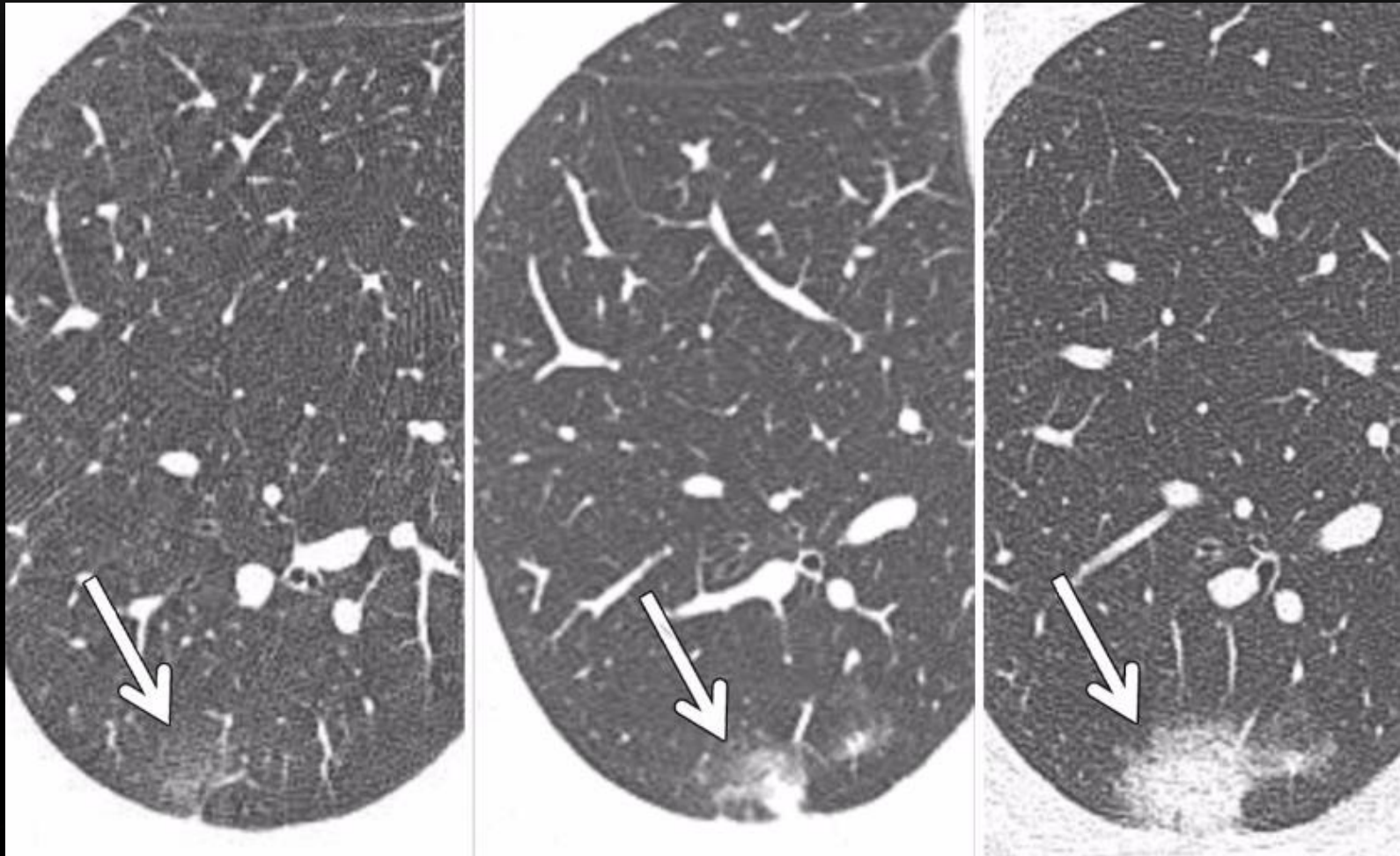
CT-guided transthoracic needle biopsy has overall low yield ~50 to 65%; worse in pure GGN (35%) than subsolid nodules

