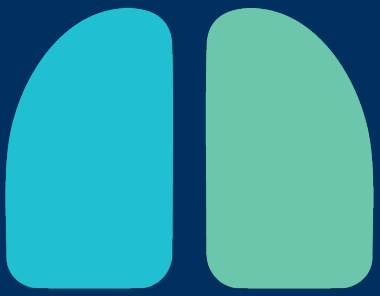
Australian Government

NATIONAL LUNG CANCER SCREENING PROGRAM



NODULE MANAGEMENT PROTOCOL

CONTENTS

Baseline

Category descriptor	Findings	Management	Category
Incomplete	Findings suggestive of an inflammatory or infectious process	1-, 2-, or 3-month LDCT	0
Very low risk	No lung nodules	24-month LDCT	1
	Baseline nodule with PanCan risk <1.5% excluding airway nodules and atypical pulmonary cysts		
	Nodule with benign features: • Complete, central, popcorn, or concentric ring calcifications • Fat-containing		
	Juxtapleural nodule: • 524 mm^3(<10 mm) AND • Solid; smooth margins; and oval, lentiform, or triangular shape		
Low risk	Baseline nodule with PanCan risk 1.5% to < 6% excluding airway nodules and atypical pulmonary cysts	12-month LDCT	2
	Airway nodule, subsegmental		
Low to moderate risk	Baseline nodule with PanCan risk 6% to < 10% excluding airway nodules and atypical pulmonary cysts	6-month LDCT	3
Moderate risk	Baseline nodule with PanCan risk 10% to < 30% excluding airway nodules and atypical pulmonary cysts	3-month LDCT	4
	Airway nodule, segmental or more proximal		
	Atypical pulmonary cyst: • Thick-walled cyst OR • Multilocular cyst		
High risk	Baseline nodule with PanCan risk ≥ 30% excluding airway nodules and atypical pulmonary cysts	Refer to Respiratory Physician linked to a lung cancer multidisciplinary team	5
Very high risk	Further features or imaging findings that increase suspicion for lung cancer	Refer to Respiratory Physician linked to a lung cancer multidisciplinary team	6
Actionable additional findings	Clinically significant or potentially clinically significant findings unrelated to lung cancer will be described with appropriate recommendations	As appropriate to the specific finding	A

Follow-up

Category descriptor	Findings	Management	Category
Incomplete	Findings suggestive of an inflammatory or infectious process	1-, 2-, or 3-month LDCT	0
Very low risk	No lung nodules	24-month LDCT	1
	Previous Category 1 lesion that is stable or decreased in size		
	Previous Category 2 lesion that is stable or decreased in size over a period of 24 months or more		
	Nodule with benign features including: • Complete, central, popcorn, or concentric ring calcifications • Fat-containing		
	Solid nodule: New < 34 mm^3 (< 4 mm)		
	Lesion evident on pre-screening CT imaging, and stable or decreased over more than 24 months (excluding persistent segmental or more proximal airway nodules)		
Low risk	Previous Category 2 lesion that is stable or decreased in size over a period of less than 24 months	12-month LDCT	2
	Previous Category 3 lesion that is stable or decreased in size at 6-month follow-up LDCT		
	Airway nodule, subsegmental – new		
	Juxtapleural nodule: • New 524 mm^3 (<10 mm) AND • Solid; smooth margins; and oval, lentiform, or triangular shape		
	Non-solid nodule (ground glass): • < 14,137 mm^3 (< 30 mm): New or growing • ≥ 14,137 mm^3 (≥ 30 mm): Slowly growing		
Low to moderate risk	Previous Category 4 lesion (excluding persistent segmental or more proximal airway nodules) that is stable or decreased in size at 3-month follow-up LDCT	6-month LDCT	3
	Atypical pulmonary cyst: • Growing cystic component (mean diameter) of a unilocular thick-walled cyst		
	Solid nodule: • New 34 to < 113 mm^3 (4 mm to < 6 mm)		
	Part solid nodule: • New < 113 mm^3 (< 6 mm total mean diameter)		
	Non-solid nodule (ground glass): • ≥ 14,137 mm3 (≥ 30 mm) new or growing		
Moderate risk	Airway nodule, segmental or more proximal - new	3-month LDCT	4
	Atypical pulmonary cyst: • Newly multilocular cyst that was previously unilocular • New atypical pulmonary cyst of any morphology		
	Solid nodule: • Growing < 268 mm^3 (< 8 mm) OR • New 113 to < 268 mm^3 (6 to < 8 mm)		
	Part solid nodule: • New or growing < 34 mm^3 (< 4 mm) solid component		

