

BTS Guideline for pulmonary nodules

On behalf of the BTS pulmonary nodules Guideline Development Group

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98 **GLOSSARY AND ABBREVIATIONS**

99	AAH	Atypical adenomatous hyperplasia
100	AI	Artificial intelligence
101	AIS	Adenocarcinoma in situ
102	CI	Confidence interval
103	CT	Computed tomography
104	EBUS	Endobronchial ultrasound
105	FDG PET-CT	Fluorodeoxyglucose positron emission tomography computed tomography
106	GDG	Guideline development group
107	GGN	Ground-glass pulmonary nodules
108	GPP	Good practice point
109	GRADE	Grading of Recommendations, Assessment, Development and Evaluation
110	IAC	Invasive adenocarcinoma
111	IASLC	International Association for the Study of Lung Cancer
112	IPLN	Intrapulmonary lymph node
113	IQR	Interquartile range
114	LCS	Lung cancer screening
115	LDCT	Low dose computed tomography
116	MDT	Mass doubling time
117	MetaDTA	Diagnostic test accuracy meta-analysis
118	MIA	Minimally invasive adenocarcinoma
119	NICE	National Institute for Health and Care Excellence
120	PET-CT	Positron emission tomography computed tomography
121	PFN	Perifissural nodule
122	PICO	Population, Intervention, Comparator, Outcome
123	PSN	Part-solid pulmonary nodule
124	SSN	Sub-solid pulmonary nodule
125	UKLS	UK Lung Screen model
126	USS/CT	Ultrasound/computed tomography
127	VA	Veterans Affairs Model
128	VDT	Volume doubling time

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135 SUMMARY OF RECOMMENDATIONS AND GOOD PRACTICE POINTS

136 Investigative approach following low dose computed tomography (LDCT) screening or incidental 137 detection

138 Recommendation

- 139 ➤ For adults with pulmonary nodules identified on a CT scan, the investigation and management should not
140 differ whether detected on low dose computed tomography (LDCT) for lung cancer screening or CT scan
141 done for other reasons. **(Conditional)**

142 Likelihood of lung cancer following a previous history of non-lung cancer

143 Recommendation

- 144 ➤ For adults with a pulmonary nodule identified on a CT scan, information about a previous history of non-
145 lung cancer should be sought as there may be an increased risk of nodule malignancy. **(Conditional)**

146 Solid nodules – Baseline diagnostic approach

147 Recommendations

- 148 ➤ The [Solid nodule diagnostic pathway](#) (Algorithm 1), incorporating different solid nodule characteristics,
149 should be used for determining lung cancer in solid pulmonary nodules. **(Conditional – by consensus)**
- 150 ➤ An FDG PET-CT (fluorodeoxyglucose positron emission tomography computed tomography) scan should
151 be offered for determining lung cancer risk in solid pulmonary nodules ≥ 8 mm. **(Conditional)**

152 Solid nodules – Surveillance

153 Recommendations

- 154 ➤ Comparison to the earliest available CT should be performed at each evaluation of solid pulmonary
155 nodules.
- 156 ➤ For adults with solid pulmonary nodules, a volume doubling time (VDT) of less than 600 days should be
157 considered suggestive of lung cancer. **(Conditional)**
- 158 ➤ The [Solid nodule follow-up pathway](#) (Algorithm 2), incorporating solid pulmonary nodule changes at follow-
159 up, should be used for determining lung cancer in progressing solid pulmonary nodules. **(Conditional –**
160 **by consensus)**
- 161 ➤ For new solid nodules, please use the [New nodule follow-up pathway](#) (Algorithm 3). **(Conditional – by**
162 **consensus)**

163 Good Practice Points

- 164 ✓ Volumetry should be used when available and reliable, in preference to diameter, to calculate nodule size.
- 165 ✓ A volume change of $> 25\%$ between interval CTs can be considered highly specific for detecting growth in
166 a solid pulmonary nodule.
- 167 ✓ In the absence of available or reliable volumetry, ≥ 2 mm increase in diameter can be considered clear
168 evidence of growth.

169 **Sub-solid nodules – Baseline diagnostic approach**

170 **Recommendations**

- 171 ➤ For adults with sub-solid pulmonary nodules, maximal nodule diameter, increased CT density, spiculation,
172 size of solid component, presence of air bronchogram and presence of bubble-like lucency can all be
173 considered when determining lung cancer risk. (**Conditional**)
- 174 ➤ For adults with ground-glass pulmonary nodules (GGN), the [Ground-glass nodule pathway](#) (Algorithm 4)
175 should be used for determining lung cancer in GGN. (**Conditional** – by consensus)
- 176 ➤ For adults with sub-solid pulmonary nodules with a solid component, the [Part-solid nodule pathway](#)
177 (Algorithm 5) should be used for determining lung cancer risk. (**Conditional** – by consensus)

178 **Good Practice Points**

- 179 ✓ Sub-solid pulmonary nodules should be reviewed on both mediastinal and lung windows to determine if
180 the nodule is of increased density.
- 181 ✓ Diameter rather than volumetry should be used to determine the size of sub-solid pulmonary nodules.
- 182 ✓ The maximum diameter of the solid component should be measured on lung windows and a lung kernel.

183 **Sub-solid nodules – Surveillance**

184 **Recommendations**

- 185 ➤ For adults with pure ground-glass pulmonary nodules (GGN), the [Ground-glass nodule pathway](#) (Algorithm
186 4) should be used for determining lung cancer in progressing GGN. (**Conditional** – by consensus)
- 187 ➤ For adults with sub-solid pulmonary nodules with a solid component, the [Part-solid nodule pathway](#)
188 (Algorithm 5) should be used for determining lung cancer in progressing part-solid pulmonary nodules.
189 (**Conditional** – by consensus)

190 **Good Practice Points**

- 191 ✓ Comparison to the earliest available CT should be performed at each evaluation of sub-solid pulmonary
192 nodule.
- 193 ✓ The following changes on interval CT scans may be suggestive of invasive lung cancer in sub-solid
194 pulmonary nodules: increase in the maximal diameter of the solid component, distortion of fissure,
195 development of air bronchograms, development of bubble-like lucency, increased CT density.

196 **Pulmonary nodule biopsy for diagnosing lung cancer**

197 **Recommendation**

- 198 ➤ For adults with a suspected malignant pulmonary nodule, bronchoscopic (**Conditional**), percutaneous
199 (**Strong**), or surgical (**Conditional**) biopsy can be considered for diagnosing lung cancer

200 **Good Practice Points**

- 201 ✓ Modality for tissue acquisition should consider patient choice, nodule location and number, need for
202 mediastinal staging, wait times, and available services.
- 203 ✓ All patients should be able to access robotic-assisted bronchoscopy, endobronchial ultrasound (EBUS),
204 percutaneous ultrasound / computed tomography (USS/CT) guided and surgical biopsy.

205 **Pre-treatment biopsy versus no pre-treatment biopsy**

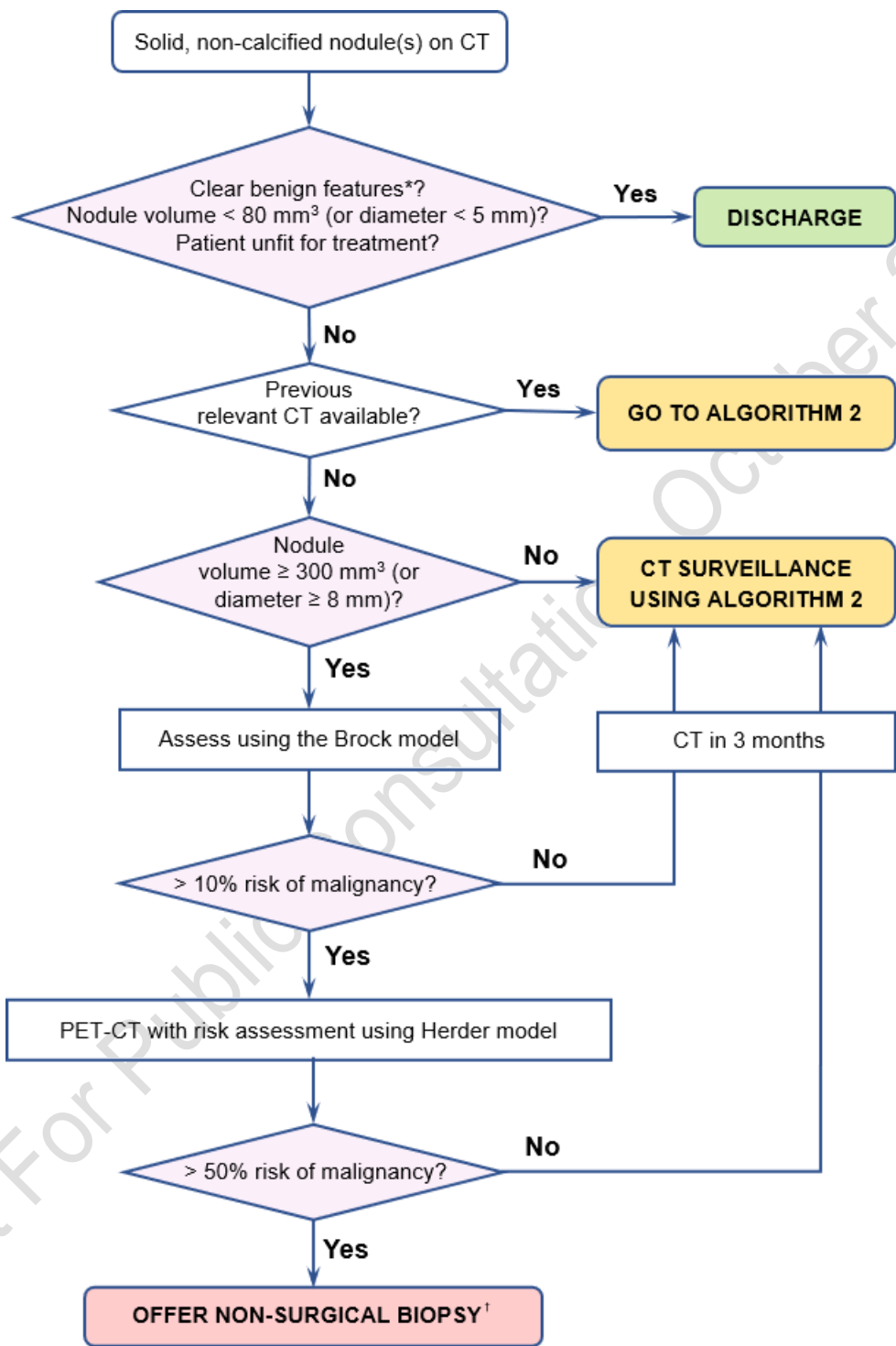
206 **Recommendation**

- 207 ➤ A pre-treatment biopsy should be offered, where feasible, to patients who are suitable for curative-intent
208 treatment. (**Conditional**)

209 **FDG PET-CT staging**

210 **Recommendations**

- 211 ➤ For patients with solid pulmonary nodules being considered for treatment with curative intent, FDG PET-
212 CT staging should be offered to detect occult nodal disease or metastases. (**Conditional**)
- 213 ➤ Solid pulmonary nodules of ≥ 8 mm diameter should be offered FDG PET-CT staging (depending on PET-
214 CT manufacturers' resolution specifications). (**Conditional** – by consensus)
- 215 ➤ Sub-solid pulmonary nodules with a solid component ≥ 10 mm diameter should be offered FDG PET-CT
216 staging. (**Conditional** – by consensus)



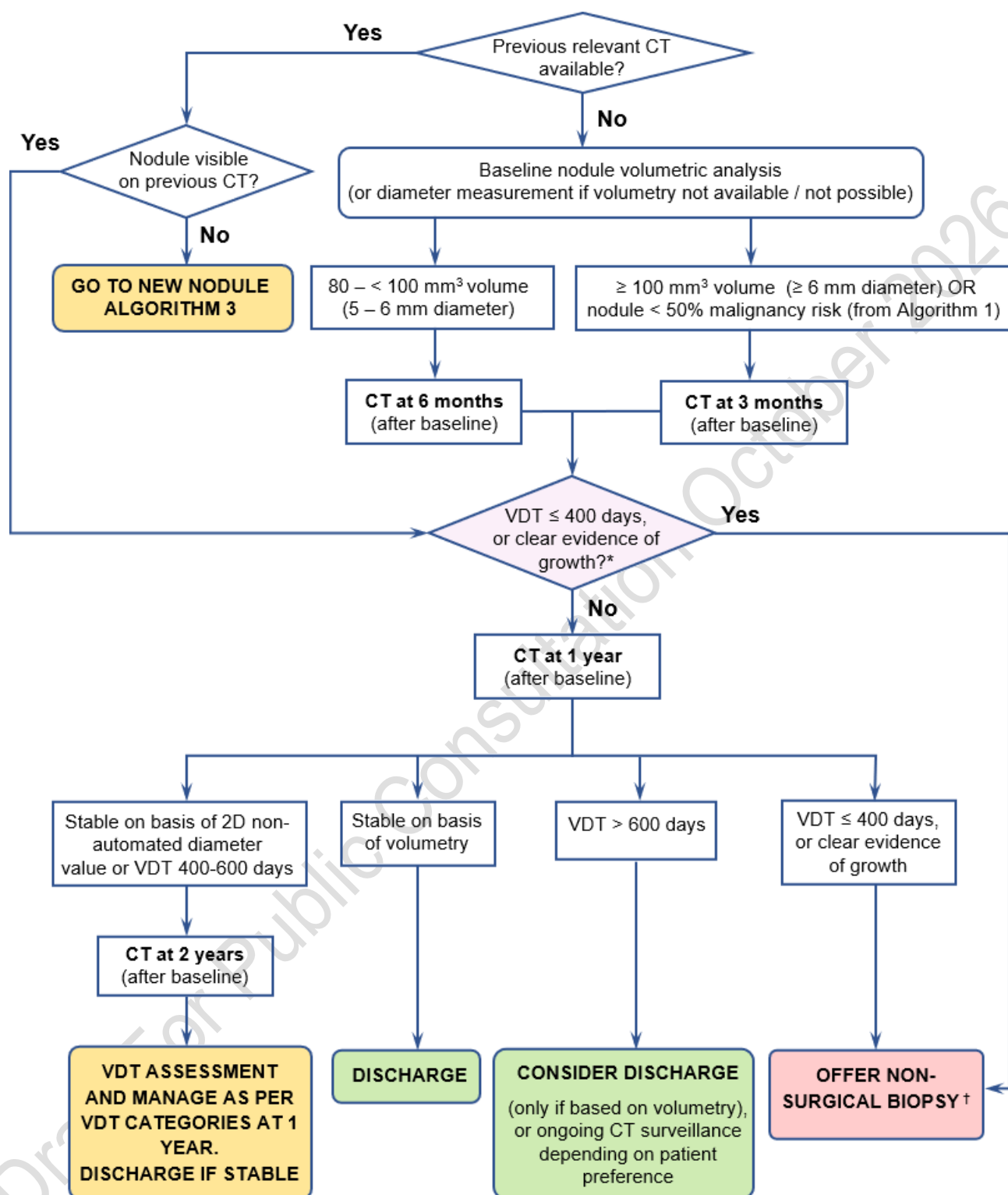
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220 * e.g., hamartoma, typical benign intrapulmonary lymph node