**\*\*Delay in surgical resection of slow growing pure GGNs does not affect subsequent staging.**

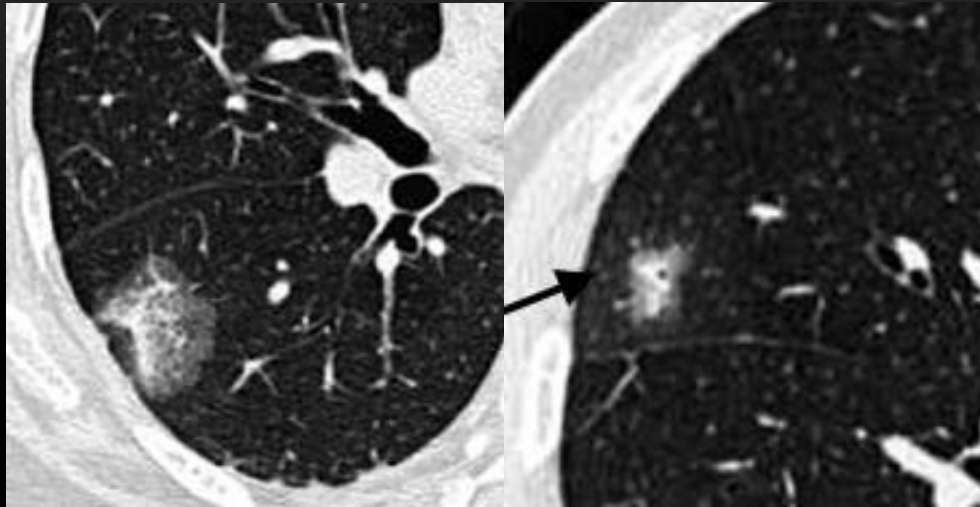
**\*\*Delay in surgical resection of slow growing part-solid nodule does not affect patient outcomes (after evidence of growth and/or increased attenuation).**

**Grade 1B: Strong Recommendation, Moderate Quality Evidence**

# PROGRESSION/ENLARGEMENT OF A GGN TO PART-SOLID TO NEAR SOLID INVASIVE ADENOCARCINOMA



## Recommendation 3: solitary part solid nodule



Nodule Type	Management Recommendations
Solitary pure GGNs	
≤5 mm	No CT follow-up required
>5 mm	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years
Solitary part-solid nodules	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component <5 mm, then yearly surveillance CT for a minimum of 3 years. If persistent and solid component ≥5 mm, then biopsy or surgical resection
Multiple subsolid nodules	
Pure GGNs ≤5 mm	Obtain follow-up CT at 2 and 4 years
Pure GGNs >5 mm without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with >5 mm solid component

**Recommendation:** initial follow up CT in 3 months to document persistence.

If lesion persists,

1. and solid component is < 5 mm → yearly HRCT follow-up for at least 3 years
  - \* some have chosen to resect these MIA with nearly 100% survival
2. and solid component is > 5 mm (consider malignant) → biopsy or surgical resection
  - \* consider CT PET if lesion is 8 - 10 mm to assess prognosis and preoperative staging – **DISAGREEMENT**
  - \* transthoracic CT biopsy only if surgery will not be considered; radiation and/or chemotherapy

\*With solid component > 5 mm → consider malignant until proven otherwise provided either growth or no change at 3 month follow up.

**Grade 1B: Strong Recommendation, Moderate Quality Evidence**

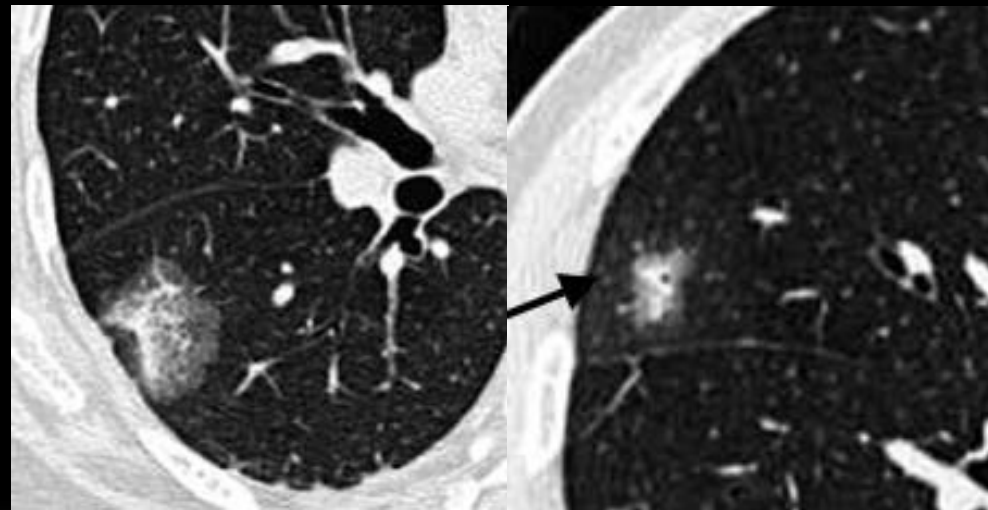
## Recommendation 3: solitary part solid nodule

\*With solid component  $> 5$  mm  $\rightarrow$  consider malignant until proven otherwise provided either growth or no change at 3 month follow up.

