

Radiology Workload and Follow-up Considerations

William C. Black, MD
Department of Radiology
Norris Cotton Cancer Center
Dartmouth-Hitchcock Medical Center
william.c.black@hitchcock.org

No financial disclosures

Outline

- Startup phase
- Ongoing phase
- Comments

Startup Phase

- Assess institutional support
- Create a plan
- Hire personnel
- Set up the electronic medical record (EMR)
- Meet radiologic qualifications
- Make final preparations

Assess Institutional Support

- Radiology chairperson
- Primary care
- Lung cancer specialists
- Hospital /clinic administration

Create a Plan

- Create interdisciplinary team
- Create or choose SDM materials
- Create system for patient flow & follow-up
- Create a business plan
- Obtain institutional support

Hire Personnel

- Program coordinator (0.5-1.0 FTE)
 - Review, schedule, phone, database
- Administrative assistant (0.5-1.0 FTE)
 - Help program coordinator
- Administrative director
 - Oversee LCS operations and budget
- Computer programmer
 - PACS, EMR, LCS databases

Set up EMR

- Assessing/ documenting patient eligibility
- Documenting SDM and smoking cessation
- Ordering & scheduling screening and follow-up exams

Meet Radiologic Qualifications

- Obtain LCS training (includes Lung-RADS)*
- Set up CT screening protocol*
- Obtain ACR LCS Designation*
- Enroll ACR LCS Registry*
- Create CT LCS reporting template
- Purchase software and build LCS database

*www.acr.org/Quality-Safety/Resources/Lung-Imaging-Resources

Make Final Preparations

- Set up hospital/ clinic billing system
- Prepare for questions about LCS program
- Announce LCS program to providers & public

Ongoing Phase

- Handle inquiries from patients/ providers
- Review screening requests
- Schedule screening exams
- Interpret screening exams
- Communicate results to patients/ providers
- Schedule and track follow-up exams
- Manage database

Handle Inquiries

- General information about LCS
- Patient-specific information about LCS
- Insurance coverage and costs to patients

Review Screening Requests

- Is patient eligible?
 - Age 55-77 years?
 - Asymptomatic?
 - Smoking history?
 - Significant co-morbidity?
 - No chest CT within last year?
 - SDM (willing and able)
- Is it all documented in EMR?

