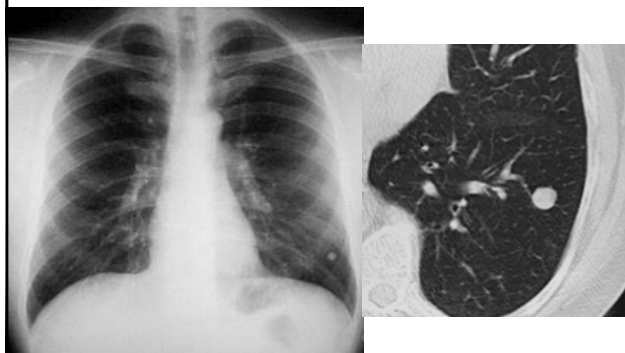


## The Lung Nodule

**Shaheen Islam, MD, MPH**  
Associate Professor  
Director, Interventional Pulmonology  
Division of Pulmonary, Allergy, Critical  
Care & Sleep Medicine  
Division of Medical Oncology  
The Ohio State University Wexner Medical Center

## The SPN



## Peripheral Lung Nodule

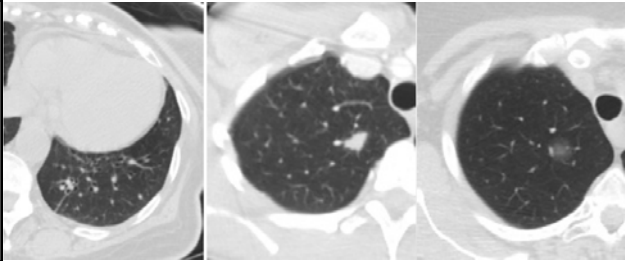
- Small focal, round or oval opacity, may be solitary or multiple surrounded by parenchyma
- May be solid, part solid or non-solid
- Less than 3 cm in maximum diameter, >3 cm are Lung Masses
- Not associated with atelectasis, pneumonia

## Prevalence

- Prevalence of SPNs in screening trials of populations at high risk for lung neoplasm:
  - 8-51%
- Prevalence of malignancy in patients with SPNs:
  - 1.1-12% in screening trials
  - 46 - 82% in PET trials

Wahidi MM, CHEST 2007;132:94s

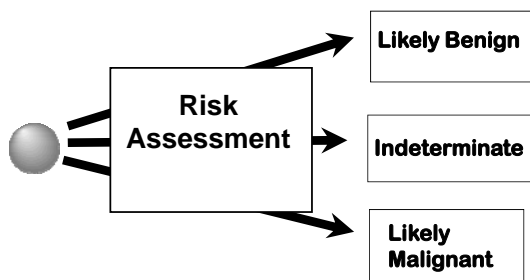
## Types of Nodules



## Why Worry?

- Malignant SPN may be potentially curable
  - Stage A survival: >60% at 5 years
- Diagnosis of a benign nodule may involve unnecessary procedure and surgery with resultant morbidities

## SPN



## Risk Assessment

- Clinical history
- Comparison with older films
- Morphology on CT
- Calculate Pre test probability
- Imaging: PET scan, Enhanced CT
- Diagnostic procedure: Bronchoscopy, TTNA

## SPN

- Determine nodule growth
  - Obtain old films and compare sizes
- When an indeterminate SPN is seen on CXR a follow up Chest CT should be performed

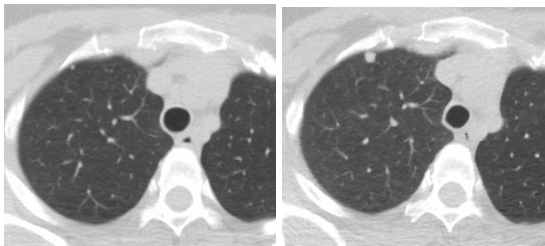
Gould MK. CHEST 2007;132:108s

## Growth Rate in Malignancy

- Volume doubling time (VDT):
  - Diameter increases by 26% with doubling of volume
- Average VDT for malignant nodules: 20-300 days
- VDT for malignant SPN usually 300 days, 2-year radiographic stability suggests a benign process