\*Malignancy rate for part solid nodules: 63%

\*Malignancy rate for pure GGN; 18%

Nodule Type	Management Recommendations	Additional Remarks
<b>Solitary pure GGNs</b>		
$\leq 5$ mm	No CT follow-up required	Obtain contiguous 1-mm-thick sections to confirm that nodule is truly a pure GGN
$> 5$ mm	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
<b>Solitary part-solid nodules</b>		
	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component $< 5$ mm, then yearly surveillance CT for a minimum of 3 years. If persistent and solid component $\geq 5$ mm, then biopsy or surgical resection	Consider PET/CT for part-solid nodules $> 10$ mm
<b>Multiple subsolid nodules</b>		
Pure GGNs $\leq 5$ mm	Obtain follow-up CT at 2 and 4 years	Consider alternate causes for multiple GGNs $\leq 5$ mm
Pure GGNs $> 5$ mm without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with $> 5$ mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer



# PART SOLID NODULE MEASUREMENTS

- Average size of the whole part-solid nodule containing the ground glass and solid components on lung windows

Overall part-solid nodule size=longest dimension X shortest dimension

2

Solid component=longest dimension of solid component on an axial image (mediastinal windows)

The greater the extent/size of the solid invasive component of a part-solid lesion:

\*more likely the lesion will be invasive

\*more predictive of the decreased survival/poorer prognosis than the total tumor size in adenocarcinomas with lepidic features

(Tsutani Y et al. 2012. J Thorac Cardiovasc Surg 143: 607-612.)

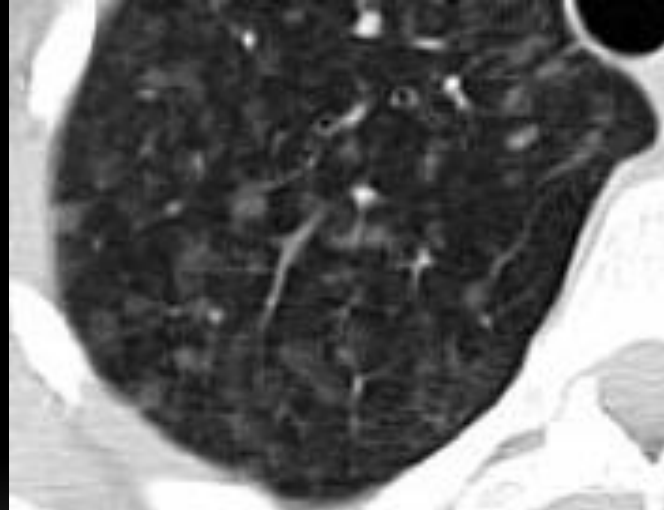
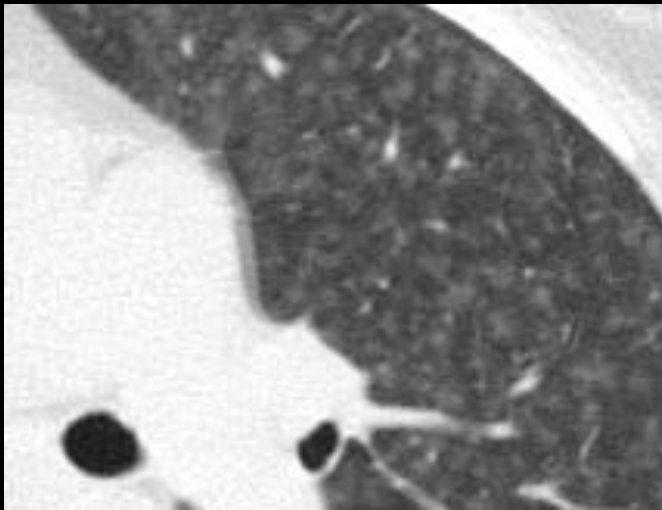