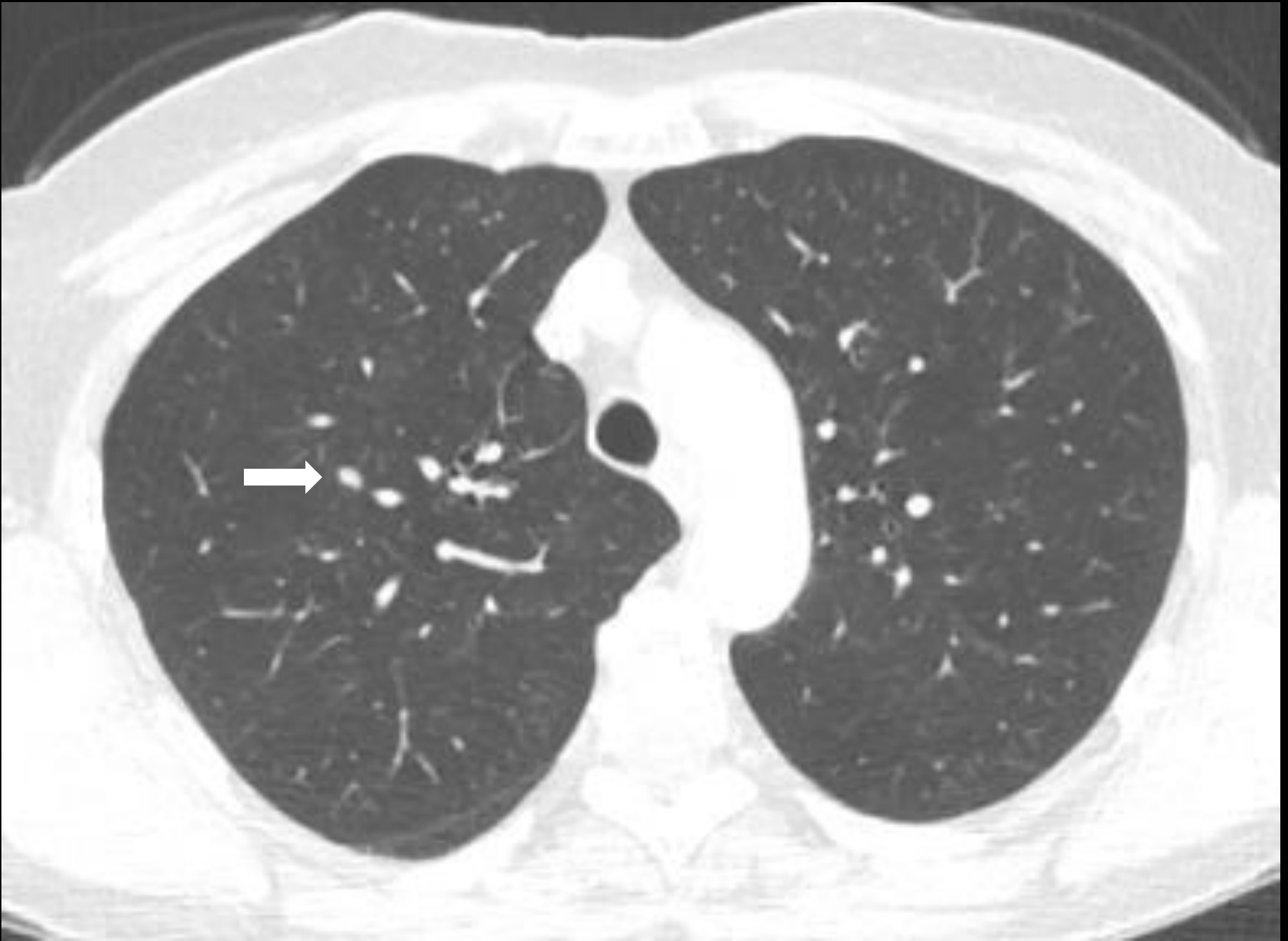
Schedule Screening Exams

- Contact patient
- Review eligibility & SDM
- Find acceptable time and date
- Ask safety questions (weight and mobility)
- Reminder call

Interpret Screening Exams

- Overall quality
- Lungs
- Mediastinum
- Upper abdomen
- Bones
- Lung-RADS





Detection of Lung Nodules on CT

- Asked 13 radiologists to find 5 mm nodules
- 40 chest CT scans (1.0 mm slices)
- Gaze tracking system
- Measured gaze volumes and detections

Rubin et al. Radiology. 2015;274(1):276-86.

Detection of Lung Nodules on CT

- Detected nodules ≤ 3 cm of gaze point
- Rad searched 27% of lungs in 3.3 min
- Within-search sensitivity 65% (47-82)%
- Overall sensitivity 49% (30-73)

Rubin et al. Radiology. 2015;274(1):276-86..

Chest CT Search Time

- Lung: 450 x 1 mm axial (13 min)
- Lung: 50 x 8 mm MIPS (2 min)
- Lung: 150 x 3 mm Cor & Sag (2 min)
- Mediastinum: 100 x 2.5 mm axial (1 min)
- Abdomen 100 x 2.5 mm axial (1 min)
- Bone: axial and sag (1 min)
- Total search (20 min)

Assessment of SmPNs

- Benign features?
- Size (average diameter)?
- Other features?
- Lung-RADS category?

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	solid nodule(s) ≥ 15 mm OR new or growing, and ≥ 8 mm part solid nodule(s) with: a solid component ≥ 8 mm OR a new or growing ≥ 4 mm solid component	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%
		4X	Category 3 or 4 nodules with additional features or imaging findings that increases the suspicion of malignancy			
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: S 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
- 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.brocku.ca/lung-cancer-risk-calculator>

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

Communicate Results

- Radiology report (ACR Lung-RADS)
- Letters to patients for all exams within 3 days
- Calls to providers at time of positive screen
- Reminders for follow-up and annual screens

EXAMINATION: [CT CHEST SCREENING LUNG CANCER]

CLINICAL HISTORY: []

TECHNIQUE: [Noncontrast, low-dose chest CT (LDCT) per DHMC lung cancer screening protocol.]