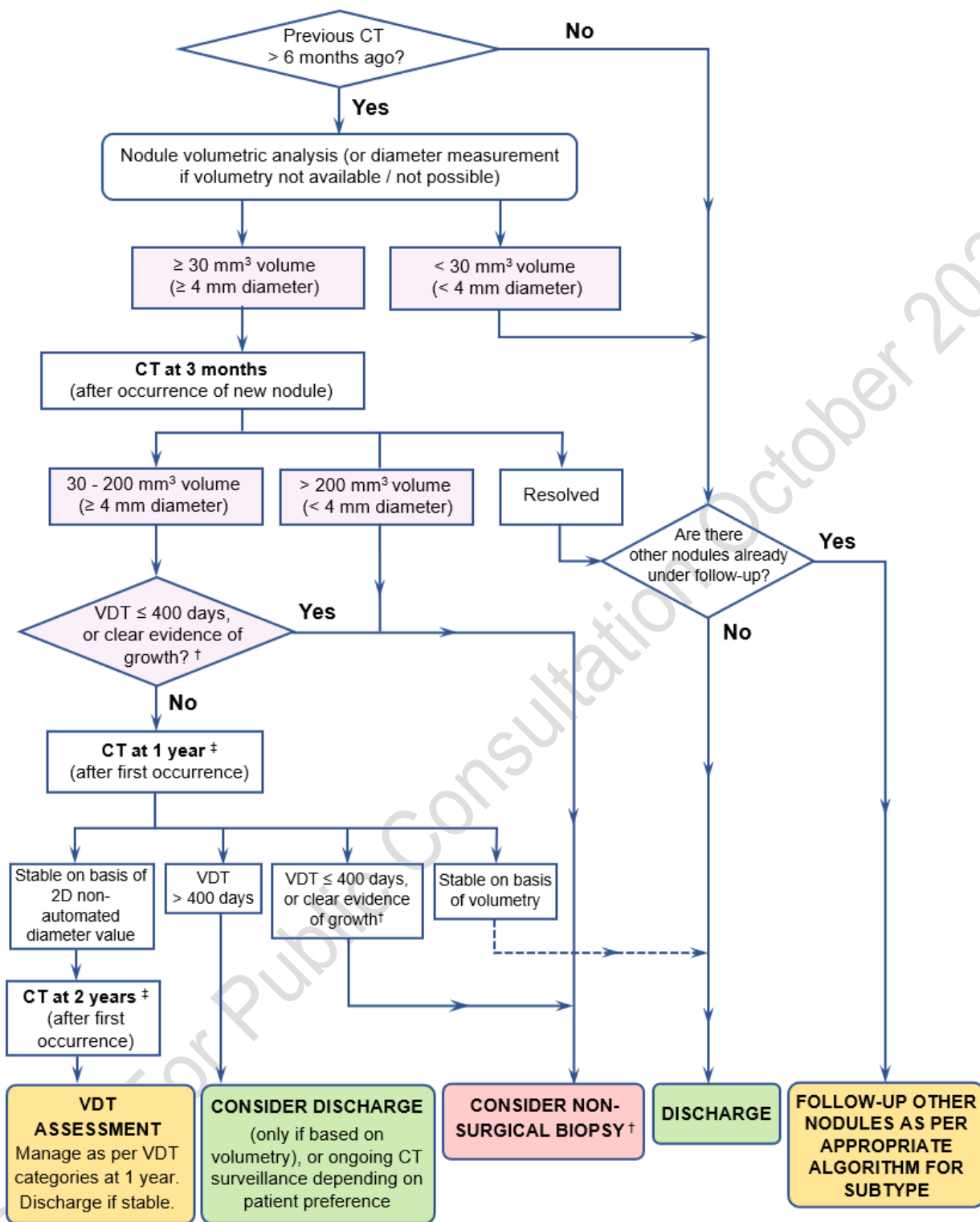
221 † Consider definitive management without biopsy if nodule is < 2 cm and risk of malignancy is > 85%

222 CT – computed tomography; FDG-PET-CT – fluorodeoxyglucose positron emission tomography computed tomography;

223 PET-CT – positron emission tomography computed tomography.



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227 * $\geq 25\%$ increase in volume, or $\geq 2\text{mm}$ in diameter
228 † Consider further CT surveillance if nodule is $< 200\text{ mm}^3$
229 Brock and Herder models not to be used for nodule discrimination after baseline scan.
230 CT – computed tomography; VDT – volume doubling time
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* Nodule must be confirmed to be truly new. If nodule is newly detected but visible in retrospect, please follow Algorithm 2.

† $\geq 25\%$ increase in volume, or $\geq 2\text{mm}$ in diameter.

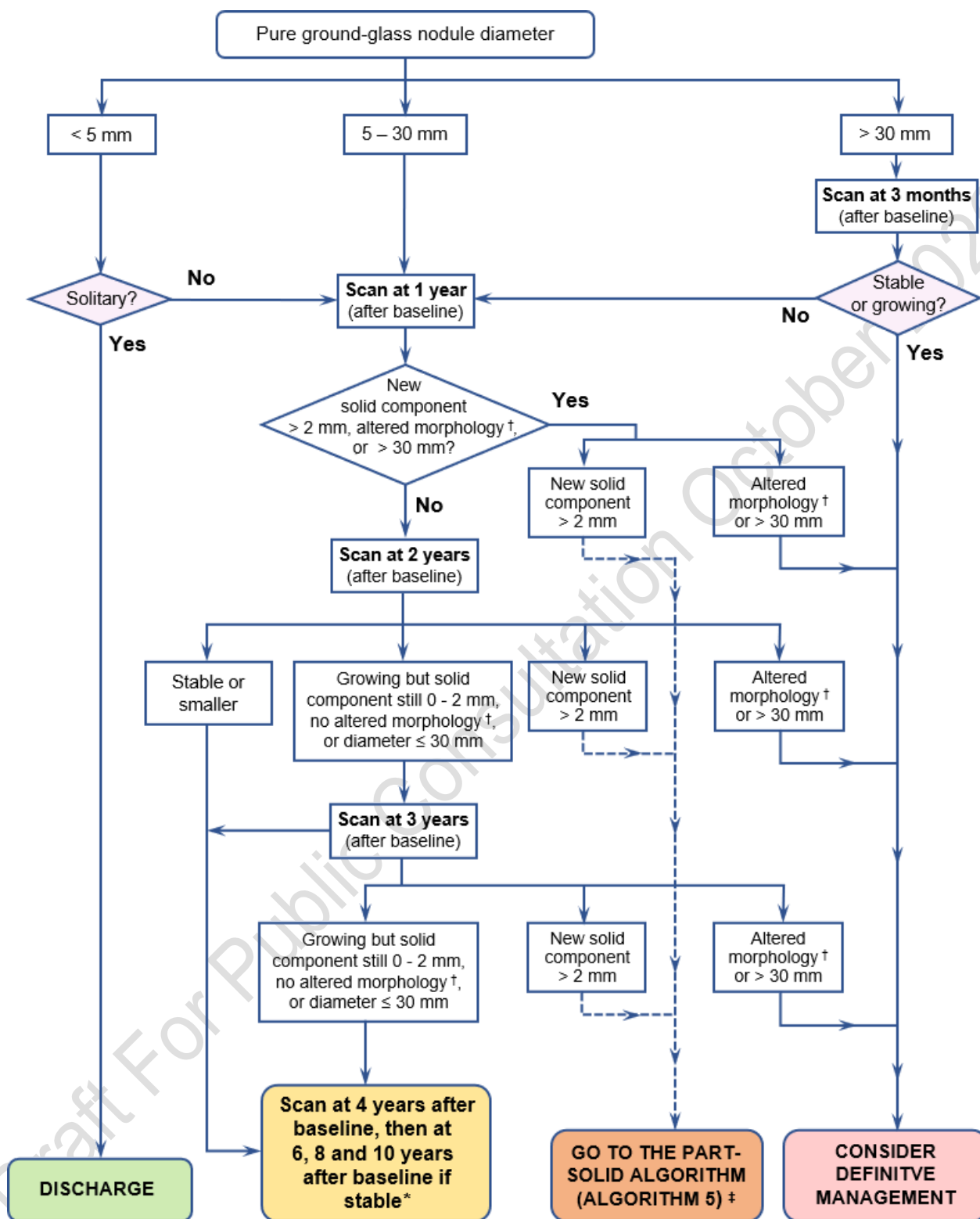
‡ If the new nodule was discovered on follow-up CTs performed for other nodules it is acceptable to modify the surveillance timepoints in this Algorithm and Algorithm 2 to ensure that both the nodule(s) originally under surveillance and the new nodule have sufficient time to permit reliable growth assessment. Please see *Section 5.3 Algorithm 3 New solid nodule follow-up pathway* and examples in Appendix 2.

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Brock and Herder models not to be used for nodule discrimination for new nodules.

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CT – computed tomography; VDT – volume doubling time



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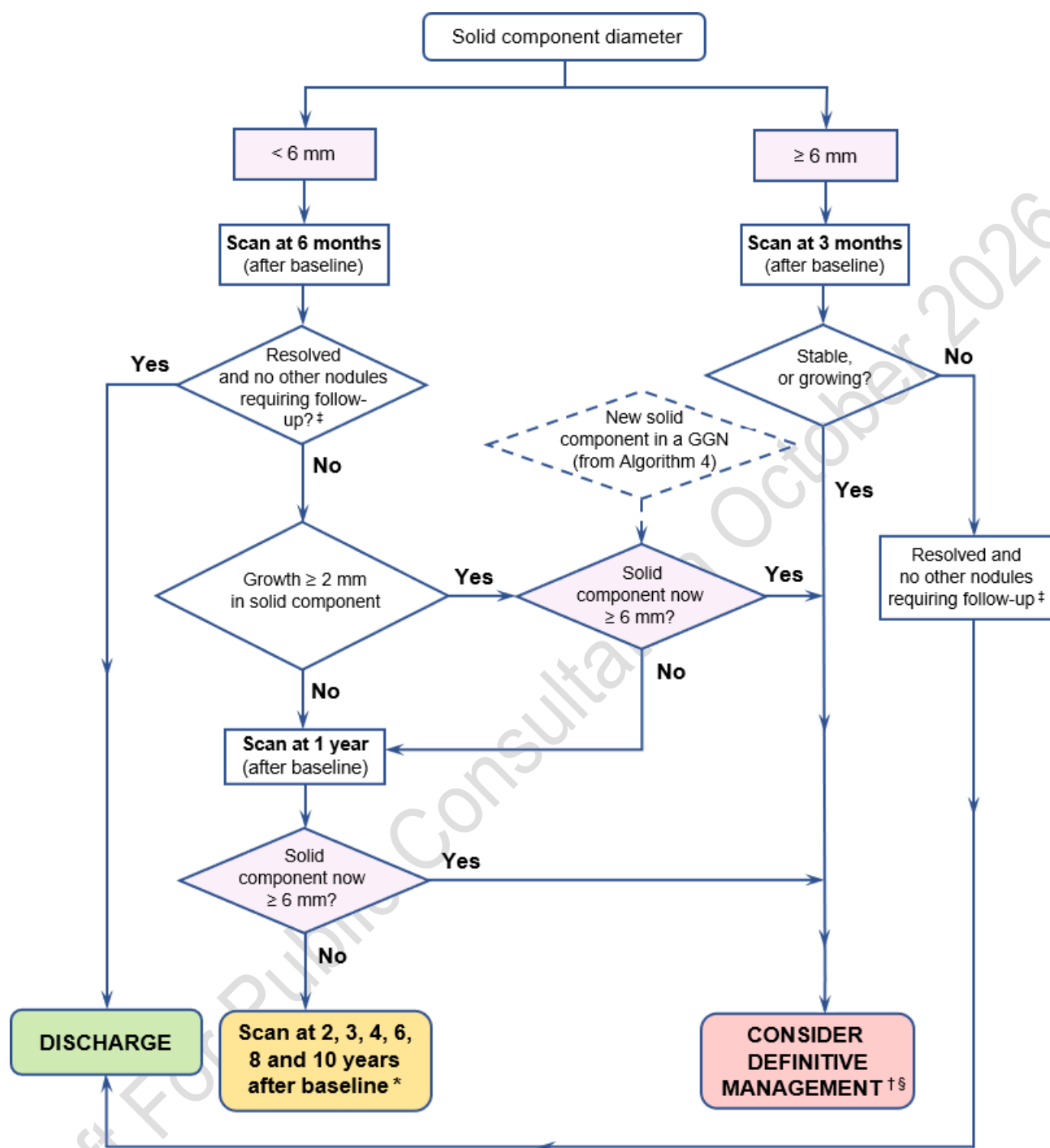
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* Length of follow-up:

- After 10 years of follow-up, consider CT every 5 years if patient remains suitable for definitive management.
- At any point at or after 4 years, if changes in the lesion occur, manage as per the steps for a scan at 2 years from baseline.

† Altered morphology: air bronchograms, bubble-like lucency, increased CT density, distortion of fissure.

‡ Definitive management should be a shared decision-making process taking into account patient choice, age, co-morbidities, and fitness for treatment.



245

246 * Length of follow-up:

247 - After 10 years of follow-up, consider CT every 5 years if patient remains suitable for definitive management.

248 - At any point at or after 4 years, if changes in the lesion occur, manage as per the steps for a scan at 2 years from
249 baseline.

† PET-CT not required for further nodule characterisation or staging if solid component < 10 mm.

‡ If multiple GGNs and still persistent – see Ground-glass nodule pathway (Algorithm 4)

§ Definitive management should be a shared decision-making process taking into account patient choice, age, and co-morbidities.

250 CT – computed tomography; GGN – ground-glass nodule; VDT – volume doubling time

251

252 1. INTRODUCTION

253 1.1 Aim of the guideline

254 The British Thoracic Society (BTS) published its previous guideline on pulmonary nodules in 2015, which was
255 widely adopted and provided a robust framework for clinical practice.[1] Since that time, several important
256 developments have occurred. These include the implementation of lung cancer screening in England,
257 advances in imaging technology, and significant progress in biopsy techniques and surgical approaches. The
258 current guideline is not an update of previous recommendations; it represents a new process, underpinned by
259 de novo systematic reviews, meta-analyses, and algorithm development conducted in accordance with the
260 GRADE Working Group framework.