## Recommendation 4: multiple ground glass nodules (GGNs) ( $\leq 5\text{mm}$ )

Conservative management:

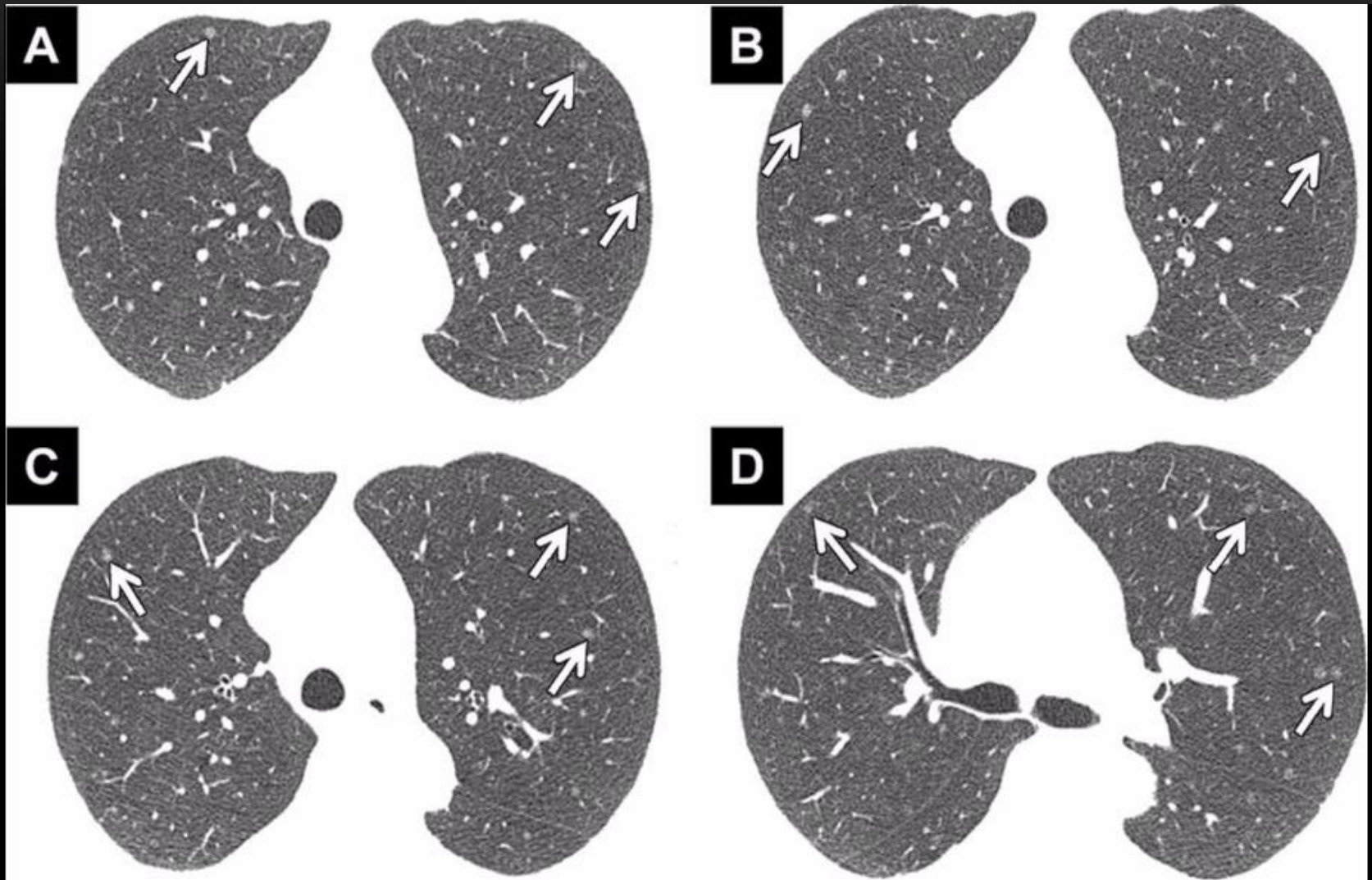
- 1. HRCT in 2 and 4 years - **Disagree**
  - 3. Bronchoscopy/VATS wedge resection
  - 4. No CT-PET
- Consider:
- 1. respiratory bronchiolitis in a smoker
  - 2. subacute hypersensitivity pneumonitis if exposure history