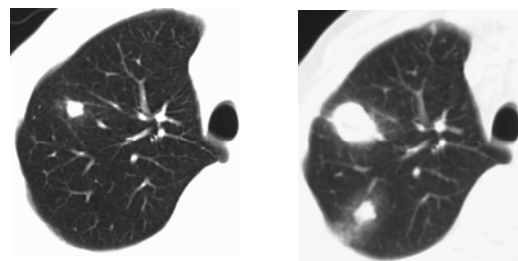
Gould MK. CHEST 2007;132:108s

## Growth Rate



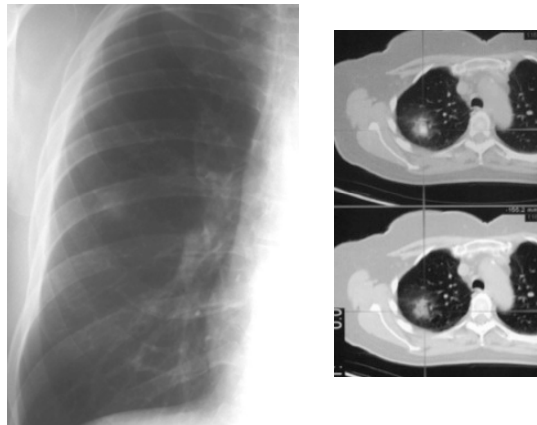
- 56 y o male with h/o Colon Ca
- Follow up CT in 6 months

## Growth Rate



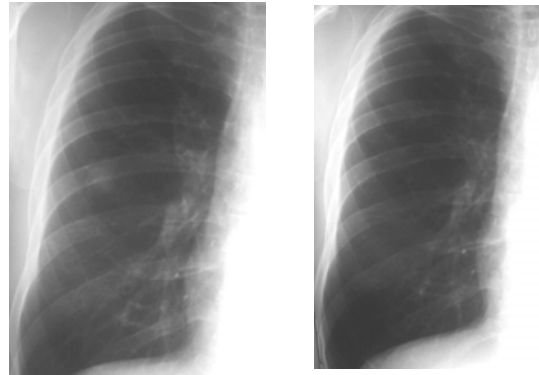
One month apart  
Infection

## Growth Rate



## 6 WEEK Follow UP CXR

Pneumonia or infection



## Calculate Pre Test Probability of Malignancy

- Review Clinical History
- Use a validated prediction model
  - [http://www.nucmed.com/nucmed/SPN\\_Risk\\_Calculator.aspx](http://www.nucmed.com/nucmed/SPN_Risk_Calculator.aspx)
- To facilitate the selection and interpretation of subsequent diagnostic tests

Gould M, CHEST 2007;132:108s

## Calculate Pre Test Probability of Malignancy

Single Pulmonary Nodule Malignancy Risk Calculator - Windows Internet Explorer provided by OSUOhio

File Edit View Favorites Tools Help X Contributions Y Edit Z Post to Blog X Convert Select

Single Pulmonary Nodule Malignancy Risk Calculator

Solitary Pulmonary Nodule Malignancy Risk Calculator

Age (year)

History of Smoking ☐ Nonsmoker ☐ Yes

Extrathoracic Cancer ☐ No ☐ Yes

Diameter (millimeter)

Spiculated Edge ☐ No ☐ Yes

Upper Lobe ☐ No ☐ Yes

FDG Uptake ☐ No PET Study ☐ Yes

Risk of Malignancy  %

Author: Farin Ismail, M.D., Ph.D.