261 The aim of this guideline is therefore to provide evidence-based, pragmatic recommendations for the
262 investigation and management of patients with pulmonary nodules within the UK healthcare setting, reflecting
263 contemporary evidence, evolving technologies, and the realities of clinical practice. Guidance should be
264 interpreted in the context of suitability for treatment, co-morbidities, competing causes of mortality and patient
265 preferences.

266 1.2 Intended users of the guideline and target patient populations

267 The guideline will be of interest to UK based clinicians diagnosing lung cancer and managing adults with
268 pulmonary nodules, including respiratory physicians, respiratory trainees, thoracic radiologists, thoracic
269 surgeons, clinical oncologists, lung cancer nurse specialists, pathologists, positron emission tomography–
270 computed tomography (PET-CT) specialists, pathologists, radiographers, other allied health professional and
271 patients and carers. Guideline group members were selected to offer a broad geographical coverage of the
272 United Kingdom and to include specialists with backgrounds in respiratory medicine, thoracic surgery,
273 oncology, pathology, radiology and nursing.

274 1.3 Scope of the guideline

275 The guideline will focus on accurately diagnosing cancerous and non-cancerous pulmonary nodules (solid or
276 sub-solid) in adults 18 years-old or older. For those that are cancerous, and represent early lung cancer, the
277 guideline will determine appropriate further investigation to optimise patient outcomes.

278 Specifically, the guideline will determine:

- 279 i) If the route of detection (CT screening versus incidental detection) influences the likelihood of a
280 pulmonary nodule being lung cancer.
- 281 ii) If a previous history of cancer influences the likelihood of a pulmonary nodule being a primary lung
282 cancer.
- 283 iii) The best imaging test(s) for detecting cancer in pulmonary nodules (solid and sub-solid).
- 284 iv) The best imaging assessment method(s) for identifying nodule morphological change(s) when using
285 CT surveillance to predict lung cancer (solid and sub-solid).
- 286 v) The diagnostic accuracy of different biopsy methods (surgical and non-surgical) for diagnosing lung
287 cancer in pulmonary nodules.
- 288 vi) If non-surgical biopsy improves clinical outcomes in those with pulmonary nodules being considered
289 for treatment with curative intent; and
- 290 vii) If PET-CT is required for all nodules being considered for treatment for lung cancer with curative intent.

291 1.4 Areas not covered by the guideline

292 The management of pulmonary nodules in patients with known extra-thoracic malignancy is not specifically
293 addressed. In this setting, the probability of metastatic disease, a second primary lung cancer, or benign
294 pathology varies substantially according to tumour type, stage, treatment history and clinical trajectory;
295 management should therefore be individualised through multidisciplinary review.

Artificial intelligence-based malignancy prediction software is also not incorporated into these recommendations. Although these tools are promising, the evidence base remains heterogeneous and is still maturing. In particular, published datasets often classify nodules incompletely, with limited separation of solid, part-solid and ground-glass nodules, making it difficult to define how AI outputs should be incorporated into management algorithms across specific nodule subtypes.

1.5 Limitations of the guideline

Healthcare providers need to use clinical judgement, knowledge and expertise when deciding whether it is appropriate to apply recommendations for the management of patients. The recommendations cited here are a guide and may not be appropriate for use in all situations. The guidance provided does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of each patient, in consultation with the patient and/or their guardian or carer.

1.6 Members of the guideline development group

The guideline development group (GDG) was chaired by two respiratory consultants and a consultant radiologist – Professor Mat Callister, Professor Neal Navani and Dr Arjun Nair. Professor Callister stepped down from the group in March 2024, with Professor Navani taking over the co-chair role. The GDG had a wide membership and included colleagues from respiratory medicine, oncology, radiology, pathology and nursing. A full list of group members can be seen in Appendix 3.

1.7 Acknowledgements

The GDG would like to thank Professor Mat Callister who co-chaired the group until March 2024. Professor Callister put considerable effort into developing the scope, developing the clinical questions and screening the abstracts in the first literature review. The GDG would also like to thank Professor Anand Devaraj who was a member of the group until December 2025.

2. METHODOLOGY

2.1 Establishment of guideline development group

The GDG was convened in February 2022, with the first meeting taking place in October 2022. Five additional trainee group members were recruited in June 2024. The full GDG met eight times during the development of the guideline and kept in close contact by teleconference and email throughout the process.

2.2 Methodology

This BTS guideline uses GRADE methodology in the guideline development process. Full details are provided in the BTS Guideline production manual (<https://www.brit-thoracic.org.uk/quality-improvement/guidelines/>) and in the detailed training materials produced for the group.

2.3 Summary of key questions, outcomes and literature search

Clinical questions were defined from the scope of the guideline formulated into PICO-type (population, intervention, comparator, and outcome) framework diagnostic accuracy, intervention or prognostic review formats. A full list of clinical questions for each section of the guideline is provided in Appendix 4.

Patient centred outcomes were agreed by the group for each question.

The PICO framework formed the basis of the literature search. Searches were completed by BTS Head Office. Systematic electronic database searches were conducted to identify all papers that may be relevant to the guideline. For each question, the following databases were searched in Search 1: Cochrane Database of Systematic Reviews (CDSR), Cochrane Central Register of Controlled Trials (CENTRAL), EMBASE and MEDLINE; and in Search 2: EMBASE and MEDLINE. The search strategy is available for review in Online Supplementary Appendix 10 (not included in the main guideline document).

2.4 Literature review

Literature searches were conducted as shown in Table 1:

Table 1: Literature search details

Search	Search date(s)	Dates covered by search	Abstracts
Search 1	23 - 26 May 2023	1990 onwards	12201
Search 2	21 - 24 March 2025	May 2023 onwards	2647
Additional	28 March 2025	1990 onwards	3553

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Letters, conference papers and news articles were removed and criteria for initial screening of the abstracts were:

- Does the study type match the study type criteria in the clinical question protocols?
- Does the population match the clinical question population(s)?
- Is the abstract in English?

The remaining abstracts were screened by Professor Mat Callister and Dr Arjun Nair (Search 1), Professor Neal Navani and Dr Arjun Nair (Search 2) and Dr Kirstie Opstad (Additional Search). Potentially relevant abstracts were allocated to the relevant clinical questions. Abstracts were not rejected based on the journal of publication, authorship, or country of origin.

GDG members were allocated to work on individual questions in small groups. Each abstract was read and at least two members agreed whether the abstract was 'potentially relevant' or 'not relevant' to the clinical question of interest. Abstracts were excluded if they were deemed 'not relevant' to the clinical question.

Full papers were obtained for all abstracts assigned as 'potentially relevant'. Each full paper was reviewed to assess if it addressed:

- i) The clinical question population
- ii) The index test and reference standard (for diagnostic accuracy questions), the intervention and comparator (for intervention questions), or the exposure and referent (for prognostic questions)
- iii) The study type(s) defined in the clinical question protocol; and
- iv) The clinical question outcome(s)

Each full paper fulfilling the above criteria, and agreed by at least two members of the GDG, was 'accepted' for meta-analysis and subsequent critical appraisal.

In circumstances where there was little, or no supporting evidence that fulfilled the above criteria, the full paper inclusion strategy was widened to include evidence which partially addressed the clinical question.

The second literature search (Search 2) was undertaken in March 2025 to capture additional published evidence while the guideline was in development prior to finalising the draft document. Due to the lack of relevant evidence from Search 1 to adequately address all clinical questions, an additional literature search was also undertaken in March 2025 to widen the search, and source further abstracts not retrieved in Searches 1 and 2. All additional abstracts were reviewed and allocated to the clinical questions as above. The full list of abstracts has been retained and is kept in an archive.

2.5 External sourcing of evidence

For clinical questions where data were still lacking after Searches 1, 2 and 'Additional', PubMed and ChatGPT (GPT-5) were used to try and source other relevant publications. Despite using this approach, only one additional publication was relevant to the evidence reviews (Clinical Question 8, Reference 12 (Online Supplementary Appendix 8, not included in the main guideline document)).

377

378 2.6 Systematic review of the evidence

379 Each 'accepted' full paper underwent a systematic review. Data were extracted and meta-analyses were
 380 performed for each clinical question on an outcome-by-outcome basis for intervention reviews, or an index test
 381 basis for diagnostic accuracy reviews. If meta-analysis was not possible, e.g. if there was insufficient evidence
 382 to perform a meta-analysis, if data could not be extracted to input into a meta-analysis, or data across studies
 383 had been published in different formats, all relevant supporting data were tabulated where possible.

384 All full papers contributing towards a meta-analysis underwent critical appraisal. For all non-meta-analysed
 385 data included in an evidence review, contributing papers also underwent critical appraisal where possible.

386 Meta-analyses and risk of bias assessments (critical appraisal) were performed in Review Manager 5.3 and
 387 agreed by at least two members of the GDG. Diagnostic accuracy meta-analyses involved an additional step
 388 which was performed by BTS Head Office using the MetaDTA app.[2,3] Papers no longer deemed relevant
 389 were removed from the systematic review, with the decision to 'exclude' a paper solely based on it not fulfilling
 390 the clinical question criteria.

391 2.7 GRADE analysis of the evidence

392 Having generated evidence profiles for each of the clinical questions, GDG question groups assessed the
 393 quality of the evidence using the Grading of Recommendations, Assessment, Development and Evaluation
 394 (GRADE) methodology.[4]

395 Where GRADE analysis was not possible, but GDG members felt the evidence was important to be included
 396 in the Evidence Statements, these have been listed as (**Ungraded**). Definitions of the Evidence statement
 397 (GRADE) scores are shown in Table 2.

398 Each clinical question was reviewed by the full GDG during the regular meetings and consensus was reached
 399 in relation to the evidence summary.

400 **Table 2:** Evidence statement (GRADE) score definitions

GRADE	Definition
High ⊕⊕⊕⊕	High confidence that the true effect is close to the estimated effect
Moderate ⊕⊕⊕○	Moderate confidence that the true effect is close to the estimated effect
Low ⊕⊕○○	Low confidence that the true effect is close to the estimated effect
Very Low ⊕○○○	Very low confidence that the true effect is close to the estimated effect
Ungraded	GRADE analysis not possible, but evidence deemed important by the GDG

401

402 2.8 Development of recommendations

403 The GDG proceeded to decide on the direction and strength of recommendations considering the quality of
 404 the evidence, the balance of desirable and undesirable outcomes and the values and preferences of patients
 405 and others. GRADE specifies two categories of strength for a recommendation, as shown in Table 3.

406 From the outset, it was acknowledged that there would be little high-quality evidence for some of the clinical
 407 questions identified. In this instance, low grade evidence was considered, along with expert opinion via
 408 consensus at the meetings.

409

410

411 **Table 3:** Explanation of the terminology used in BTS recommendations

Strength	Benefits and risks	Implications
Strong Recommended, so “offer”	Benefits appear to outweigh the risks (or vice versa) for the majority of the target group	Most service users would want to, or should receive this intervention
Conditional Suggested, so “consider”	Risks and benefits are more closely balanced, or there is more uncertainty in likely service users’ values and preferences	Service users should be supported to arrive at a decision based on their values and preferences

412
413 Good practice points (GPPs) were developed by consensus in areas where there was no quality evidence, but
414 the GDG felt that some guidance, based on the clinical experience of the GDG, might be helpful to the reader.
415 These are indicated as shown below.

416 ✓ Advised best practice based on the clinical experience of the guideline development group

417 In some instances where evidence was limited, but GDG members felt that it was important to include a
418 recommendation rather than a GPP, recommendations were agreed by consensus and categorised as
419 (**Conditional** – by consensus), based on the same criteria detailed in Table 3.

420 Cost-effectiveness was not considered in detail as in-depth economic analysis of recommendations falls
421 outside of the scope of the BTS guideline production process. However, the GDG were asked to be mindful of
422 any potential economic barriers to the implementation of recommendations and GPPs.

423 Research recommendations were also identified and listed in Online Supplementary Appendix 11 (not included
424 in the main guideline document).

425 **2.9 Diagnostic test accuracy reviews**

426 Diagnostic test accuracy reviews evaluate how good, or bad, a diagnostic test is for diagnosing a disease and
427 have been used for several clinical question reviews within the guideline. Test accuracies are usually reported
428 as sensitivity and specificity and commonly labelled as ‘Very high’, ‘High’, ‘Moderate’ or ‘Low’, but currently
429 there is no standard definition of what each level is. Hence, for the purposes of this guideline the definitions in
430 Table 4 have been used (cut-offs not validated). It is important when considering implementation of the
431 recommendations to consider the prevalence of the condition within the clinical setting. This will affect the
432 positive and negative predictive values of a test, i.e. the proportion of patients with a positive or negative test
433 who are correctly diagnosed.

434 **Table 4:** Guideline definitions of ‘Very high’, ‘High’, ‘Moderate’ and ‘Low’ sensitivity/specificity

Level	Pooled estimate sensitivity / specificity
Very high	90% to 100%
High	>80% to 90%
Moderate	65% to 80%
Low	<65%

435
436 **2.10 Drafting the guideline**

437 The guideline group corresponded regularly by email and meetings of the full group were also held in the
438 period between December 2025 and August 2026. A revised draft guideline document was circulated to all
439 stakeholders for consultation in October 2026 followed by a period of online public consultation. The BTS
440 SOCC reviewed the draft guideline in June 2026 and October 2026.

441 **2.11 Review of the guideline**

442 The guideline will be reviewed five years after the date of publication.

443 **2.12 Declarations of interests**

444 BTS Declarations of Interest forms have been completed by all members for each year they were part of the
445 GDG. Details of these forms can be obtained from BTS Head Office. "Declarations of Interests" was a standing
446 item at each GDG meeting.

447 **2.13 Stakeholders**

448 Stakeholders were identified at the start of the process. All stakeholder organisations were notified when the
449 guideline was available for public consultation, and a list is published in Appendix 5.

450

451 **3. PULMONARY NODULES**

452 **3.1 Background**

453 A pulmonary nodule is defined as a focal opacity within the lung measuring less than 3 cm in diameter on
454 computed tomography (CT). Pulmonary nodules are classified into three radiological subtypes: (1) solid
455 nodules, which completely obscure the underlying lung parenchyma; (2) pure ground-glass nodules, through
456 which the underlying lung architecture remains visible; and (3) part-solid nodules, which contain both ground-
457 glass and solid components. Accurate distinction between these subtypes is essential, as they can differ
458 significantly in their probability of malignancy, natural history, prognosis, and optimal management strategies.
459 For example, persistent part-solid nodules are frequently malignant but may exhibit indolent behaviour,
460 necessitating prolonged surveillance rather than immediate intervention.