Category descriptor	Findings	Management	Category
High risk	Airway nodule, segmental or more proximal – stable or growing	Refer to Respiratory Physician linked to a lung cancer multidisciplinary team	5
	Atypical pulmonary cyst: • Thick-walled cyst with growing wall thickness/nodularity OR • Growing multilocular cyst (mean diameter) OR • Multilocular cyst with increased loculation or new/increased opacity (nodular, ground glass, or consolidation)		
	Solid nodule: • New or growing ≥ 268 mm^3 (≥ 8 mm)		
	Part solid nodule: • New or growing ≥ 34 mm^3 (≥ 4 mm) solid component		
	Slowly growing solid or part solid nodule		
Very high risk	Further features or imaging findings that increase suspicion for lung cancer	Refer to Respiratory Physician linked to a lung cancer multidisciplinary team	6
Actionable additional findings	Clinically significant or potentially clinically significant findings unrelated to lung cancer will be described with appropriate recommendations	As appropriate to the specific finding	A

Explanatory notes

<table>
<tr><th>#</th><th>Notes</th></tr>
<tr><td>1</td><td>Category: Each exam should be categorised 0 to 6, based on the nodule with the highest degree of suspicion (and therefore highest category).</td></tr>
<tr><td>2</td><td>Management: The timing of follow-up LDCT is from the date of the exam being interpreted. For example, if a study is reported as Category 2 and generates a 12-month follow-up LDCT recommendation, that follow-up scan should be performed 12 months from the date of the current exam. Also note that management of lesions that are stable or decreased follows a stepped management approach: increasing follow-up intervals are recommended at each follow-up LDCT.</td></tr>
<tr><td>3</td><td>PanCan risk: the PanCan risk calculator is to be applied for all nodules demonstrated on the baseline LDCT, except for nodules that meet the below definitions for suspected infections or inflammatory findings, juxtapleural nodules, airway nodules, and atypical pulmonary cysts. For a link to the calculator see NLCSP resources on RANZCR website.
a. Use the maximal axial diameter to enter into the calculator.
b. Family history for the calculator is defined as a parent, sibling, or child who has had lung cancer.
c. For nodule count in the calculator: count every visible lung nodule on the study.
d. Spiculation is defined as multiple fine linear strands extending from a nodule into the surrounding lung parenchyma in a stellate manner.</td></tr>
<tr><td>4</td><td>Practice Audit Definitions: A negative screen is defined as Category 1; a positive screen is defined as Categories 5 and 6. A negative screen does not mean that a participant does not have lung cancer. A positive screen does not mean that a participant has lung cancer.</td></tr>
<tr><td>5</td><td>Nodule Measurement:
a. Volumetry by automated segmentation should be performed for measurement of solid nodules due to its reliability and sensitivity for growth. Volumes should be reported to the nearest whole number in mm^3. Note that a change in volume between -25% and +25% is within the margin of error for comparison between studies and therefore not considered significant. See below for definitions of “growing”, “slowly growing”, “stable”, and “decreased” based on volumetry.
b. In situations where volumetry cannot be applied accurately, or is unavailable, measure using nodule mean diameter. To calculate nodule mean diameter, measure both the long and short axis to one decimal point in mm, and report mean nodule diameter to one decimal point. The long and short axis measurements may be in any orthogonal plane (i.e. axial, coronal, or sagittal, but not oblique plane), to reflect the true size of the nodule. The plane in which the nodule is measured should be documented in the standardised report. See below for definitions of “growing”, “slowly growing”, “stable”, and “decreased” based on mean diameter measurement.</td></tr>
<tr><td>6</td><td>Definitions of “growing”, “slowly growing”, “stable, and “decreased”
<table>
<tr><th></th><th>Nodule measurement using volumetry (preferred method)</th><th>Nodule measurement using mean diameter (when measurement using volumetry is not possible)</th></tr>
<tr><td>Growing</td><td>Increase greater than 25% and VDT < 600 days</td><td>Increase of more than 1.5mm, 24 months or less</td></tr>
<tr><td>Slowly growing</td><td>Increase greater than 25% and VDT >600 days, on more than one scan interval</td><td>Increase of more than 1.5mm, over more than 24 months</td></tr>
<tr><td>Stable</td><td>Change between -25% and +25% or increase from baseline greater than 25% and VDT>600 days but not slow growth</td><td>Change of between -1.5mm and +1.5mm</td></tr>
<tr><td>Decreased</td><td>Decrease of 25% or more</td><td>Decrease of 1.5 mm or more</td></tr>
</table>
Note that the earliest scan available should be used as the comparison study to establish initial change. Unless there is a pre-screening CT available, this will be the baseline NLCSP LDCT.