Nodule Type	Management Recommendations	Additional Remarks
<b>Solitary pure GGNs</b>		
$\leq 5\text{ mm}$	No CT follow-up required	Obtain contiguous 1-mm-thick sections to confirm that nodule is truly a pure GGN
$> 5\text{ mm}$	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
<b>Solitary part-solid nodules</b>		
	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component $< 5\text{ mm}$ , then yearly surveillance CT for a minimum of 3 years. If persistent and solid component $\geq 5\text{ mm}$ , then biopsy or surgical resection	Consider PET/CT for part-solid nodules $> 10\text{ mm}$
<b>Multiple subsolid nodules</b>		
Pure GGNs $\leq 5\text{ mm}$	Obtain follow-up CT at 2 and 4 years	Consider alternate causes for multiple GGNs $\leq 5\text{ mm}$
Pure GGNs $> 5\text{ mm}$ without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with $> 5\text{ mm}$ solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer



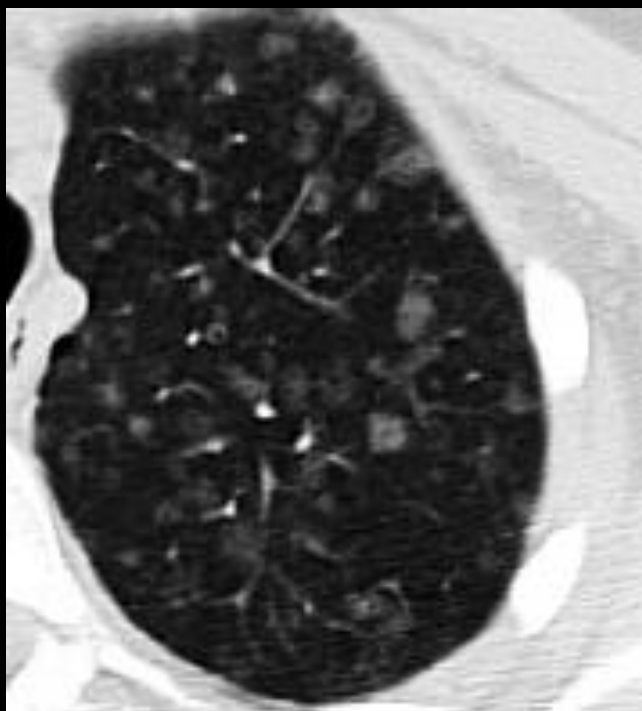
Grade 1C: Strong Evidence, Low or Very Low Quality Evidence

# MULTIPLE GGNs LESS THAN 5 MM



# Recommendation 5: multiple pure ground glass nodules (GGNs $\leq 5$ mm) with at least one GGN larger than 5 mm without dominant lesion

1. Repeat HRCT in 3 months
2. If lesions persist, annual HRCT for at least 3 years
3. Use consistent HRCT technique and measurement technique
4. No role for CT-PET
5. No role for transbronchial biopsy