461 While lung cancer remains the leading cause of cancer-related mortality worldwide, randomised controlled
462 trials of low-dose CT (LDCT) screening have demonstrated a significant reduction in lung cancer-specific
463 mortality. Lung cancer screening (LCS) is now being implemented across England, with full national roll-out
464 anticipated by 2030. As a consequence, the detection of pulmonary nodules has increased substantially.
465 Nodules are identified in a significant proportion (15-20%) of screening scans, and as of July 2026, over 1.2
466 million LDCT scans have been performed in England, with approximately 198,000 individuals undergoing
467 nodule surveillance through the screening programme. In parallel, the widespread use of CT imaging for other
468 clinical indications—such as suspected pulmonary embolism or coronary artery disease—has further
469 increased the incidental detection of pulmonary nodules.

470 The management of pulmonary nodules is a complex clinical challenge that extends beyond distinguishing
471 benign from malignant disease. High-quality care requires balancing early cancer diagnosis with the avoidance
472 of harm. This includes minimising false-positive findings from screening programmes, reducing unnecessary
473 follow-up imaging, optimising diagnostic yield from biopsy procedures, limiting overdiagnosis, preventing stage
474 progression during surveillance, and avoiding unnecessary surgical resection of benign lesions.

475 This guideline therefore aimed to provide evidence-based, pragmatic recommendations for the investigation
476 and management of patients with pulmonary nodules within the UK healthcare setting, reflecting contemporary
477 evidence, evolving technologies, and the realities of clinical practice. Guidance should be interpreted in the
478 context of suitability for treatment, co-morbidities, competing causes of mortality and patient preferences.

479 **3.2 Investigative approach following low dose computed tomography (LDCT) screening or** 480 **incidental detection**

481 Pulmonary nodules are common incidental findings on computed tomography (CT) scans performed for other
482 clinically indicated reasons. These incidentally detected nodules have been the main source of pulmonary
483 nodules requiring follow up in accordance with previous BTS guidelines. More recently, lung cancer screening
484 has become a significant source of pulmonary nodules requiring follow up. This question focused on whether
485 incidentally detected and screen detected pulmonary nodules differed in their risk for malignancy and therefore
486 whether they required different follow up guidelines.

487 **Question 1:** In adults, is there a difference in the likelihood of diagnosing lung cancer in pulmonary nodules
 488 detected by low dose computed tomography (CT) screening compared to those detected on
 489 CT scans done for other reasons?

490 The findings of this question are summarised in Tables 5 and 6.

491 **Table 5:** Evidence summary of the likelihood of diagnosing lung cancer in pulmonary nodules detected by
 492 LCDT screening versus incidental detection

Clinical Outcome	Summary of evidence review (LDCT versus incidental)
Actionable pulmonary nodules after pulmonary nodule detection	Greater following LCDT screening detection (25 [16, 38] % versus 12 [5,31] % respectively, median [IQR], $p < 0.01^*$)
Lung cancer after actionable pulmonary nodule detection	No difference (6 [4,10] % versus 6 [3, 10] % respectively, median [IQR], $p = 0.58^*$)

493 * Mann-Whitney U Test

494 IQR – interquartile range

495 **Table 6:** Evidence summary of the likelihood of diagnosing lung cancer in pulmonary nodules detected by
 496 LDCT screening, with or without previous CT imaging, versus incidental detection

Comparison	Summary of evidence review (lung cancer detection)
LDCT with previous CT imaging versus LDCT without previous CT imaging	No difference (5 [3,12] % versus 6 [4,8] % respectively, median [IQR], $p = 0.52^*$)
LDCT with previous CT imaging versus incidental detection	No difference (6 [4, 8] % versus 6 [3,10] % respectively, median [IQR], $p = 0.51^*$)
LDCT without previous CT imaging versus incidental detection	No difference (5 [3, 12] % versus 6 [3,10] % respectively, median [IQR], $p = 0.96^\dagger$)

497 * Unpaired t-test

498 † Mann-Whitney U Test

499 IQR – interquartile range

500 Evidence statements

- 501 - An actionable pulmonary nodule is more likely to be identified on screening low-dose computed
 502 tomography (LDCT) than on a CT scan performed for another reason. (**Ungraded**)
- 503 - The likelihood that a pulmonary nodule is diagnosed as lung cancer is similar whether it is detected through
 504 low-dose computed tomography (LDCT) screening or incidentally on a CT scan performed for another
 505 reason. (**Ungraded**)

506 Recommendation

- 507 ➤ For adults with pulmonary nodules identified on a CT scan, the investigation and management should not
 508 differ whether detected on low dose computed tomography (LDCT) for lung cancer screening or CT scan
 509 done for other reasons. (**Conditional**)

510 Issues with the data

511 Only one paper directly compared the lung cancer incidence in incidentally detected versus screen detected
 512 pulmonary nodules. However, this study had to be excluded from analysis as data reporting was incomplete.
 513 Therefore, the analysis is limited to single arm studies only and the data were not suitable for meta-analysis.

514 **Point of ongoing contention**

515 As lung cancer screening programmes internationally mature and publish new data this topic will be open to
516 further review.

517 The full Evidence Review is available in Online Supplementary Appendix 1 (not included in the main guideline
518 document).

519 **3.3 Likelihood of lung cancer following a previous history of non-lung cancer**

520 Patients with a prior history of non-lung cancer frequently undergo thoracic imaging as part of follow-up care,
521 leading to detection of incidental pulmonary nodules. Pulmonary nodules in these patients may represent
522 benign disease, primary lung cancer, or metastatic recurrence of the previous malignancy. It remains uncertain
523 whether a previous history of non-lung cancer increases the likelihood of diagnosing primary lung cancer in a
524 pulmonary nodule, and whether this should influence interpretation or follow-up imaging strategies.

525 **Question 2:** In adults with pulmonary nodules, is there a difference in the likelihood of diagnosing lung
526 cancer between patients with or without a previous history of non-lung cancer?

527 The findings of this question are summarised in Table 7.

528 **Table 7:** Evidence summary of the likelihood of diagnosing lung cancer between patients with or without a
529 previous history of non-lung cancer

Clinical Outcome	Summary of evidence review (“with” versus “without” a previous history)
Lung cancer	Greater with a previous history of non-lung cancer (31 [18,48] % versus 5 [2,11] % of subjects respectively, median [IQR], $p < 0.001^*$ (single arm studies))

530 * Mann-Whitney U Test

531 IQR – interquartile range

532 **Evidence statement**

533 - A previous history of non-lung cancer appears to increase the likelihood of diagnosing lung cancer in a
534 pulmonary nodule (**Very low**)

535 **Recommendation**

536 ➤ For adults with a pulmonary nodule identified on a CT scan, information about a previous history of non-
537 lung cancer should be sought as there may be an increased risk of nodule malignancy. (**Conditional**)

538 **Issues with the data**

539 The available evidence was limited and largely derived from small observational studies, with only two
540 comparative studies suitable for meta-analysis. Many studies lacked pathological confirmation of malignancy
541 or combined multiple histological subtypes without clear reporting, limiting interpretation of the data. In several
542 studies it was also difficult to determine whether pulmonary nodules represented primary lung cancer or
543 metastatic disease from a previous malignancy.

544 **Point of ongoing contention**

545 Key areas of ongoing uncertainty include the extent to which a previous history of non-lung cancer
546 independently increases the likelihood of pulmonary nodule being a primary lung cancer. Despite this, extra-
547 thoracic cancer is included in the Herder model which has been used effectively in the 2015 BTS Guidelines
548 for the investigation and management of pulmonary nodules [1] and has been externally validated.

549 The full Evidence Review is available in Online Supplementary Appendix 2 (not included in the main guideline
550 document).

3.4 Solid nodules – Baseline diagnostic approach

Solid pulmonary nodules identified at baseline (prevalence) imaging may represent a range of pathologies, from benign to malignant, and therefore not all solid pulmonary nodules require immediate invasive diagnostic procedures. Solid pulmonary nodules, when compared with part-solid or pure ground-glass nodules, are known to have different malignancy risk profiles and underlying pathologies and therefore require different diagnostic and surveillance methods when identified at baseline imaging. Question 3 aimed to interrogate the baseline data on these types of nodules to inform downstream decision making (immediate intervention versus surveillance versus discharge from follow up).

Question 3: What is the diagnostic accuracy of imaging tests, and the optimal strategy for image utilisation for diagnosing lung cancer in a solid pulmonary nodule?

The findings of this question are shown in Tables 8 and 9.

Table 8: Evidence review summary for the diagnostic accuracy of imaging tests for diagnosing lung cancer in solid pulmonary nodules

Imaging test	n	Cut-off	Sensitivity [95% CI]	Specificity [95% CI]
Nodule diameter	5	> 8 mm	0.86 [0.71, 0.94]	0.55 [0.31, 0.78]
Nodule volume	1	> 2.17 cm ³	0.62 [0.50, 0.72]	0.64 [0.52, 0.75]
Upper lobe location	5	-	0.59 [0.50, 0.68]	0.74 [0.57, 0.85]
Spiculation	8	-	0.56 [0.44, 0.67]	0.74 [0.57, 0.85]
FDG-avidity	9	-	0.84 [0.76, 0.89]	0.76 [0.66, 0.83]
Brock score	1	>13.4%	0.75 [0.69, 0.80]	0.52 [0.41, 0.62]
Herder score	1	>70%	0.74 [0.68, 0.80]	0.64 [0.53, 0.73]
Mayo score	1	>29.6%	0.69 [0.63, 0.75]	0.68 [0.57, 0.77]
VA	-	-	-	-
UKLS	-	-	-	-

CI – confidence intervals; n – number of datasets

Evidence statements

- Solid pulmonary nodule diameter greater than 8 mm appears to have a high sensitivity and low specificity for diagnosing lung cancer. (**Low**)
- Solid nodule upper lobe location appears to have a low sensitivity and low specificity for diagnosing lung cancer. (**Low**)
- Solid nodule spiculation appears to have a low sensitivity and a moderate specificity for diagnosing lung cancer. (**Very low**)
- Solid nodule FDG-avidity appears to have a high sensitivity and moderate specificity for diagnosing lung cancer. (**Low**)

Recommendations

- The [Solid nodule diagnostic pathway](#) (Algorithm 1), incorporating different solid nodule characteristics, should be used for determining lung cancer in solid pulmonary nodules. (**Conditional** – by consensus)
- An FDG PET-CT (fluorodeoxyglucose positron emission tomography computed tomography) scan should be offered for determining lung cancer risk in solid pulmonary nodules ≥ 8 mm. (**Conditional**)

579 **Issues with the Data**

580 The evidence base for Question 3 had several important limitations. Data on solid pulmonary nodules identified
581 at baseline imaging are heterogeneous, with no standardised approach to reporting diameter, volume or other
582 imaging characteristics. This assessment was further limited by the fact that studies often report solid and part-
583 solid nodule characteristics together, without separating these distinct nodule groups. Much of the relevant
584 literature focussed on de novo risk scores, tools which combine multiple clinical and imaging biomarkers (often
585 presented as AI-generated algorithms) to predict underlying malignancy, but these could not be included due
586 to heterogeneity of the components used to create the scores, and limitations around the clinical reproducibility
587 of these risk scores. Certain metrics specified in the question had insufficient data to be assessed. In addition,
588 some clinically relevant information could not be incorporated due to restrictions related to question definition,
589 extraction methodology, or meta-analysis requirements. As such, a consensus view on solid pulmonary nodule
590 management was taken, to allow for practical management of solid nodules identified at baseline imaging.

591 Due to a relatively limited sample of data meeting the criteria for inclusion in the meta-analysis, a consensus
592 statement on how to manage solid pulmonary nodules has been agreed (see Algorithm 1 [Solid nodule](#)
593 [diagnostic pathway](#)). This algorithm represents a practical approach to management of these nodules, while
594 acknowledging the results from the meta-analysis.

595 The full Evidence Review is available in Online Supplementary Appendix 3 (not included in the main guideline
596 document).

597 **3.5 Solid nodules – Surveillance**

598 The assessment of interval change in solid pulmonary nodules is a key component of establishing the risk of
599 malignancy and potential for a subsequent lung cancer diagnosis, in patients with a low initial probability of
600 malignancy. In these patients, immediate invasive investigation may not be appropriate or feasible, and serial
601 computed tomography (CT) surveillance is an established modality to help distinguish benign from malignant
602 nodules. Several strategies have been proposed to define significant growth, and therefore the potential of a
603 cancer diagnosis, including changes in diameter, volume, and volume doubling time (VDT). Accurate
604 assessment of growth patterns is clinically important to avoid delaying cancer diagnosis, while minimising
605 unnecessary imaging, procedures, and patient anxiety associated with benign nodules. This question
606 evaluates the diagnostic accuracy of CT-based strategies used to detect interval change suggestive of
607 malignancy.

608 **Question 4:** In adults with solid pulmonary nodules, what is the diagnostic accuracy of strategies used to
609 detect change between interval computed tomography (CT) scans for diagnosing lung
610 cancer?

611 The findings of this review are summarised in Table 9.

612 **Table 9:** Evidence review summary for the diagnostic accuracy of imaging test changes between CT scans for
613 diagnosing lung cancer in solid pulmonary nodules

Imaging strategy	n	Cut-off	Sensitivity [95% CI]	Specificity [95% CI]
Visual analysis	-	-	-	-
Diameter change	1	> 1.5 mm	0.55 [0.23, 0.83]	1.00 [0.96, 1.00]
Volume doubling time (VDT)	4	< 400 days	0.76 [0.59, 0.87]	0.94 [0.79, 0.98]
Volume doubling time (VDT)	5	< 600 days	0.87 [0.72, 0.94]	0.84 [0.64, 0.93]
Mass doubling time (MDT)	-	-	-	-
Volume change	2	> 25 %	0.62 [0.31, 0.86]	0.81 [0.47, 0.91]

614 CI – confidence intervals; n – number of datasets

615 Evidence Statements

- 616 - A volume doubling time of <400 days appears to have a moderate sensitivity and a very high specificity
617 for detecting change between interval computed tomography (CT) scans for diagnosing lung cancer in
618 solid pulmonary nodules. (**Very low**)
- 619 - A volume doubling time of <600 days appears to have a high sensitivity and a high specificity for detecting
620 change between interval computed tomography (CT) scans for diagnosing lung cancer in solid pulmonary
621 nodules. (**Low**)
- 622 - A volume change of > 25% between interval computed tomography (CT) scans may have a low sensitivity
623 and a high specificity for detecting change between interval computed tomography (CT) scans for
624 diagnosing lung cancer in solid pulmonary nodules. (**Low**)
- 625 - There was insufficient evidence to support the use of visual analysis, diameter change, or mass doubling
626 time (MDT) to detect change between interval computed tomography (CT) scans for diagnosing lung
627 cancer in solid pulmonary nodules. (**Very low**)
- 628 - There was insufficient evidence to consider peri-cystic lesion and consolidated solid pulmonary nodule
629 subgroups.