Nodules may undergo change in trajectory, meaning growth followed by stability, or slow growth followed by decrease etc. When there is trajectory change, the scan on which the nodule has last demonstrated the previous trajectory should be used as the new comparison study.</td></tr>
</table>

<table>
<tr><th>#</th><th>Notes</th></tr>
<tr><td>7</td><td>
Prior exams: Comparison to prior imaging is essential for interpretation of LDCT in the NLCSP. Radiologists are advised to review the oldest available CT to ensure slow growth is not missed. Comparison could include review of non-NLCSP CT performed before or between screening LDCT.

For stable pulmonary nodules based on comparison to pre-NLSCP CT, a suggested approach is as follows:
<table>
<tr><td>Any nodule stable for more than 24 months</td><td colspan="2">Assign Category 1</td></tr>
<tr><td>Any nodule stable for 9 to 24 months</td><td colspan="2">Assign Category 2</td></tr>
<tr><td rowspan="5">If nodule stable for less than 9 months: calculate PanCan risk and assign based on the pre-NLCSP CT as described</td><td>If previous Category 1</td><td>Assign Category 1</td></tr>
<tr><td>If previous Category 2</td><td>Assign Category 2</td></tr>
<tr><td>If previous Category 3</td><td>Stable for 6 or more months: assign Category 2
Stable for less than 6 months: assign Category 3</td></tr>
<tr><td>If previous Category 4</td><td>Stable for 3 or more months: assign Category 3
Stable for less than 3 months: assign Category 4</td></tr>
<tr><td>If previous Category 5 or 6</td><td>Consider referral unless stability is strongly radiologically reassuring</td></tr>
</table>
</td></tr>
<tr><td>8</td><td>
Suspected Infectious or Inflammatory Findings:
<ol type="a">
Lung findings suggesting an indeterminate infectious or inflammatory process may be recommended for follow- up LDCT in 1, 2 or 3 months (Category 0). Such findings may include segmental or lobar consolidation, multiple new nodules (more than six), large solid nodules (≥ 8 mm) appearing in a short interval, and new nodules in certain clinical contexts such as in immunocompromised participants. The reporting radiologist will stipulate a specific follow-up interval (for example 2 months) based on clinical judgement. At 1–3-month follow-up, a new category and management recommendation should be provided based on the most suspicious nodule.
New solid or part solid nodules, with imaging features more concerning for malignancy than an infectious or inflammatory process, and meeting Category 5 criteria by size, may be classified as Category 5.
Some findings indicative of an infectious or inflammatory process may not warrant short-term, Category 0 follow-up, given the high likelihood of non-neoplastic aetiology. For example, clear tree-in-bud nodules can be applied Category 1.

</td></tr>
<tr><td>9</td><td>Juxtapleural nodules: Nodules meeting the following criteria are most likely intrapulmonary lymph nodes: < 524 mm^3 or < 10 mm; solid composition; smooth margins; oval, lentiform, or triangular shape; either in any location and contacting the pleura OR located in the middle or lower lobes and within 15 mm of the pleura). These have a near-zero risk of malignancy. At baseline, these can be assigned Category 1. At follow up, nodules that meet the same criteria but are new should be treated with more slightly more caution, hence the recommendation for Category 2.</td></tr>
<tr><td>10</td><td>
Airway Nodules:
<ol type="a">
Baseline endotracheal or endobronchial abnormalities that are segmental or more proximal are classified as Category 4.
Typical appearances of subsegmental retained secretions should be assigned Category 1. If a subsegmental nodule is not typical for retained secretions, this can be reported as Category 2.
The presence of air in segmental or more proximal airway abnormalities often favours secretions. If no underlying soft tissue nodule is identified, these findings may be classified as Category 1.
Segmental or more proximal airway nodules that persist on 3-month follow-up LDCT are upgraded to Category 5.
Growing subsegmental airway nodules should be measured and categorised in the same way as solid nodules.