Reference:

Heider GJ, van Tinteren H, Golding RP, Kostense PJ, Comans EF, Smit EF, Hoeksma OS.  
Clinical prediction model to characterize pulmonary nodules: validation and added value of 18F-fluorodeoxyglucose positron emission tomography.  
Chest. 2005 Oct;128(4):2490-6. Link to PubMed

## High Risk Nodules

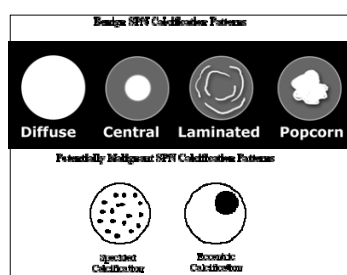
- Size
- Calcification
- Attenuation
- Border
- Morphology

## Size & Risk of Malignancy

<3 mm	0.2%
4-7 mm	0.9%
8-20 mm	18%
>20 mm	50%

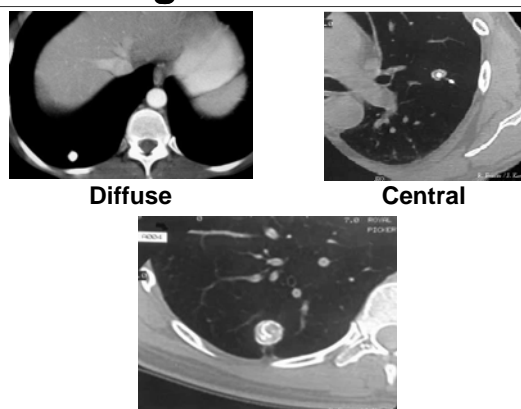
MacMahon H. Radiology. 2005;237:295  
Midhun DE. Lung Cancer 2003;41:S40

## Calcification Patterns

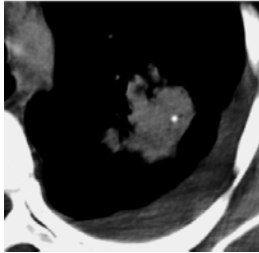


- SPNs calcified in a clearly benign pattern do not warrant additional diagnostic evaluation

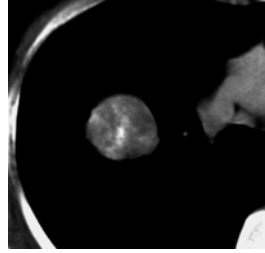
## Benign Calcifications



## Malignant Calcifications



Eccentric



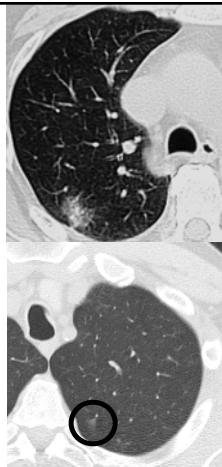
Speckled

## Attenuation

- Pure ground glass or sub solid lesion
- Could be infection or adenocarcinoma-in-situ
- Formerly BAC
- Volume doubling 3-5 years



- Part Solid more likely malignant
- Solitary GGO < 5mm - Atypical alveolar hyperplasia
- No follow up

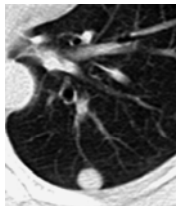


## Solitary GGO > 5mm

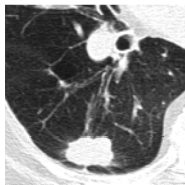
- Obtain 1mm thin section
- Initial follow up in 3 months
- If unresolved, yearly CT for minimum of 3 years
- PET not useful



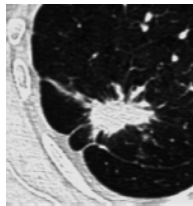
## Border



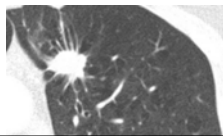
**Smooth**



**Lobulated**



**Spiculated**



**Corona Radiata**

## Border & Risk of Malignancy

- Smooth borders 20-30%
- Scalloped or lobulated 60%
- Spiculated 90%
- Corona Radiata 95%

- Risk of malignancy is 33-100% in nodules with irregular, lobulated, or spiculated borders