630 Recommendations

- 631 ➤ Comparison to the earliest available CT should be performed at each evaluation of solid pulmonary
632 nodules.
- 633 ➤ For adults with solid pulmonary nodules, a volume doubling time (VDT) of less than 600 days should be
634 considered suggestive of lung cancer. (**Conditional**)
- 635 ➤ The [Solid nodule follow-up pathway](#) (Algorithm 2), incorporating solid pulmonary nodule changes at follow-
636 up, should be used for determining lung cancer in progressing solid pulmonary nodules. (**Conditional** –
637 by consensus)
- 638 ➤ For new solid nodules, please use the [New nodule follow-up pathway](#) (Algorithm 3). (**Conditional** – by
639 consensus)

640 Good Practice Points

- 641 ✓ Volumetry should be used when available and reliable, in preference to diameter, to calculate nodule size.
- 642 ✓ A volume change of > 25% between interval CTs can be considered highly specific for detecting growth in
643 a solid pulmonary nodule.
- 644 ✓ In the absence of available or reliable volumetry, ≥ 2mm increase in diameter can be considered clear
645 evidence of growth.

646 Issues with the data

647 The evidence base for Question 4 had several important limitations. Studies evaluating combined diagnostic
648 imaging approaches, such as positron emission tomography (PET) metrics alongside growth assessment,
649 were outside the scope of the review question. Similarly, de novo risk scores that combine multiple clinical and
650 imaging biomarkers, often presented as AI-generated algorithms, were common in the literature but could not
651 be included because of heterogeneity in score components and concerns regarding clinical reproducibility.
652 Several prespecified metrics also lacked sufficient data for assessment, including mass doubling time and peri-
653 cystic lesions. In addition, some clinically relevant information could not be incorporated because of constraints
654 related to the question definition, extraction methodology, or meta-analysis requirements. There was further
655 heterogeneity across studies in how growth was defined and measured, including variation in thresholds for
656 changes in diameter, volume, and volume doubling time (VDT). Finally, this question did not specifically
657 evaluate the impact of different surveillance intervals (for example, 3- versus 12-month CT follow-up) or the
658 optimal duration of surveillance required to confirm benignity.

Insufficient evidence was available to assess visual analysis, diameter change, mass doubling time, peri-cystic lesions, and consolidation. Evidence was limited as some studies did not report solid and sub-solid nodules separately. More standardised reporting of solid nodule growth is needed, including the use of accepted VDT thresholds.

The full Evidence Review is available in Online Supplementary Appendix 4 (not included in the main guideline document).

3.6 Solid nodules – New nodules

New solid pulmonary nodules identified at follow-up were not considered as one of the clinical questions. However, please refer to Section 5.3 Algorithm 3 New solid nodule follow-up pathway and [Algorithm 3 New solid nodule follow-up pathway](#) (developed by clinical consensus) for information.

3.7 Sub-solid nodules – Baseline diagnostic approach

CT is the cornerstone imaging modality for assessment of sub-solid pulmonary nodules (SSNs), while PET-CT may be considered in selected cases. SSNs may represent benign pathology, such as focal infection or fibrosis, or lesions within the adenocarcinoma spectrum ranging from pre-invasive abnormalities to invasive adenocarcinoma. Persistent SSNs are more likely to be malignant than solid nodules, although many demonstrate indolent behaviour and favourable outcomes, contributing to uncertainty regarding optimal investigation and management strategies, including surveillance and intervention.[5,6]

Question 5: What is the diagnostic accuracy of imaging tests, and the optimal strategy for image utilisation for diagnosing lung cancer in a sub-solid pulmonary nodule?

The overall findings for this question are summarised in Tables 10 and 11.

Table 10: Evidence review summary for the diagnostic accuracy of imaging tests for diagnosing lung cancer in sub-solid pulmonary nodules

Imaging test	n	Sensitivity [95% CI]	Specificity [95% CI]
Nodule diameter	-	-	-
Nodule volume	-	-	-
Upper lobe location	12	0.63 [0.61, 0.65]	0.43 [0.35, 0.51]
Spiculation	22	0.28 [0.18, 0.39]	0.91 [0.86, 0.94]
FDG-avidity	-	-	-
Air bronchogram	12	0.27 [0.18, 0.40]	0.88 [0.79, 0.94]
Bubble-like lucency	19	0.25 [0.19, 0.31]	0.89 [0.85, 0.91]
Clear lung/tumour interface	6	0.76 [0.52, 0.90]	0.25 [0.15, 0.38]
CT density	-	-	-
Size of solid component	-	-	-
Brock score	2	0.82 ± 0.00*	0.55 ± 0.02*
Mayo score	1	0.72	0.76
VA	-	-	-
UKLS	-	-	-

* Not meta-analysed (mean ± SD)

CI – confidence intervals; n – number of datasets

683 **Table 11:** Evidence summary of imaging tests for diagnosing lung cancer in malignant (IAC + MIA) versus
684 benign (AIS + AHH) sub-solid pulmonary nodules

Imaging test	Evidence summary of malignant nodules versus benign nodules (95% CI)
Nodule diameter (maximal)	Malignant nodules 4.0 (3.2 to 4.8) mm greater
Nodule volume	Malignant nodules 0.9 (0.4 to 1.4) cm ³ greater
FDG-avidity	Malignant nodules 2.8 (2.5 to 3.1) g/mL greater*
CT density	Malignant nodules 104.1 (81.4 to 126.8) HU greater
Size of solid component	Malignant nodules 3.3 (3.0 to 3.5) mm greater

685 * Based on 1 study; CI – confidence intervals

686 **Part solid nodule (PSN) and ground-glass nodule (GGN) subgroups**

687 Part-solid nodules (PSN) and ground-glass nodules (GGN) were considered as separate subgroups.
688 Unfortunately, there was insufficient separation of the PSN and GGN subgroups in the literature for all
689 subgroup analyses. However, where GGN data were available, GGN subgroup analyses were considered,
690 and the results are summarised in Tables 12 and 13.

691 **Ground-glass Nodules**

692 **Table 12:** Evidence review summary for the diagnostic accuracy of imaging tests for diagnosing lung cancer
693 in ground-glass sub-solid pulmonary nodules (GGN)

Imaging test	n	Sensitivity [95% CI]	Specificity [95% CI]
Nodule diameter	-	-	-
Nodule volume	-	-	-
Upper lobe location	6	0.65 [0.60, 0.70]	0.41 [0.27, 0.60]
Spiculation	8	0.17 [0.07, 0.36]	0.95 [0.87, 0.98]
FDG-avidity	-	-	-
Air bronchogram	4	0.38 [0.20, 0.61]	0.84 [0.64, 0.93]
Bubble-like lucency	7	0.23 [0.13, 0.37]	0.90 [0.78, 0.95]
Clear lung/tumour interface	-	-	-
CT density	-	-	-
Brock score	-	-	-
Mayo score	-	-	-
VA	-	-	-
UKLS	-	-	-

694 CI – confidence intervals; n – number of datasets

695

696

697

698

699 **Table 13:** Evidence summary of imaging tests for diagnosing lung cancer in malignant (IAC + MIA) versus
700 benign (AIS + AHH) ground-glass sub-solid pulmonary nodules (GGN)

Imaging test	Evidence summary of malignant nodules versus benign nodules (95% CI)
Nodule diameter (maximal)	Malignant nodules 3.6 (2.4 to 4.8) mm greater
Nodule volume	No evidence
FDG-avidity	No evidence
CT density	Malignant nodules 54.6 (42.6, 66.6) HU greater

701 * Based on 2 studies

702 Evidence statements

- 703 - Malignant sub-solid pulmonary nodules appear to have a greater maximal nodule diameter than benign
704 sub-solid pulmonary nodules. (**Very low**)
- 705 - There was insufficient evidence to determine if pulmonary nodule volume can be used for determining lung
706 cancer in sub-solid pulmonary nodules.
- 707 - Upper lobe location appears to have a low sensitivity and a low specificity for diagnosing lung cancer in
708 sub-solid pulmonary nodules. (**Moderate**)
- 709 - Upper lobe location appears to have a moderate sensitivity and a low specificity for diagnosing lung cancer
710 in ground-glass pulmonary nodules. (**Low**)
- 711 - Spiculation appears to have a low sensitivity and a very high specificity for diagnosing lung cancer in sub-
712 solid pulmonary nodules. (**Very low**)
- 713 - Spiculation appears to have a low sensitivity and a very high specificity for diagnosing lung cancer in
714 ground-glass pulmonary nodules. (**Low**)
- 715 - There was insufficient evidence to determine if FDG-avidity can be used for determining lung cancer in
716 sub-solid pulmonary nodules.
- 717 - The presence of air bronchogram appears to have a low sensitivity and a high specificity for diagnosing
718 lung cancer in sub-solid pulmonary nodules. (**Very low**)
- 719 - The presence of air bronchogram appears to have a low sensitivity and a high specificity for diagnosing
720 lung cancer in ground-glass pulmonary nodules. (**Moderate**)
- 721 - The presence of bubble-like lucency appears to have a low sensitivity and a high specificity for diagnosing
722 lung cancer in sub-solid pulmonary nodules. (**Low**)
- 723 - The presence of bubble-like lucency appears to have a low sensitivity and a very high specificity for
724 diagnosing lung cancer in ground-glass pulmonary nodules. (**Low**)
- 725 - The presence of a clear lung/tumour interface appears to have a moderate sensitivity and a low specificity
726 for diagnosing lung cancer in sub-solid pulmonary nodules. (**Very low**)
- 727 - Malignant sub-solid pulmonary nodules appear to have a greater CT density than benign sub-solid
728 pulmonary nodules. (**Very low**)
- 729 - Malignant sub-solid pulmonary nodules appear to have a greater size of solid component than benign sub-
730 solid pulmonary nodules. (**Very low**)
- 731 - There was insufficient evidence to determine the diagnostic accuracy of risk calculator models (Brock,
732 Herder, Mayo, VA and UKLS) for diagnosing lung cancer in sub-solid nodules.

733 **Recommendations**

- 734 ➤ For adults with sub-solid pulmonary nodules, maximal nodule diameter, increased CT density, spiculation,
735 size of solid component, presence of air bronchogram and presence of bubble-like lucency can all be
736 considered when determining lung cancer risk. **(Conditional)**
- 737 ➤ For adults with ground glass pulmonary nodules (GGN), the [Ground glass nodule pathway](#) (Algorithm 4)
738 should be used for determining lung cancer in GGN. **(Conditional – by consensus)**
- 739 ➤ For adults with sub-solid pulmonary nodules with a solid component, the [Part-solid nodule pathway](#)
740 (Algorithm 5) should be used for determining lung cancer risk. **(Conditional – by consensus)**

741 **Good Practice Points**

- 742 ✓ Sub-solid pulmonary nodules should be reviewed on both mediastinal and lung windows to determine if
743 the nodule is of increased density.
- 744 ✓ Diameter rather than volumetry should be used to determine the size of sub-solid pulmonary nodules.
- 745 ✓ The maximum diameter of the solid component should be measured on lung windows and a lung kernel.

746 **Issues with the Data**

747 The available literature was dominated by studies of adenocarcinoma-spectrum lesions, with limited evidence
748 directly comparing all benign SSNs with invasive lung cancer. Consistent with the International Association for
749 the Study of Lung Cancer/American Thoracic Society/European Respiratory Society (IASLC/ATS/ERS)
750 classification framework [7], invasive adenocarcinoma (IAC) and minimally invasive adenocarcinoma (MIA)
751 sub-solid pulmonary nodules were classified as malignant lesions; whereas adenocarcinoma in situ (AIS) and
752 atypical adenomatous hyperplasia (AAH) were considered benign pre-invasive lesions. Consequently, a
753 substantial number of studies were excluded due to inconsistent lesion classification, including the grouping
754 of AIS (and AAH) with the malignant cohorts, the classification of MIA as a pre-invasive lesion, or insufficient
755 reporting of adenocarcinoma subtype stratification. This classification framework is pivotal for guiding clinical
756 decision-making and optimising patient management. In addition, analyses were limited to surgically resected
757 specimens because of the recognised limitations of biopsy sampling in accurately identifying invasive
758 components within adenocarcinoma-spectrum lesions.

759 Key areas of ongoing uncertainty include whether imaging-defined malignant SSNs represent clinically
760 significant invasive lung cancer requiring intervention, the optimal classification of adenocarcinoma-spectrum
761 lesions in diagnostic accuracy studies, and the relative value of imaging biomarkers compared with clinical risk
762 prediction models for guiding management decisions.

763 The full Evidence Review is available in Online Supplementary Appendix 5 (not included in the main guideline
764 document).

765 **3.8 Sub-solid nodules – Surveillance**

766 When the likelihood of invasive malignant tumour is felt to be low, CT surveillance of sub-solid nodules is
767 favoured. Timely identification of CT features, such as growth or changes in nodule morphology, which may
768 indicate progression to an invasive tumour, can help guide further intervention and prognosis.

769 **Question 6:** In adults with sub-solid pulmonary nodules, what is the diagnostic accuracy of strategies used
770 to detect change between interval computed tomography (CT) scans for diagnosing lung
771 cancer?