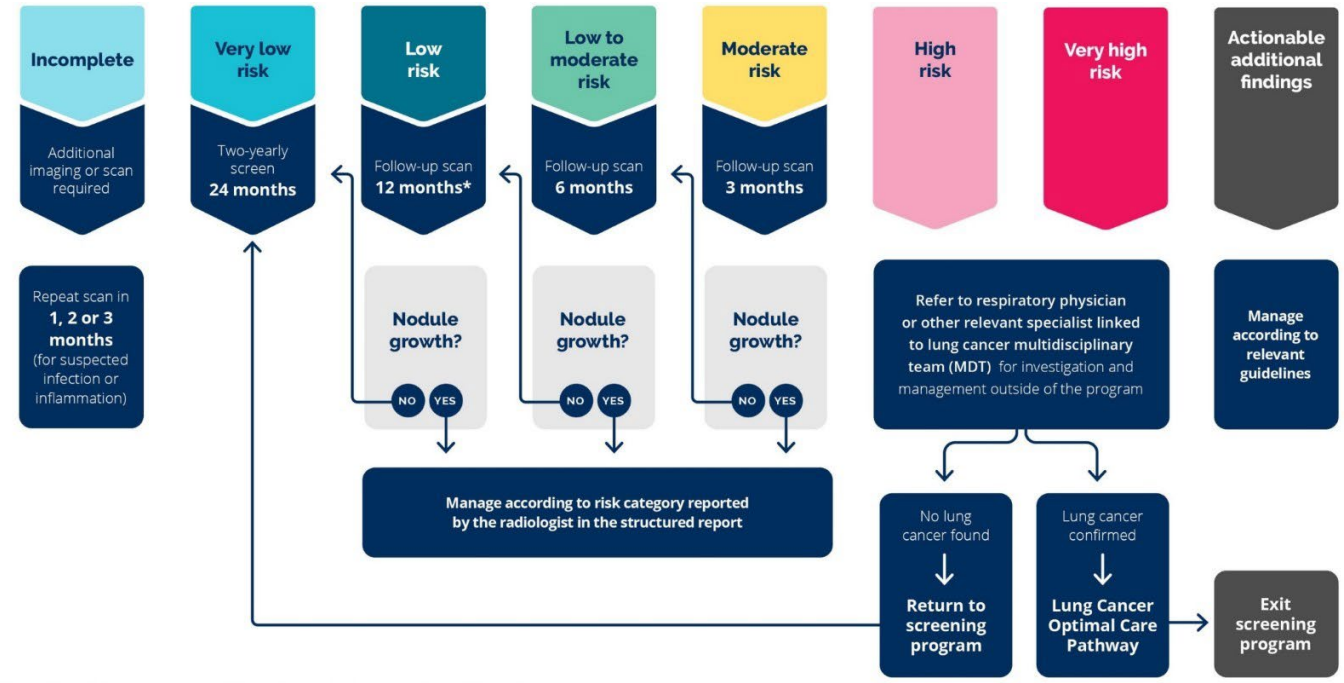
</td></tr>
</table>

<table>
<tr><th>#</th><th>Notes</th></tr>
<tr><td>11</td><td>Atypical Pulmonary Cysts:
a. Thin-walled Cyst: Unilocular with uniform wall thickness < 2 mm. Thin-walled cysts are considered benign and are not classified or managed in the NLCSP protocol.
b. Thick-walled Cyst: Unilocular with uniform wall thickness, asymmetric wall thickening, or nodular wall thickening ≥ 2 mm (cystic component is the dominant feature); manage as an atypical pulmonary cyst.
c. Multilocular Cyst: Thick or thin-walled cyst with internal septations; manage as an atypical pulmonary cyst.
d. Cavitary Nodule: Wall thickening is the dominant feature; manage as a solid nodule.
e. Cyst with an Associated Nodule: Any cyst with adjacent internal (endophytic) or external (exophytic) nodule (solid, part solid, or ground-glass); management is based upon category assigned to the most concerning feature.
f. Cyst growth definition: An increase > 1.5 mm in nodule size (mean diameter), wall thickness, and/or size of the cystic component (mean diameter). Volumetry for atypical pulmonary cysts is not currently recommended, due to technical limitations associated with contouring these lesions.
g. Fluid-containing cysts may represent an infectious process and are not classified in the NLCSP protocol unless other concerning features are identified.
h. Multiple cysts may indicate an alternative diagnosis (cystic lung disease such as Langerhans cell histiocytosis or lymphangioleiomyomatosis) and are not classified in the NLCSP protocol unless other concerning features are identified.</td></tr>
<tr><td>12</td><td>Respiratory Physician* linked to a lung cancer multidisciplinary team (MDT) (Category 5 and 6): Once a participant is referred, further management (including additional work-up such as PET/CT, invasive tissue sampling, and/or staging CT scans) is no longer considered screening.
The responsible physician and MDT will:
• Determine if and when the patient is returned to screening
• Reclassify a nodule, if clinicoradiological assessment alters nodule category.
*This may include other specialists with relevant expertise who are linked with a lung cancer MDT</td></tr>
<tr><td>13</td><td>Category 6: Further imaging findings that increase the suspicion of lung cancer, such as lymphadenopathy, frank metastatic disease, a ground-glass nodule that doubles in size in one year or other malignant finding.</td></tr>
<tr><td>14</td><td>Management of benign findings: Participants with previous Category 5 or 6 lesion proven to be benign in aetiology following appropriate evaluation, will resume screening at 24 month LDCT.</td></tr>