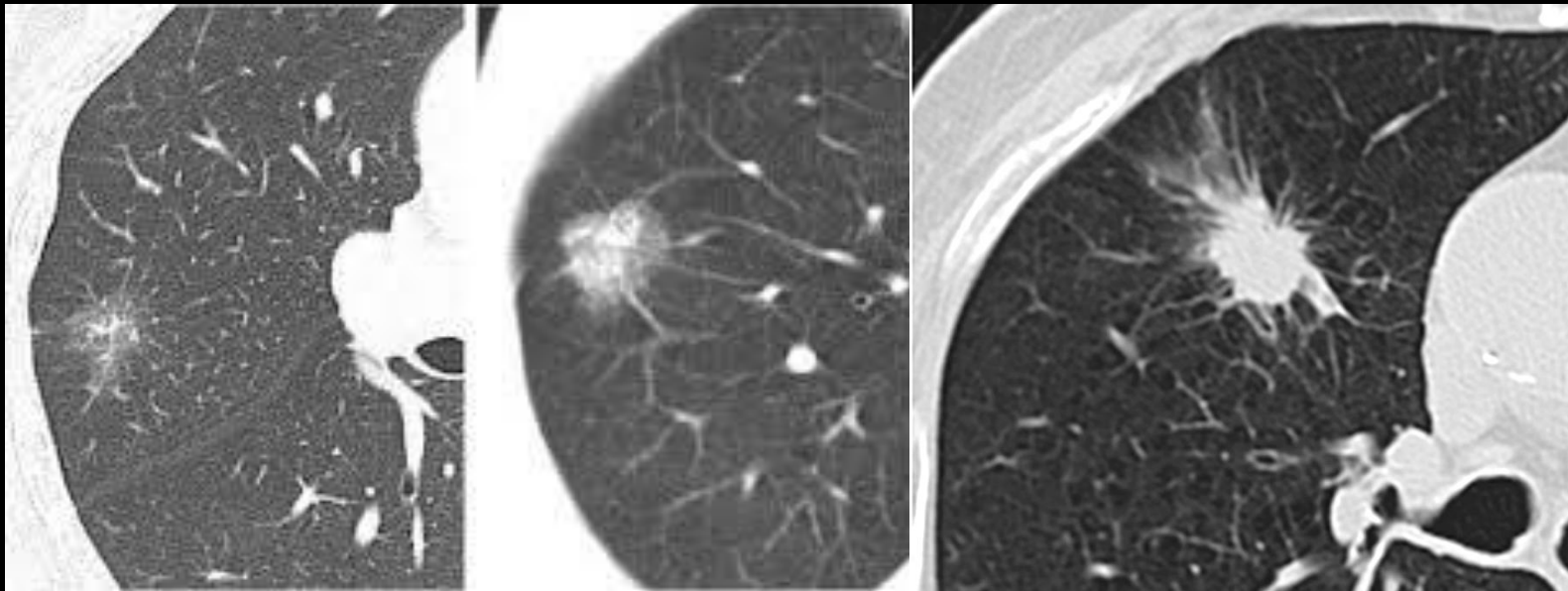
Nodule Type	Management Recommendations	Additional Remarks
<b>Solitary pure GGNs</b>		
$\leq 5$ mm	No CT follow-up required	Obtain contiguous 1-mm-thick sections to confirm that nodule is truly a pure GGN
$> 5$ mm	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
<b>Solitary part-solid nodules</b>		
	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component $< 5$ mm, then yearly surveillance CT for a minimum of 3 years. If persistent and solid component $\geq 5$ mm, then biopsy or surgical resection	Consider PET/CT for part-solid nodules $> 10$ mm
<b>Multiple subsolid nodules</b>		
Pure GGNs $\leq 5$ mm	Obtain follow-up CT at 2 and 4 years	Consider alternate causes for multiple GGNs $\leq 5$ mm
Pure GGNs $> 5$ mm without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with $> 5$ mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer

Grade 1B: Strong Recommendation, Moderate Quality Evidence

# Recommendation 6: multiple part solid nodules with a dominant nodule(s)

1. Repeat HRCT in 3 months to confirm persistence
2. Aggressive approach:  
VATS wedge resection(s) of dominant nodule(s)
3. Continue annual HRCT surveillance for at least 3 years

Nodule Type	Management Recommendations	Additional Remarks
Solitary pure GGNs	≤5 mm	No CT follow-up required Obtain contiguous 1-mm-thick sections to confirm that nodule is truly a pure GGN
	>5 mm	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years FDG PET is of limited value, potentially misleading, and therefore not recommended
Solitary part-solid nodules	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component <5 mm, then yearly surveillance CT for a minimum of 3 years. If persistent and solid component ≥5 mm, then biopsy or surgical resection	Consider PET/CT for part-solid nodules >10 mm
Multiple subsolid nodules	Pure GGNs ≤5 mm	Obtain follow-up CT at 2 and 4 years Consider alternate causes for multiple GGNs ≤5 mm
	Pure GGNs >5 mm without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years FDG PET is of limited value, potentially misleading, and therefore not recommended
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with >5 mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer



Grade 1C: Strong Recommendation, Low or Very Low Quality Evidence

# ONGOING ISSUE

How often does AAH or AIS progress into invasive carcinoma?

75% pure GGNs increased in size (over a mean of 450 days)

17% pure GGNs developed a solid component

23% subsolid nodules had an increasing solid component

# Key Distinction from Fleischner Solid Nodule Guidelines

- Individuals with a history of smoking are not consistently differentiated from ex-smokers or those who have never smoked due to concerns of increasing incidence of adenocarcinoma in younger and nonsmoking individuals.
- No distinction made for family history of lung cancer or exposure to potentially carcinogenic agents.

# REFERENCES

Naidich DP et al. 2013. Recommendations of the Management of Subsolid Pulmonary Nodules Detected at CT: A Statement from the Fleischner Society. Radiol 266: 304.