Rigler LG. Semin Roentgenol 1977;12:161

## Risk Factors

Variable	Risk of cancer		
	Low	Intermediate	High
Diameter of nodule (cm)	<1.5	1.5-2.2	≥2.3
Age (years)	<45	45-60	>60
Smoking status	Never smoked	Current smoker (≤20 cigarettes/day)	Current smoker (>20 cigarettes/day)
Smoking-cessation status	Quit ≥7 years ago or never smoked	Quit <7 years ago	Never quit
Characteristics of nodule margins	Smooth	Scalloped	Corona radiata or spiculated

<http://bestpractice.bmj.com/best-practice/monograph/547/diagnosis.html>

## Solid nodule <4mm

- Risk of malignancy
  - <3mm: 0.2%
  - 4-7mm: 0.9%
- Low risk: No follow up
- High risk: Follow up in one year

Midhun DE, Swensen SJ, Jett JR, Hartman TE. Evaluation of nodules detected by screening for lung cancer with low dose spiral computed tomography. Lung Cancer 2003;41(suppl 2):S40.

## Solid nodule: 5 to 8 mm in size

### Fleischner Society Guidelines

Nodule Size	Low-Risk Patient	High-Risk Patient
>4-6 mm	Follow-up at 12 mths If unchanged, no follow-up	Follow-up at 6-12 mths If unchanged, follow-up in 18-24 mths
>6-8 mm	Follow-up at 6-12 mths If unchanged, follow-up in 18-24 mths	Follow-up at 3-6 mths If unchanged, follow-up in 9-12 and 24 mths

Should try to perform follow-up scans using low-dose protocol

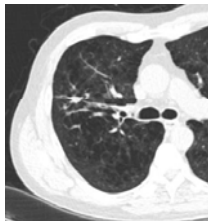
Holler MacMahon, John H. Austin, Gordon Gamsu, Christian J. Herold, James R. Jett, David P. Naidich, Edward F. Feltl, Jr, and Stephen J. Swensen. Guidelines for Management of Small Pulmonary Nodules Detected on CT Scans: A Statement from the Fleischner Society Radiology November 2009 233:395-400

## >8mm Solid Nodule

- Short follow up in 4-6 weeks
- If unresolved
  - Follow up
  - PET imaging
  - Diagnostic procedure e.g bronchoscopy, TTNA, VATS

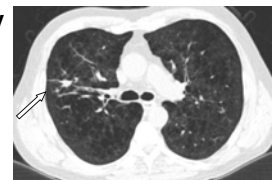
## First Case

- 62 y o male with COPD presents with a 1.6x2cm RUL spiculated nodule
- 50 PY smoking history
- Best option?
  1. PET scan
  2. CT guided needle core biopsy
  3. VATS
  4. Radiographic surveillance
  5. Bronchoscopy with navigation



## CASE ANALYSIS

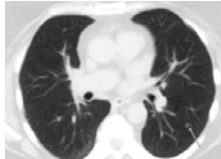
- RISK FACTORS
  - Likelihood of malignancy is high
    - Age
    - Smoker
    - Size 1.6mm
    - Spiculated
  - Navigation bronchoscopy with EBUS





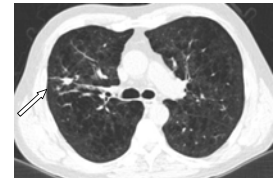
## Second Case

- 57 year old female with post intubation tracheal stenosis found to have 5mm nodule in the LLL.
- Never smoked
- Best option?
  1. PET scan
  2. CT guided needle core biopsy
  3. VATS
  4. Radiographic surveillance
  5. Bronchoscopy with navigation



## CASE ANALYSIS

- RISK FACTORS
  - Likelihood of malignancy is low
    - Non-Smoker
    - Size 5mm
    - Smooth rounded border
- Follow up CT Chest in 12 months



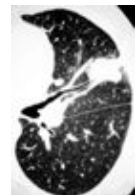
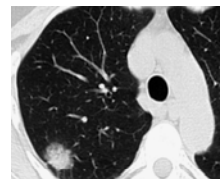
## Indeterminate Nodules