772 The findings of this question are summarised in Tables 14 and 15.

773

774

775

776 **Table 14:** Evidence review summary for the diagnostic accuracy of imaging test changes between CT scans
 777 for diagnosing lung cancer in sub-solid pulmonary nodules

Imaging strategy	n	Cut-off	Sensitivity [95% CI]	Specificity [95% CI]
Visual analysis	-	-	-	-
Diameter change	4	-	0.63 [0.37, 0.83]	0.39 [0.22, 0.61]
Volume doubling time (VDT)	-	-	-	-
Mass doubling time (MDT)	2	≤ 400 days	0.76 [0.34, 0.94]	0.43 [0.14, 0.81]
Volume change	2	< 25 %	0.62 [0.31, 0.86]	0.81 [0.47, 0.91]

778 CI – confidence intervals; n – number of datasets

779 **Table 15:** Evidence summary of imaging test changes between CT scans for diagnosing lung cancer in
 780 malignant (IAC + MIA) versus benign (AIS + AHH) sub-solid pulmonary nodules

Imaging strategy	Evidence summary of imaging test changes between CT scans (CI)
Diameter change at ≤ 2-year follow-up	Malignant nodules 1.5 (-0.5 to 3.5) mm greater Benign nodules 0.7 (-0.8 to 2.2) mm greater
Diameter change at > 2-year follow-up	Malignant nodules 2.5 (1.0 to 4.0) mm greater Benign nodules 0.8 (-2.2 to 3.8) mm greater*

781 * Based on 2 studies

782 AHH – atypical adenomatous hyperplasia; AIS – adenocarcinoma in situ; CI – confidence intervals; IAC – invasive
 783 adenocarcinoma; MIA – minimally invasive adenocarcinoma

784 Evidence Statements

- 785 - There was insufficient evidence to support the use of visual analysis to detect change between interval
 786 computed tomography (CT) scans for diagnosing lung cancer in sub-solid pulmonary nodules.
- 787 - Diameter change may have a low sensitivity and low specificity for detecting change between interval
 788 computed tomography (CT) scans for diagnosing lung cancer in sub-solid pulmonary nodules. (**Very low**)
- 789 - A diameter change of ≥ 2 mm between interval CT scans may indicate lung cancer in a sub-solid pulmonary
 790 nodule. (**Very low**)
- 791 - There was insufficient evidence to support the use of volume doubling time (VDT) to detect change
 792 between interval computed tomography (CT) scans for diagnosing lung cancer in sub-solid pulmonary
 793 nodules.
- 794 - A mass doubling time (MDT) of ≤ 400 days may have a moderate sensitivity and a low specificity for
 795 detecting change between interval computed tomography (CT) scans for diagnosing lung cancer in sub-
 796 solid pulmonary nodules. (**Very low**)
- 797 - Volume change may have a low sensitivity and a low specificity for detecting change between interval
 798 computed tomography (CT) scans for diagnosing lung cancer in sub-solid pulmonary nodules. (**Very low**)
- 799 - There was insufficient evidence to consider ground-glass nodule (GGN) and part solid nodule (PSN)
 800 subgroups.

801 Recommendations

- 802 ➤ For adults with pure ground glass pulmonary nodules (GGN), the [Ground glass nodule pathway](#) (Algorithm
 803 4) should be used for determining lung cancer in progressing GGN. (**Conditional** – by consensus)

804 ➤ For adults with sub-solid pulmonary nodules with a solid component, the [Part-solid nodule pathway](#)
805 (Algorithm 5) should be used for determining lung cancer in progressing part-solid pulmonary nodules.
806 (**Conditional** – by consensus)

807 **Good Practice Points**

- 808 ✓ Comparison to the earliest available CT should be performed at each evaluation of sub-solid pulmonary
809 nodule.
- 810 ✓ The following changes on interval CT scans may be suggestive of invasive lung cancer in sub-solid
811 pulmonary nodules: increase in the maximal diameter of the solid component, distortion of fissure,
812 development of air bronchograms, development of bubble-like lucency, increased CT density.

813 **Issues with the data**

814 Data analysis was hindered by limited sample size and inconsistent classification. Although several studies
815 reported longitudinal changes or stability in SSNs, the small number of resected nodules in most studies
816 (usually < 50 resected nodules) precluded meaningful analysis. In most studies, longitudinal stability was
817 equated with benignity, and therefore nodules remained unresected, although notable exceptions to this were
818 identified.[8] Inconsistent adenocarcinoma spectrum classification (similar to Question 4, Section 3.5 Baseline
819 diagnostic approach – sub-solid nodules) confounded the analysis of those studies reporting resected nodules.
820 Some studies reported only resected adenocarcinoma spectrum lesions, excluding other causes of SSNs
821 including fibrosis and inflammation, thus introducing an inherent bias.

822 There is ongoing uncertainty regarding the likelihood of invasive tumour in growing pure ground-glass nodules,
823 particularly regarding risk of overdiagnosis and overtreatment of such lesions. The lack of published data
824 reporting longitudinal change in benign resected non-adenocarcinoma spectrum lesions adds to this
825 uncertainty.

826 The full Evidence Review is available in Online Supplementary Appendix 6 (not included in the main guideline
827 document).

828 **3.9 Pulmonary nodule biopsy for diagnosing lung cancer**

829 The decision to biopsy a pulmonary nodule is often complex. Deciding which modality to choose is based on
830 both patient and nodule characteristics. There are several modalities available to clinicians to obtain a
831 diagnostic biopsy, and these can be broadly categorised into:

- 832 i) Bronchoscopic biopsy (flexible bronchoscopy, navigational bronchoscopy or robotic assisted
833 bronchoscopy)
- 834 ii) Percutaneous biopsy (USS or CT guided biopsy); and
- 835 iii) Surgical biopsy.

836 This question aimed to address the diagnostic accuracy of using biopsy to diagnose lung cancer in a pulmonary
837 nodule.

838 **Question 7:** In adults with pulmonary nodules, what is the diagnostic accuracy of biopsy of a pulmonary
839 nodule for diagnosing lung cancer?

840 The findings of this review are summarised in Table 16.

841
842
843
844
845

846 **Table 16:** Evidence review summary for the diagnostic accuracy of biopsy for diagnosing lung cancer in
847 pulmonary nodules

Biopsy type	n	Sensitivity [95% CI]	Specificity [95% CI]
All	36	0.93 [0.90, 0.95]	1.00 [0.99, 1.00]
Bronchoscopic	10	0.91 [0.80, 0.96]	1.00 [0.77, 1.00]
Percutaneous	23	0.93 [0.89, 0.95]	1.00 [0.96, 1.00]
Surgical	3	0.98 [0.78, 1.00]	0.98 [0.74, 1.00]

848 CI – confidence intervals; n – number of datasets

849 Evidence statements

- 850 - Biopsy appears to have a very high sensitivity and very high specificity for diagnosing lung cancer in
851 pulmonary nodules. (**Moderate**)
- 852 - Percutaneous biopsy appears to have a very high sensitivity and very high specificity for diagnosing lung
853 cancer in pulmonary nodules (**High**) with a small interquartile range.
- 854 - Bronchoscopic biopsy appears to have a very high sensitivity and very high specificity for diagnosing lung
855 cancer in pulmonary nodules (**Low**) with a moderate interquartile range.
- 856 - Surgical biopsy appears to have a very high sensitivity and very high specificity for diagnosing lung cancer
857 in pulmonary nodules. (**Low**)
- 858 - There was insufficient evidence to consider solid and sub-solid nodule subgroups.

859 Recommendation

- 860 ➤ For adults with a suspected malignant pulmonary nodule, bronchoscopic (**Conditional**), percutaneous
861 (**Strong**), or surgical (**Conditional**) biopsy can be considered for diagnosing lung cancer

862 Good Practice Points

- 863 ✓ Modality for tissue acquisition should consider patient choice, nodule location and number, need for
864 mediastinal staging, wait times, and available services.
- 865 ✓ All patients should be able to access robotic-assisted bronchoscopy, endobronchial ultrasound (EBUS),
866 percutaneous ultrasound / computed tomography (USS/CT) guided and surgical biopsy.

867 Issues with the data

868 Publication bias is likely to impact the perceived accuracy of all three modalities, with a predominance of
869 studies reporting percutaneous biopsies and a relatively low number of studies reporting bronchoscopic
870 biopsies. The high accuracy reported with bronchoscopic biopsy was mainly in studies utilising advanced
871 bronchoscopic techniques such as robotic assisted bronchoscopy. There were also very few randomised
872 studies assessing diagnostic accuracy and yield of different pulmonary nodule biopsy modalities. Evidence for
873 this question mostly relied on observational real-world data.

874 The evidence base in this area is likely to change rapidly over the coming years, due to the increasing adoption
875 of advanced bronchoscopic techniques such as robotic assisted bronchoscopy.

876 The full Evidence Review is available in Online Supplementary Appendix 7 (not included in the main guideline
877 document).

878 3.10 Pre-treatment biopsy versus no pre-treatment biopsy

879 In patients with pulmonary nodules considered at high risk of malignancy, treatment with curative intent may
880 include surgical resection, stereotactic ablative radiotherapy, or other definitive therapies. While histological

confirmation through pre-treatment biopsy is often recommended, biopsy procedures can carry risks associated with morbidity or may be technically not feasible. In some patients with a high clinical and radiological probability of lung cancer, treatment may proceed without tissue confirmation. This question examines whether obtaining a pre-treatment biopsy influences clinical outcomes compared with proceeding directly to curative-intent treatment without biopsy, balancing diagnostic certainty, treatment delay, procedural risk, and overtreatment.

Question 8: In adults with pulmonary nodules being considered for treatment for lung cancer with curative intent, does pre-treatment biopsy provide the same clinical outcomes as no biopsy?

The findings are summarised in Table 17.

Table 17: Evidence summary of the effect on clinical outcomes following pre-treatment biopsy or no pre-treatment biopsy

Clinical outcome	Evidence summary of pre-treatment biopsy versus no pre-treatment biopsy (95% CI)
Benign resection	Greater with no pre-treatment (67/1000 (19 to 245) versus 371/1000 respectively)*
Mortality	No difference (short-term 0 [0, 0] % versus 0.7 [0, 0.9] % respectively, median [IQR], $p = 0.16^{\dagger}$; longer-term (80 months) 166/1000 (59 to 466) versus 113/1000 respectively*)
Morbidity	Greater following pre-treatment biopsy (29 [16, 39] versus 7 [7, 13] % respectively, median [IQR], $p = 0.004^{\ddagger}$)
Quality of life	No evidence
Recurrence	Greater following pre-treatment biopsy (336/1000 (246 to 462) versus 85/1000 respectively)*

* Reported per 1000 patients (based on 2 studies)

[†] Unpaired t-test, with pre-treatment biopsy group $n = 2$, without pre-treatment biopsy group $n = 5$

[‡] Unpaired t-test, primarily pneumothorax following percutaneous biopsy

CI – confidence interval; IQR – interquartile range; n – number of datasets

Evidence statements

- Pre-treatment biopsy may reduce the incidence of benign resection in adults with pulmonary nodules being considered for treatment for lung cancer with curative intent when compared with no pre-treatment biopsy. **(Very low)**
- Pre-treatment biopsy appears to have no effect on short-term mortality (up to 30-days post-treatment) in adults with pulmonary nodules being considered for treatment for lung cancer with curative intent when compared with no pre-treatment biopsy. **(Ungraded)**
- Pre-treatment biopsy appears to have no effect on longer-term mortality (up to 80 months post-treatment) in adults with pulmonary nodules when compared with no pre-treatment biopsy. **(Very low)**
- There was insufficient evidence to consider solid and sub-solid pulmonary nodule subgroups separately.

Recommendation

- A pre-treatment biopsy should be offered, where feasible, to patients who are suitable for curative-intent treatment. **(Conditional)**

Issues with the data

The available evidence base was limited, with relatively few studies directly comparing outcomes between patients undergoing pre-treatment biopsy and those treated without prior tissue confirmation. There was also

substantial methodological variation between studies, including differences in patient selection, biopsy techniques, definitions of clinical/procedural outcomes, and thresholds for malignancy risk. In particular, several studies reported mixed cohorts with both intraoperative biopsies and percutaneous biopsies [9] or defined non-biopsy cohorts as those with previous failed attempts [10,11] which led to their exclusion. No randomised controlled trials were identified. Analysis was therefore based on a small number of eligible studies which raises possibility of publication bias and limits the certainty of conclusions that can be drawn from the evidence. There were no studies looking at quality of life outcomes in this cohort and therefore no conclusions could be made regarding this.

There are ongoing considerations regarding the balance between avoiding unnecessary biopsy-related complications and minimising the risk of overtreating benign disease. The data currently available for analysis could not definitively answer the posed question and therefore expert clinical opinion was used where necessary whilst waiting for more published data on this topic.

Newer interventional procedures, such as robotic assisted bronchoscopy, allow for tissue confirmation of malignancy in nodules which were previously inaccessible. This may increase the evidence base for treating smaller biopsy confirmed cancers and will be an area for review once these data are published.

The full Evidence Review is available in Online Supplementary Appendix 8 (not included in the main guideline document).

3.11 FDG PET-CT staging

Current guidance suggests that people with lung cancer who are being considered for treatment with curative intent are offered positron emission tomography computed tomography (PET-CT) to stage their disease and identify nodal and distant metastases. The value of PET-CT in adults with pulmonary nodules has been debated, particularly in adults with small solid nodules and sub-solid nodules, where there is reduced risk of metastasis and PET-CT may have limited spatial resolution. Furthermore, lung cancer screening has led to increased identification of individuals with pulmonary nodules and higher demand for radiological investigations including PET-CT. This question aimed to address if fluorodeoxyglucose (FDG) PET-CT staging improves clinical outcomes in adults with pulmonary nodules being considered for treatment with curative intent.

Question 9: In adults with pulmonary nodules being considered for treatment with curative intent, does FDG positron emission tomography computed tomography (PET-CT) staging provide the same clinical outcomes as no PET-CT staging?

The findings of this review are summarised in Tables 18 and 19.

Table 18: Evidence summary of the incidence of occult nodal or distant metastases after definitive treatment with or without pre-treatment FDG-PET-CT staging

Nodule type	Evidence summary of nodal or distant metastases following FDG-PET-CT staging or no FDG-PET-CT staging (95% CI)
All	No difference (174/1000 versus 139/1000 (87 to 224) respectively*; and 6 [4, 13] % versus 8 [0, 31] % respectively, median [IQR], $p = 0.20^{\dagger}$)
Solid	May be greater with no FDG-PET-CT staging (13 [7, 14] % versus 22 [12, 31] % respectively, median [IQR], $p = 0.06^{\dagger}$)
Sub-solid	No difference (0 [0, 5] % versus 0 [0, 1] % respectively, median [IQR], $p = 0.25^{\dagger}$)

* Reported per 1000 patients (based on 2 studies)

[†] Unpaired t-test

CI – confidence interval; IQR – interquartile range

949 **Table 19:** Evidence summary of the incidence of occult nodal or distant metastases in solid versus sub-solid
 950 nodules after definitive treatment with or without pre-treatment FDG-PET-CT staging

Staging type	Evidence summary of nodal or distant metastases in solid versus sub-solid nodules following FDG-PET-CT staging or no FDG-PET-CT staging (95% CI)
FDG-PET-CT	Greater in solid nodules (13 [7, 14] % versus 0 [0, 5]% respectively, median [IQR], $p = 0.001^{\dagger}$)
No FDG-PET-CT	May be greater in solid nodules (22 [12, 31] % versus 0 [0, 1] % respectively, median [IQR], $p = 0.08^{\ddagger}$)

951 * Reported per 1000 patients (based on 2 studies)

952 [†] Unpaired t-test

953 [‡] Unpaired t-test, small study numbers ($n = 2$ for both groups)

954 CI – confidence interval; IQR – interquartile range

955 Evidence statements

- 956 - FDG PET-CT staging detects unexpected nodal/metastatic disease in patients with solid pulmonary
 957 nodules. (**Ungraded**)
- 958 - The incidence of nodal/metastatic disease appears to be greater in patients with solid pulmonary nodules
 959 when compared with sub-solid pulmonary nodules. (**Ungraded**)
- 960 - There was insufficient evidence to consider sub-centimetre nodules.