<tr><td>15</td><td>Additional findings: Clinically significant or potentially clinically significant findings unrelated to lung cancer are to be described and given appropriate recommendations. For the relevant additional findings, recommendations should adhere to the NLCSP Additional Findings Guidelines available from the NLCSP resources on RANZCR website.</td></tr>
<tr><td>16</td><td>Delayed or missed scan appointments:
It is possible that participants in the screening program may delay or miss scan appointments and return for follow-up scans after durations longer than those specified by the protocol. The following approach is suggested for such cases:

For new, growing, or slow-growing nodules, manage according to the protocol.

For stable nodules:
<table>
<tr><td>If stable for more than 24 months</td><td>Assign Category 1</td><td></td></tr>
<tr><td>If stable for 9 to 24 months</td><td>Assign Category 2</td><td></td></tr>
<tr><td>If stable for less than 9 months</td><td>AND previous Category 3</td><td>Assign Category 2</td></tr>
<tr><td>If stable for less than 9 months</td><td>AND previous Category 4</td><td>Assign Category 3</td></tr>
<tr><td colspan="3">For participants who unavoidably present for imaging earlier than recommended, clinical judgment is required. Imaging may be inappropriate.</td></tr>
</table></td></tr>
</table>

Simplified NLCSP Nodule Management Protocol flowchart



*Low risk participants require two 12 month scans before extending to 24 months.

Simplified NLCSP Nodule Management Protocol flowchart (text alternative)

The simplified NLCSP Nodule Management Protocol flowchart illustrates the risk categories defined by the NLCSP Nodule Management Protocol, along with the corresponding actions required for managing low-dose CT scan results. Low-dose CT scan results are categorised based on nodule risk and other findings. The categories are:

- Incomplete
- Very low risk
- Low risk
- Low to moderate risk
- Moderate risk
- High risk
- Very high risk.

"Actionable additional findings" can be added to categories for any clinically significant findings unrelated to lung cancer.

Incomplete

If a scan is incomplete, an additional imaging or scan is required.

The participant will need a repeat scan in 1, 2 or 3 months due to suspected infection or inflammation.

Very low risk

If a scan is reported as very low risk, a participant will return for a two-yearly screen in 24 months.

Low risk

If a scan is reported as low risk, a participant will return for a follow-up scan in 12 months.

The follow-up scan in 12 months is then assessed for nodule growth.

Nodule growth?

If yes, there is nodule growth, the participant will be managed according to the risk category reported by the radiologist in the structured report.

If no, there is no nodule growth, the participant will return for a follow-up scan in 24 months. Go to two-yearly screen 24 months.

See footnote.