- Obtain PET scan
- Management options:
  - Radiographic surveillance if clinical probability is low (30-40%) and no activity on PET
  - Sampling by bronchoscopy or TTNA if:
    - Discordance between clinical pre-test probability and imaging tests (high suspicion but lesion is not active on PET)
    - A benign diagnosis that requires specific treatment (eg. fungal infection)
    - A fully-informed patient desires proof of malignancy diagnosis prior to surgery
    - Surgery is high risk

Gould M, CHEST 2007;132:108S-130S

## Choice of Sampling Modality

- TTNA if nodule is peripherally located
- Bronchoscopy:
  - Air-bronchograms or bronchus sign are present
  - Experience with advanced bronchoscopy tools exists:
    - Electromagnetic navigation
    - Radial EBUS



### Small Subcentimeter Pulmonary Nodules (< 8 mm)

- For patients with NO risk factors for lung cancers:
- Nodules < 4mm
  - No further follow-up
- Nodules 4 – 6 mm
  - Re-evaluate with a chest CT at 12 months
  - No further follow-up if unchanged at 12 months
- Nodules 6 – 8 mm
  - Re-evaluate with a chest CT between 6-12 months and between 18-24 months

### The NEW ENGLAND JOURNAL of MEDICINE

PUBLISHED IN JANUARY 4, 2011

#### Reduced Lung-Cancer Mortality with Low-Dose Computed Tomographic Screening

The National Lung Screening Trial Research Team\*

**Large Randomized Clinical Trial**  
**N= 53,454**  
**High Risk patients**  
**20% Relative Risk Reduction of mortality from Lung Cancer**

Lung Cancer Screenings

**The James**  
Ohio State's Comprehensive Cancer Center  
designated by the National Cancer Institute

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Cancer Programs > Lung Cancer > Lung Cancer Screenings

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  - Hodgkin's Disease
  - Leukemia
  - Lung Cancer
  - All About Lung Cancer
  - Melanoma

**Lung Cancer Screenings**

THE JAMES OFFERS LUNG CANCER SCREENINGS EVERY OTHER WEEK

The James now provides lung cancer screenings every other Monday to those at high risk of developing lung cancer, including current smokers with a significant smoking history and ex-smokers who have quit within the past 15 years.

Although incidence rates for lung cancer are declining, it continues to be the largest source of cancer-related deaths among both men and women in the United States. However, early detection through computed tomography (CT) screenings has been proven to significantly reduce lung cancer deaths.

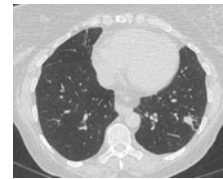
The screenings, which involve one low-dose CT scan each year for a three-year period, will be available from 4-6 p.m. every other Monday on the third floor of the Martha Morehouse Medical Plaza Tower building, located at 2050 Kenny Road.

After receiving their first CT scan, patients will schedule their second one for a year later and then schedule their third scan for a year after their second one. Each scan will cost \$95 to be paid when performed.

To qualify for the screenings, you must be 55-74 years old, be a current smoker with a history of smoking two packs per day for 15 years or one pack per day for 30 years, or be an ex-smoker who has quit within the past 15 years.

## Last Case

- 65 year old female
- 30PY smoking
- Quit 9 years ago
- Maternal aunt breast Ca
- 1.6cm spiculated mass on screening CT



What is the best approach?

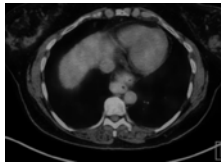
1. TTNA
2. Bronchoscopy
3. VATS
4. Radiographic surveillance

## Sent for TTNA

- Minute fragments of alveolar parenchyma with focal chronic inflammation



- Next plan
  1. Surgery
  2. Bronchoscopy with navigation
  3. Radiographic surveillance
  4. PET scan



## Conclusion

- Careful evaluation of risk factors
- Estimate pre-test probability
  - Size, morphology of nodule
  - Age, smoking status, previous malignancy
- Risk of malignancy
  - Low risk: serial chest CT's
  - Moderate risk: consider PET scan, diagnostic sampling, or surgical resection
  - High risk: surgical resection