961 Recommendations

- 962 ➤ For patients with solid pulmonary nodules being considered for treatment with curative intent, FDG PET-
 963 CT staging should be offered to detect occult nodal disease or metastases. (**Conditional**)
- 964 ➤ Solid pulmonary nodules of ≥ 8 mm diameter should be offered FDG PET-CT staging (depending on PET-
 965 CT manufacturers' resolution specifications). (**Conditional** – by consensus)
- 966 ➤ Sub-solid pulmonary nodules with a solid component ≥ 10 mm diameter should be offered FDG PET-CT
 967 staging. (**Conditional** – by consensus)

968 Issues with the data

969 The review question aimed to compare outcomes between individuals who did and did not have PET-CT,
 970 however, most studies offered PET-CT to all individuals. Several studies defined their outcome by a positive
 971 PET-CT scan instead of biopsy-proven metastatic disease. Studies provided limited data on pulmonary nodule
 972 size or pooled participants into broad groups, such as grouping all participants with a solid component of 3 cm
 973 or smaller. The optimal size threshold at which PET-CT is less likely to be beneficial remains contentious.

974 The full Evidence Review is available in Online Supplementary Appendix 9 (not included in the main guideline
 975 document).

976 4. EVALUATION, MEASUREMENT AND FOLLOW-UP CONSIDERATIONS

977 4.1 Technical considerations for pulmonary nodule evaluation

978 The diagnostic accuracy of different CT acquisition and reconstruction parameters, and variation in the
 979 evaluation of nodule characteristics was not evaluated in this review. As such, it is suggested that good practice
 980 for the evaluation of pulmonary nodules follow those from multiple international recommendations [12-16] and
 981 include:

- 982 • Multidetector CT systems with at least 16 detector rows, but 64-detector or wider configurations are
 983 preferred for volumetric analysis;

- 984 • Whole-thorax acquisition should be performed in a single breath-hold at full inspiration
- 985 • Radiation exposure should be minimised, targeting a CTDI vol ≤ 3 mGy with automated exposure control
- 986 and weight-adapted tube voltages between 80 – 120 kVp.
- 987 • Thin-section reconstruction (minimum 1.5 mm, but ≤ 1 mm preferred) with 50 % overlap, mandatory for
- 988 volumetric assessment
- 989 • Soft- to medium-frequency reconstruction kernel to avoid edge-enhancement artefacts that can impair
- 990 volumetric accuracy
- 991 • Iterative reconstruction, including deep-learning-based techniques, preferred to filtered back projection at
- 992 all dose levels
- 993 • Review of images using both standard lung (width 1500 HU, level – 600 HU) and mediastinal (width 400
- 994 HU, level m40 HU) window settings with axial and coronal multiplanar reformats
- 995 • Review of maximum-intensity projection (MIP) reconstructions for nodule detection, and thin-section
- 996 reconstructions for nodule characterisation
- 997 • Maintaining protocol consistency (including scanner, reconstruction kernel, radiation dose, and software)
- 998 is critical for reliable serial assessment.

999 4.2 Considerations for nodule measurement and description

1000 The technical aspects of methods for measuring pulmonary nodules were not evaluated. In line with consensus
 1001 recommendations for best practice, this guideline recognises that volumetric analysis (both semi-automated
 1002 and fully automated) is more accurate, repeatable and reproducible than diameter for the measurement of
 1003 solid nodules when available and reliable, as both maximum and mean diameter measurements overestimate
 1004 the true size of a nodule (Figure 1). However, the incremental benefit of volume of the diameter is probably
 1005 less apparent for larger nodules (Figure 2).

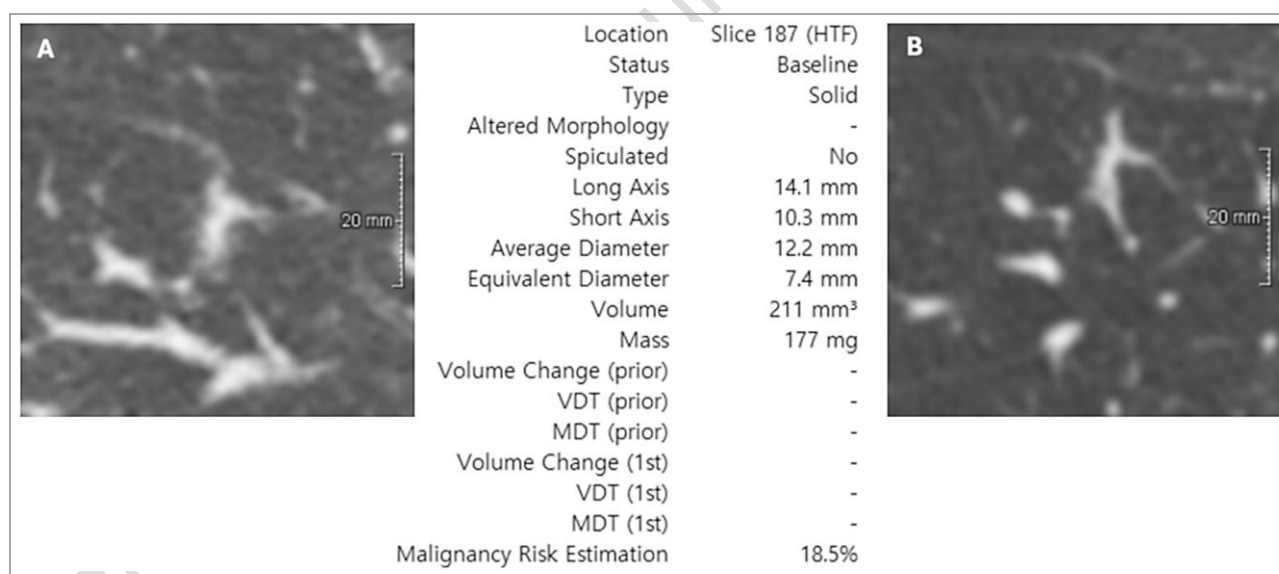


Figure 1: 60-year-old female lung cancer screening participant with an irregular 14 x 10 mm nodule in the right lower lobe (A, on a background of mild emphysema. Using the maximum diameter of 14 mm, the probability of malignancy is overestimated at 14.4%; using the average diameter of 12 mm would still overestimate the probability of malignancy at 10.9% using the Brock score. Reliance on diameter here would have instigated further workup with FDG PET-CT. Reliable volumetric segmentation shows the nodule to only be 211 mm³, and therefore the nodule was followed up for 1 year, where it has demonstrated shrinkage to 100 mm³ (B).

1006 Simple tools for modifying the segmentation of a nodule to ensure the segmentation accurately reflects the
 1007 entire volume of the nodule are available in some volumetric software: their use is neither recommended or
 1008 discouraged, but it is suggested that where there is doubt in the veracity of volumetric segmentation, and/
 1009 the user has limited experience with the use of segmentation modification tools, the use of diameter as a

convenient and reproducible metric may be more pragmatic and desirable (see the [Solid Nodule Follow-up Pathway, Algorithm 2](#)) (Figure 3).

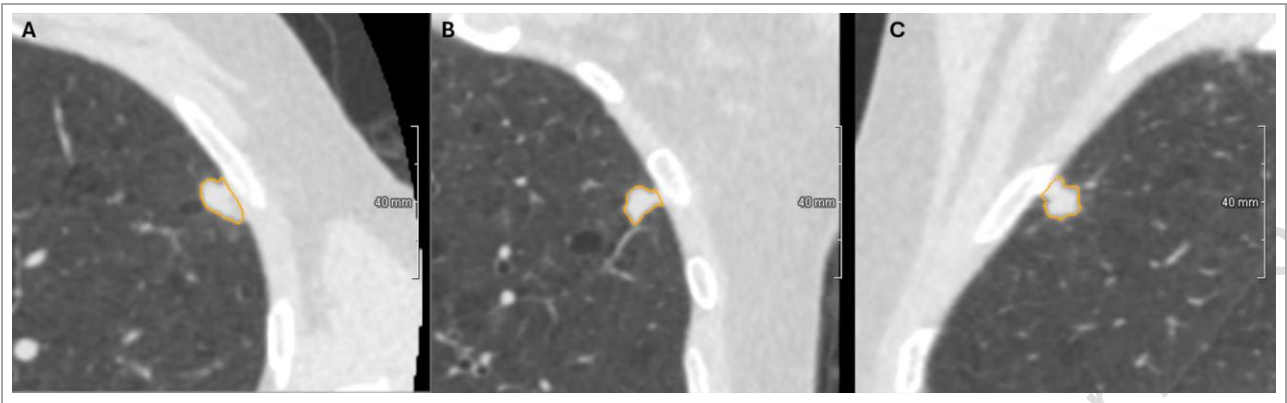


Figure 2: 68-year-old female lung cancer screening participant with a 16 mm, reliably segmented 617 mm³ subpleural non-spiculated left upper lobe solid nodule in (A) axial, (B) coronal and (C) sagittal planes, on a background of mild centrilobular emphysema, giving this nodule of a Brock score of 33.9%. This nodule would be recommended for immediate workup even if volumetric analysis had not been available or possible and diameter alone was used to measure its size.

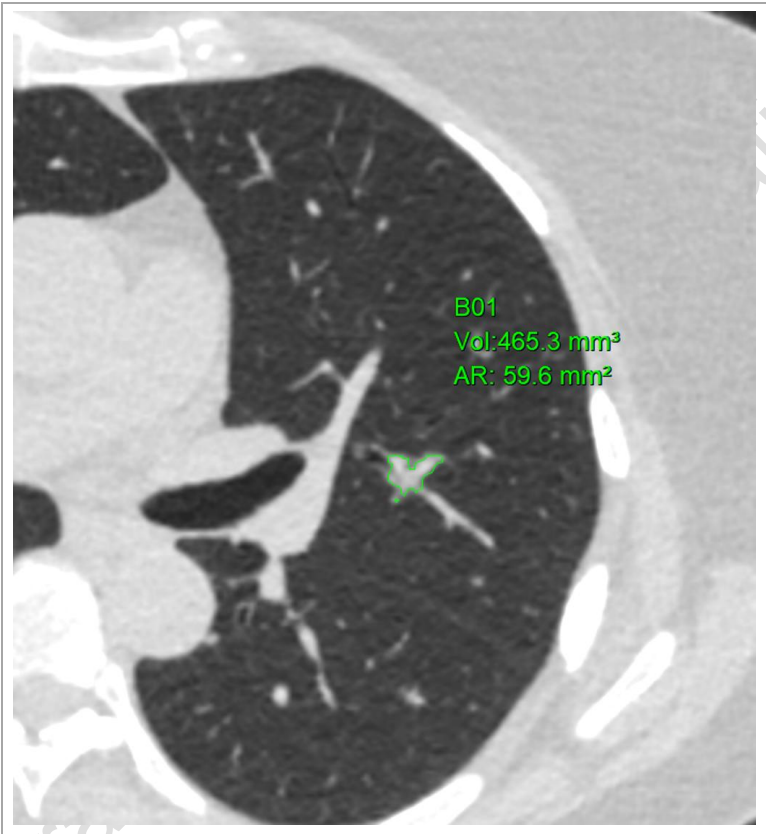


Figure 3: 64-year-old male lung cancer screening participant with a juxtavascular left upper lobe nodule that is unreliably segmented.

The use of volumetric analysis for ground-glass nodules or part-solid nodules (including the solid component of part-solid nodules) is not recommended as the variability of volumetry in this subgroup of nodules, and incremental benefits (if any) over diameter measurement, still require validation.

The diameter thresholds recommended in this guideline are maximum diameter measurements, as the evidence reviewed largely reported maximum diameters (although there was huge heterogeneity). As per the Fleischner Society recommendations [12] on measuring pulmonary nodules, it is good practice to measure pulmonary nodules on standard lung windows, using a lung kernel.

1021 Radiologists should use their clinical discretion to dismiss overtly inflammatory nodules, especially ground-
1022 glass nodules (Figure 4). For new nodules, it is emphasised that only discrete nodules considered non-
1023 inflammatory should be designated for follow-up.



Figure 4: 68-year-old male lung cancer screening participant with clustered nodules (arrows) in the right lower lobe, that are considered inflammatory and do not require follow-up.

1024
1025 There is no consensus definition of significant shrinkage in pulmonary nodules. Nodules that decrease in size
1026 but persist should remain under imaging surveillance until resolution or until the reporting radiologist considers
1027 further follow-up unnecessary.

1028 **4.3 Pulmonary nodule follow-up considerations**

1029 When considering follow-up of pulmonary nodules, it is recommended that imaging surveillance is always
1030 interpreted within the broader clinical context. Decisions should take account of patient preferences, anxiety,
1031 competing health priorities, co-morbidities, and fitness for further investigation and treatment. Where a patient
1032 would not be suitable for, or would not wish to undergo, treatment, the value of prolonged surveillance should
1033 be discussed carefully.

1034 **5. ALGORITHM CONSIDERATION**

1035 **5.1 Algorithm 1 Solid nodule diagnostic pathway**

1036 Several key elements of this algorithm deserve attention. Morphological characterisation of solid nodules is
1037 paramount. Nodules with clear benign features such as popcorn calcification together with low density in a
1038 pulmonary hamartoma do not require follow-up. Caution should be exercised when determining whether there
1039 is fat density in nodules (to characterise it as benign) on images with increased noise, particularly those
1040 reconstructed on CT protocols with very low radiation doses.