Footnote

It should be noted that low-risk participants require two 12 month scans before extending to 24 months. Further details are in the NLCSP Nodule Management Protocol.

Low to moderate risk

If a scan is reported as low to moderate risk, the participant will return for a follow-up scan in 6 months.

The follow-up scan in 6 months is then assessed for nodule growth.

Nodule growth?

If yes, there is nodule growth, the participant will be managed according to the risk category reported by the radiologist in the structured report.

If no, there is no nodule growth, the participant will return for a follow-up screen in 12 months. Go to follow-up scan in 12 months.

Moderate risk

If a scan is moderate risk, the participant will return for a follow-up scan in 3 months.

The follow-up scan in 3 months is then assessed for nodule growth.

Nodule growth?

If yes, there is nodule growth, the participant will be managed according to the risk category reported by the radiologist in the structured report.

If no, there is no nodule growth, the participant will return for a follow-up screen in 6 months. Go to follow-up scan in 6 months.

High risk

If a scan is high risk, the participant is referred to a respiratory physician or other relevant specialist linked to a lung cancer multidisciplinary team for investigation and management outside of the program.

If no lung cancer is found at investigation, the participant will remain in the screening program. The participant's next scan will be the two-yearly screen 24 months.

If lung cancer is confirmed, the participant will be managed according to the relevant Lung Cancer Optimal Care Pathway. The participant will exit the program.

Very high risk

If a scan is very high risk, the participant is referred to a respiratory physician or other relevant specialist linked to a lung cancer multidisciplinary team for investigation and management outside of the program.

If no lung cancer is found at investigation, the participant will remain in the screening program. The participant's next scan will be the two-yearly screen 24 months.

If lung cancer is confirmed, the participant will be managed according to the relevant Lung Cancer Optimal Care Pathway. The participant will exit the program.

Actionable additional findings

If actionable additional findings are reported as part of the scan results, the participant will be managed according to relevant guidelines.

Attributions

This Screening Protocol is a screening tool, intended for use by health professionals to assist with reporting and screening of lung cancer risk under the National Lung Cancer Screening Program. The Protocol does not provide a diagnosis. It must not be used in place of the clinical and professional judgement of medical professionals.

This Screening Protocol is a compilation of derivative and original work, provided subject to the terms of the respective licenses set out below. The Screening Protocol is provided for use as part of the National Lung Cancer Screening Program only. Any commercial use is strictly prohibited. Copyright in original material vests in the owners identified below or, in respect of new material, in the Department of Health on behalf of the Commonwealth of Australia.

Lung Nodule Malignancy Risk Calculator (**as found here**) © 2013, A McWilliams, MC Tammemagi, JR Mayo and S Lam (the "Software"). The Software remains the property of Brock University, The British Columbia Cancer Agency Branch, and The University of British Columbia ("the Institutions"). The Software is distributed "AS IS" under its Licence solely for non-commercial use in accordance with its license which can be found **here** (**Nodule Malignancy Prediction Calculator - Lung Cancer Screening and Risk Prediction)**

The International Lung Cancer Screening Protocol (ILST) is licensed under a **Creative Commons Attribution – Non-Commercial – No Derivatives 4.0 International license** by Lim KP, H Marshall, M Tammemägi, F Brims, A McWilliams, E Stone, R Manser, K Canfell, M Weber, L Connelly, RV Bowman, IA Yang, P Fogarty, J Mayo, J Yee, R Myers, S Atkar_Khattra, DCL Lam, A Rosell, CD Berg, KM Fong and S Lam. License to this material is subject to the disclaimer of warranties and the limitation of liability by the Licensors set out at **section 5 of the License**. The ILST is based on a work **at this link**.

Lung-RADs® is a registered trademark of the American College of Radiology.

The **Lung-CT Screening Reporting & Data System (Lung-RADs®)** is licensed under **a Creative Commons Attribution-No Derivatives 4.0 International License** by the American College of Radiology. Lung-RADs® is based on a work **at this link** by the American College of Radiology Lung-RADs® Committee: E Kazerooni, DR Aberle, WC Black, MK. Gould, A Leung, BJ McKee, RF Munden, D Yankelevitz. License to this material is subject to the disclaimer of warranties and the limitation of liability by the Licensor set out at **section 5 of the License**.