COMPARISON: [None]

FINDINGS:Lung-RADS

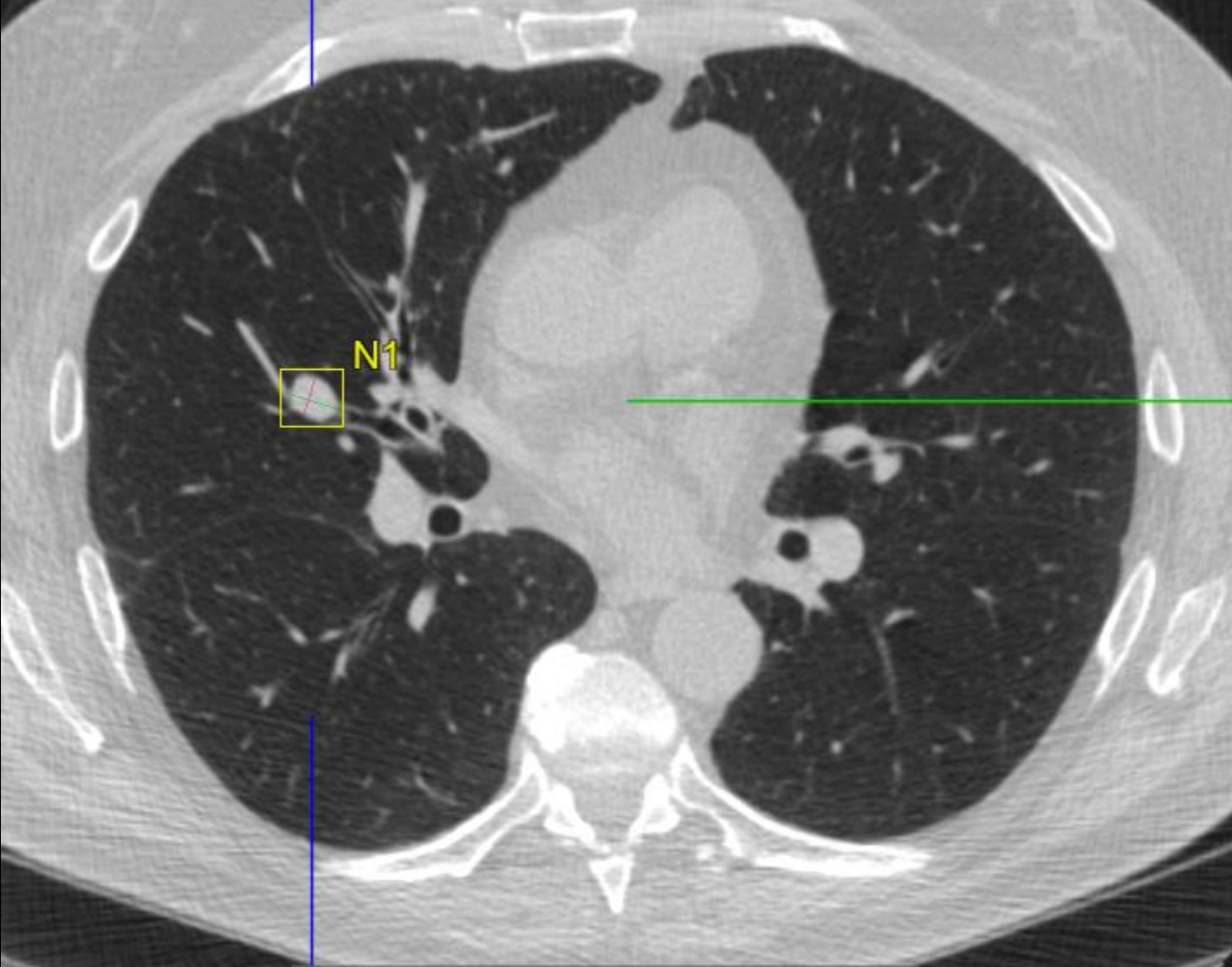
Lung screening specific: None/pulmonary nodule (size, shape, attenuation, opacity, margin, location)/other.

Potentially significant incidental findings: None.