Lee HY et al. 2014. Pure Ground-Glass Opacity Neoplastic Lung Nodules: Histopathology, Imaging and Management. AJR 202: 224.

# BONUS: LUNG-RADS (2015)

BASED ON THE NLST RESULTS AND OTHER STUDIES:

1. THE NATIONAL COMPREHENSIVE CANCER NETWORK
2. AMERICAN LUNG ASSOCIATION
3. AMERICAN ASSOCIATION FOR THORACIC SURGERY
4. AMERICAN SOCIETY FOR CLINICAL ONCOLOGISTS
5. AMERICAN COLLEGE OF CHEST PHYSICIANS
6. AMERICAN THORACIC SOCIETY
7. AMERICAN CANCER SOCIETY

ALL NOW RECOMMEND THAT INDIVIDUALS AT HIGH RISK FOR DEVELOPING LUNG CANCER CONSIDER ANNUAL SCREENING WITH LDCT.

- NLST - determine whether screening chest CT exams could reduce death rates from lung cancer among those at high risk for the disease.
- 53,000 men and women aged 55 to 74 who were current or former heavy smokers at 33 sites across the United States
- Each participant was randomly assigned to receive screenings with either low dose CT (LDCT) or standard chest x-ray once per year for three consecutive years
- Trial demonstrated **20 percent fewer lung cancer deaths among the trial participants screened with LDCT.**



# LUNG-RADS

Lung-RADS™ Version 1.0 Assessment Categories Release date: April 28, 2014

Category	Category Descriptor	Category	Findings	Management	Probability of Malignancy	Estimated Population Prevalence
Incomplete	-	0	prior chest CT examination(s) being located for comparison part or all of lungs cannot be evaluated	Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed	n/a	1%
Negative	No nodules and definitely benign nodules	1	no lung nodules nodule(s) with specific calcifications: complete, central, popcorn, concentric rings and fat containing nodules	Continue annual screening with LDCT in 12 months	< 1%	90%
Benign Appearance or Behavior	Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth	2	solid nodule(s): < 6 mm new < 4 mm			
			part solid nodule(s): < 6 mm total diameter on baseline screening non solid nodule(s) (GGN): < 20 mm OR ≥ 20 mm and unchanged or slowly growing category 3 or 4 nodules unchanged for ≥ 3 months			
Probably Benign	Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer	3	solid nodule(s): ≥ 6 to < 8 mm at baseline OR new 4 mm to < 6 mm part solid nodule(s) ≥ 6 mm total diameter with solid component < 6 mm OR new < 6 mm total diameter non solid nodule(s) (GGN) ≥ 20 mm on baseline CT or new	6 month LDCT	1-2%	5%
Suspicious	Findings for which additional diagnostic testing and/or tissue sampling is recommended	4A	solid nodule(s): ≥ 8 to < 15 mm at baseline OR growing < 8 mm OR new 6 to < 8 mm part solid nodule(s): ≥ 6 mm with solid component ≥ 6 mm to < 8 mm OR with a new or growing < 4 mm solid component endobronchial nodule	3 month LDCT; PET/CT may be used when there is a ≥ 8 mm solid component	5-15%	2%
			4B			
		4X	Category 3 or 4 nodules with additional features or imaging findings that increase the suspicion of malignancy			
Other	Clinically Significant or Potentially Clinically Significant Findings (see lung cancer)	5	modifier - may add on to category 0-4 coding	As appropriate to the specific finding	n/a	10%
Prior Lung Cancer	Modifier for patients with a prior diagnosis of lung cancer who return to screening	C	modifier - may add on to category 0-4 coding	-	-	-

# U.S. PREVENTIVE SERVICES TASK FORCE (USPSTF)

- The USPSTF recommends annual screening for lung cancer with low-dose computed tomography (LDCT)
  1. 55 to 80 years old
  2. 30 pack-year smoking history
  3. Currently smoking or a former smoker who quit within the past 15 years.

Individuals who are at least 50 years old and have at least a 20 pack-year history of smoking as well as one other risk factor (except contact with secondhand smoke) are also considered to be at high risk by the NCCN and may also benefit from lung cancer screening with LDCT.

Screening should be discontinued once a person has not smoked for 15 years or develops a health problem that substantially limits life expectancy or the ability or willingness to have curative lung surgery.

Grade: B