Other incidental findings: None/aorta/CAC/mass.../pulmonary fibrosis/other interstitial lung disease(UIP,ILD other).

IMPRESSION: []

RECOMMENDATION: []



Volume	859.5 mm ³
Eff Diam	11.8 mm
Max Diam	15.8 mm
Short Axis Diam	10.7 mm
Min/Max/Avg	-554/83/-141 HU

Lung Cancer Risk Calculator

- Based on 2 high risk screening populations
- Calculates lung cancer risk at first screen
- Uses patient and nodule characteristics

McWilliams et al. N Engl J Med. 2013:910-9.

Calculator: Solitary pulmonary nodule malignancy risk

Input:

Age ▼

Sex Female (0.6011)
 Male (0)

Family history of lung cancer (0.2961)

Emphysema (0.2953)

Nodule size ▼

Nodule type Nonsolid or ground-glass (-0.1276)
 Partially solid (0.377)
 Solid (0)

Nodule in upper lung (0.6581)

Nodule count ▼

Spiculation (0.7729)

Results:

Log odds

Cancer probability ▼

Decimal precision: ▼

McWilliams et al. N Engl J Med. 2013:910-9.

Schedule and Track FU Exams

- Confirm order for FU exam
- Find acceptable time and date
- Report back to provider & radiologist
- Follow-up exam result
- Report back to provider

Manage Database

- Enter new patients into database
- Enter screening results
- Enter follow-up results
- Submit to ACR LCSR
- Query for follow-ups & annual screens
- Prepare for audits

Summary

- Radiology workload considerable and requires additional support
- Large component related to eligibility and SDM, communication & database
- Large component related to searching for nodules and reporting

Radiology Workload Reduction

- Centralize eligibility assessment and SDM
- Computer-aided detection
- Computer-aided diagnosis
- Automated structured reporting

References

- 1. American College of Radiology. Lung Cancer Screening Resources. 2016. Available from: <http://www.acr.org/Quality-Safety/Resources/Lung-Imaging-Resources>.
- 2. Aberle DR, Adams AM, Berg CD, Black WC, Clapp JD, Fagerstrom RM, et al. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med*. 2011 Aug 4;365(5):395-409. PubMed PMID: 21714641. Epub 2011/07/01. eng.
- 3. McWilliams A, Tammemagi MC, Mayo JR, Roberts H, Liu G, Soghrati K, et al. Probability of cancer in pulmonary nodules detected on first screening CT. *N Engl J Med*. 2013 Sep 5;369(10):910-9. PubMed PMID: 24004118. Pubmed Central PMCID: 3951177.
- 4. Rubin GD, Roos JE, Tall M, Harrawood B, Bag S, Ly DL, et al. Characterizing search, recognition, and decision in the detection of lung nodules on CT scans: elucidation with eye tracking. *Radiology*. 2015 Jan;274(1):276-86. PubMed PMID: 25325324.

Lung Cancer Screening Program Timeline

Phase (Milestone)	Description	Status	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	June-13	July-13	Aug-13	Sept-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	June-14	July-14	Aug-14	Sept-14	Oct-14	Nov-14	Dec-14	Jan-15						
			Provider Brochure	Provider educational materials	Complete	█																													
Lung Cancer Screening Registry	DH patients who meet NLST criteria - IRB approval	In Progress	█																																
Patient Fact Sheet	Patient educational materials	Complete	█																																
Patient Brochure	Patient educational materials	Complete	█																																
Option Grid	Shared Decision-Making Tool	In Progress	█																																
Clinical Pathway	Strategic pathway for patients who are eligible for lung cancer screening	In progress	█																																
Patient & Provider education	Distribute Provider and Patient Materials encourage shared decision-making	In progress	█																																
Phase 1 Screening	Target DH-Lebanon Employees - 200 Screens	Pending	█																★																
Phase 2 Screening	Target DH-Lebanon Providers - 200 Screens	Pending	█																		★														
Phase 3 Screening	Open to Public	Pending	█																						★										
Process & Quality Evaluation		Pending	█																								★								



Nodule Detection

- Orientation
- Visual scanning
- Pattern recognition
- Decision making

Kundel et al. Investigative Radiology. 1978;13(3):175-81.