1041 Perifissural and juxtapleural nodules with benign features [17] are a reliable radiological correlate of benign
1042 intrapulmonary lymph nodes (IPLNs) and do not require follow-up. In the absence of an internationally agreed
1043 consensus definition, IPLNs are defined incorporating the latest evidence (Box 1).[18-21]

Box 1: Radiological characteristics of benign intrapulmonary lymph nodes (IPLNs) (Figure 5)

Well-defined

Polygonal, triangular or lentiform in at least 2 orthogonal views

Up to 10 mm in maximum diameter

Located on or within 10 mm of a pleural surface (i.e. juxtapleural)

Have fine linear extensions

Not in contact with a branch of a pulmonary artery

Located in the middle lobe, lingula or lower lobes

1044

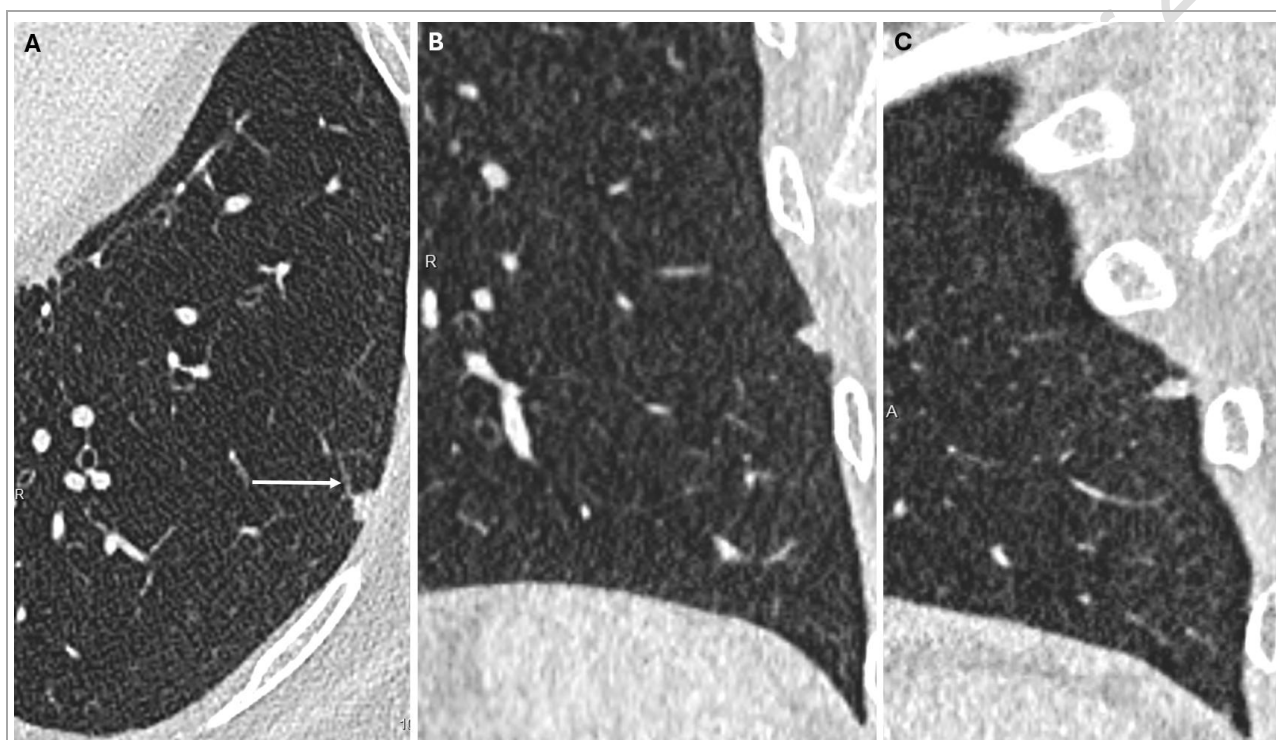


Figure 5: 75-year-old man with an 8 mm subpleural left lower lobe non-calcified well-defined solid nodule on low-dose CT that appears ovoid on the axial reconstructions (A), where it is contact with a branch of a pulmonary vein (arrow) but not an artery, and quite flat on the coronal (B) and sagittal (C) reconstructions. This is consistent with a benign intrapulmonary lymph node.

1045 A low threshold for follow-up should be exercised when juxtapleural nodules are in the upper lobes [20], are
1046 not fully ovoid (Figure 6), are adjacent to the termination of a pulmonary artery branch (a feature never seen
1047 in isolation with IPLNs (Figure 7) [22]), an active or previous history of cancer and those larger than 10 mm.

1048 The importance of searching for, and reviewing, any previous CT imaging is reinforced, as a lower size
1049 threshold for follow-up is used for truly new nodules ([Algorithm 3 New solid nodule follow-up pathway](#)) while
1050 nodules that were already present require assessment of growth ([Algorithm 2 Solid nodule follow-up pathway](#)).

1051 An 80 mm³ cut-off has been retained, rather than the 100 mm³ cut-off proposed in other guidelines [23-25] for
1052 two reasons. On the one hand, it accommodates limitations in volumetry repeatability- that is, the degree to
1053 which the volumetry result will vary under the same conditions. The 95% confidence limits for relative difference
1054 in measured nodule volume between scans done minutes apart is reported as $\pm 25\%$ with all conditions kept
1055 the same (scanner, acquisition parameters, volumetry software) [19], although it has been suggested this
1056 threshold could be lower, between -16% to +15%, for smaller nodules (mean 81 mm³, range 28–170 mm³) in
1057 one study [26]. Importantly, this repeatability may vary even more widely with different software packages [25]
1058 and therefore is important to acknowledge (Figure 8).

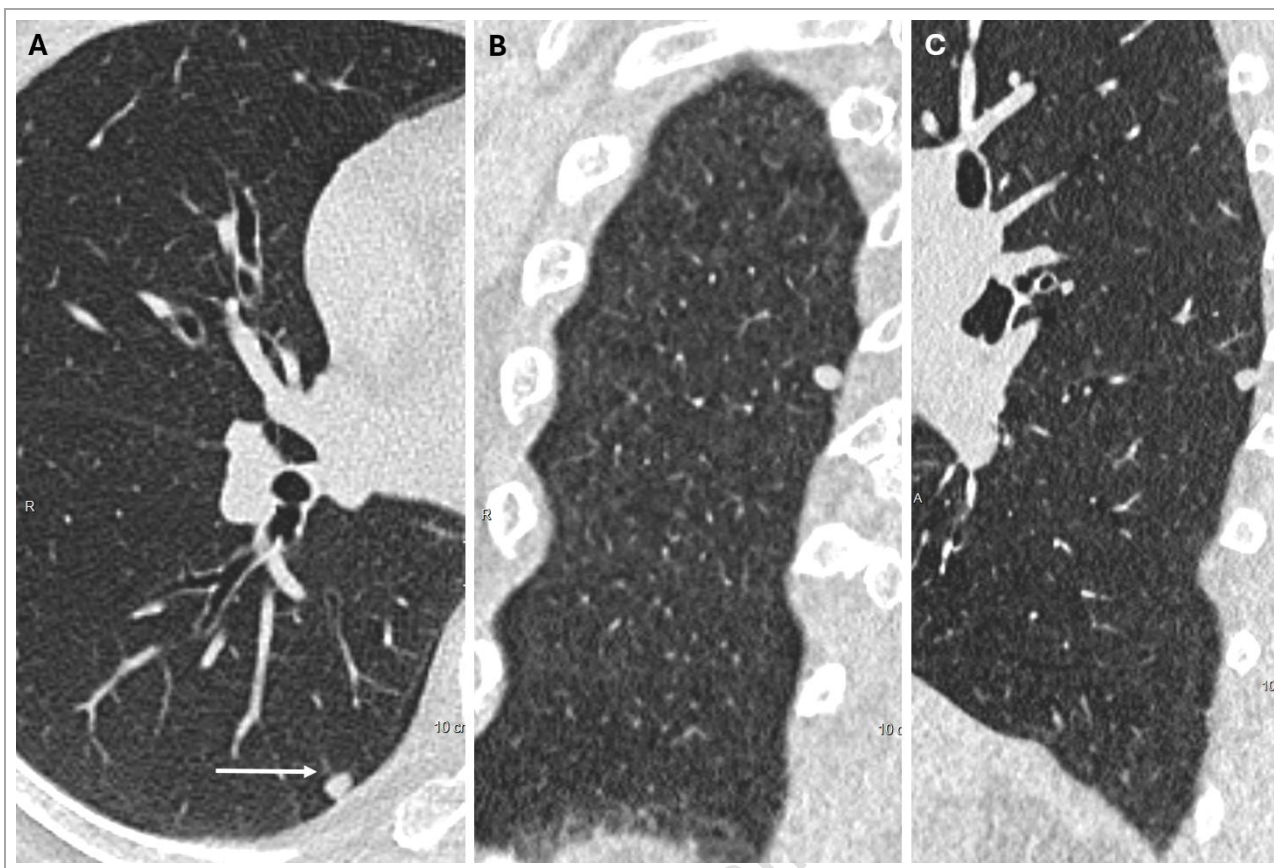


Figure 6: 68-year-old woman with a 7 mm subpleural non-calcified well-defined solid nodule on low-dose CT that appears ovoid on the axial (A) and coronal (B) reconstructions (A), and in contact with a branch of a pulmonary vein (arrow in A) but not an artery. It appears more rounded at its anterior border, and slightly more convex at its inferior border, on the sagittal (C) reconstruction. This would be classified as atypical for an intrapulmonary lymph node.

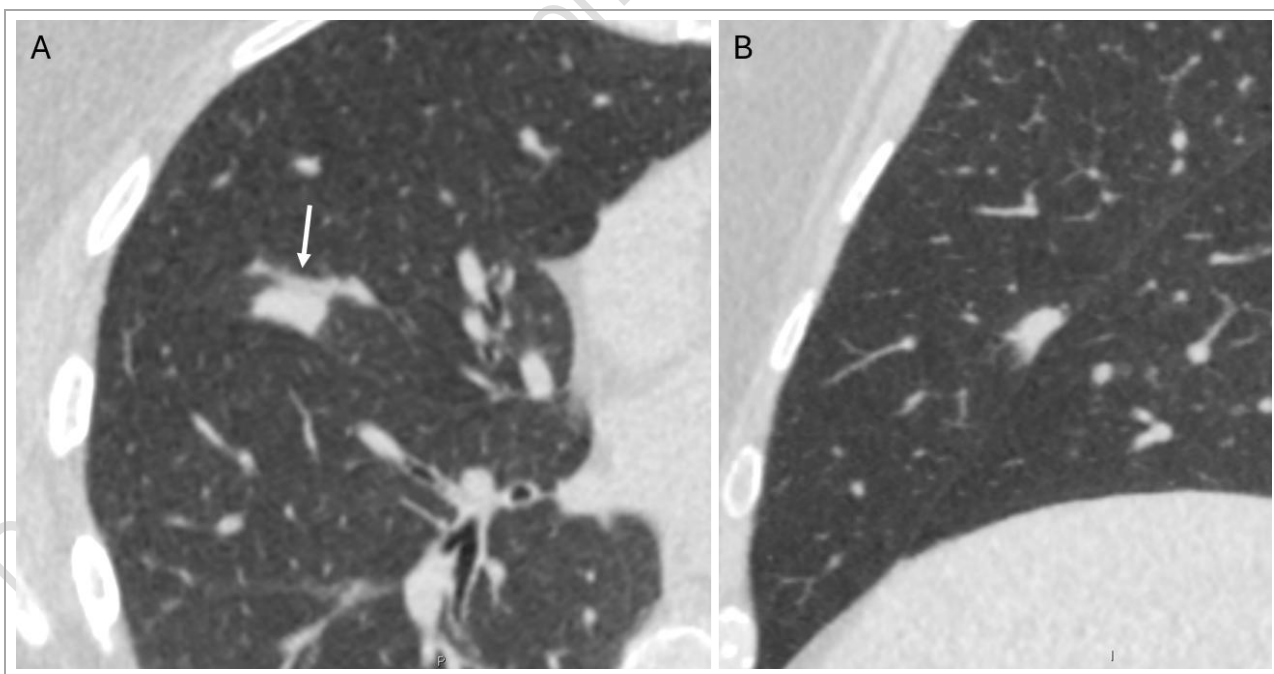


Figure 7: 60-year-old woman with a 14mm perifissural ovoid nodule slightly distorting the fissure on both axial (a) and sagittal (b) views. Although perifissural and ovoid, it is irregular and in contact with a branch of the pulmonary artery (arrow), which are not typical of intrapulmonary lymph nodes. Further work-up revealed the nodule to be a T1b lung papillary adenocarcinoma.

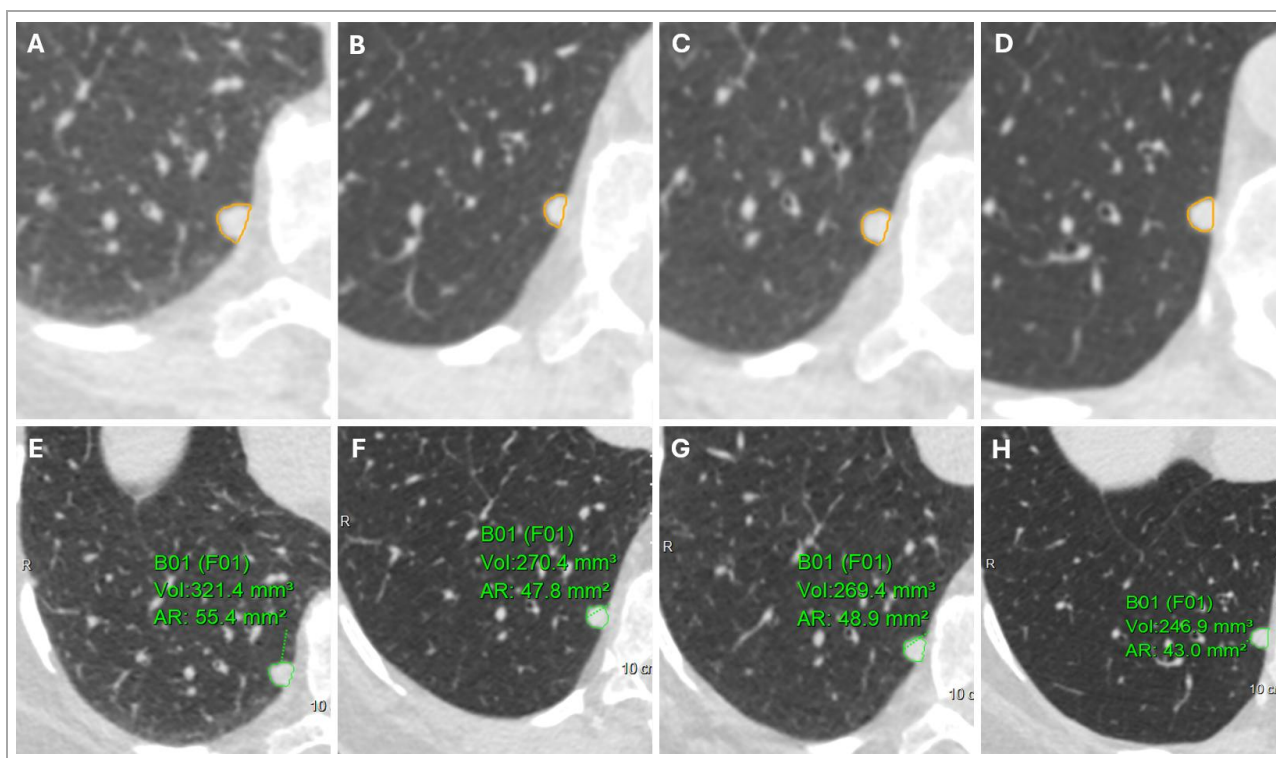


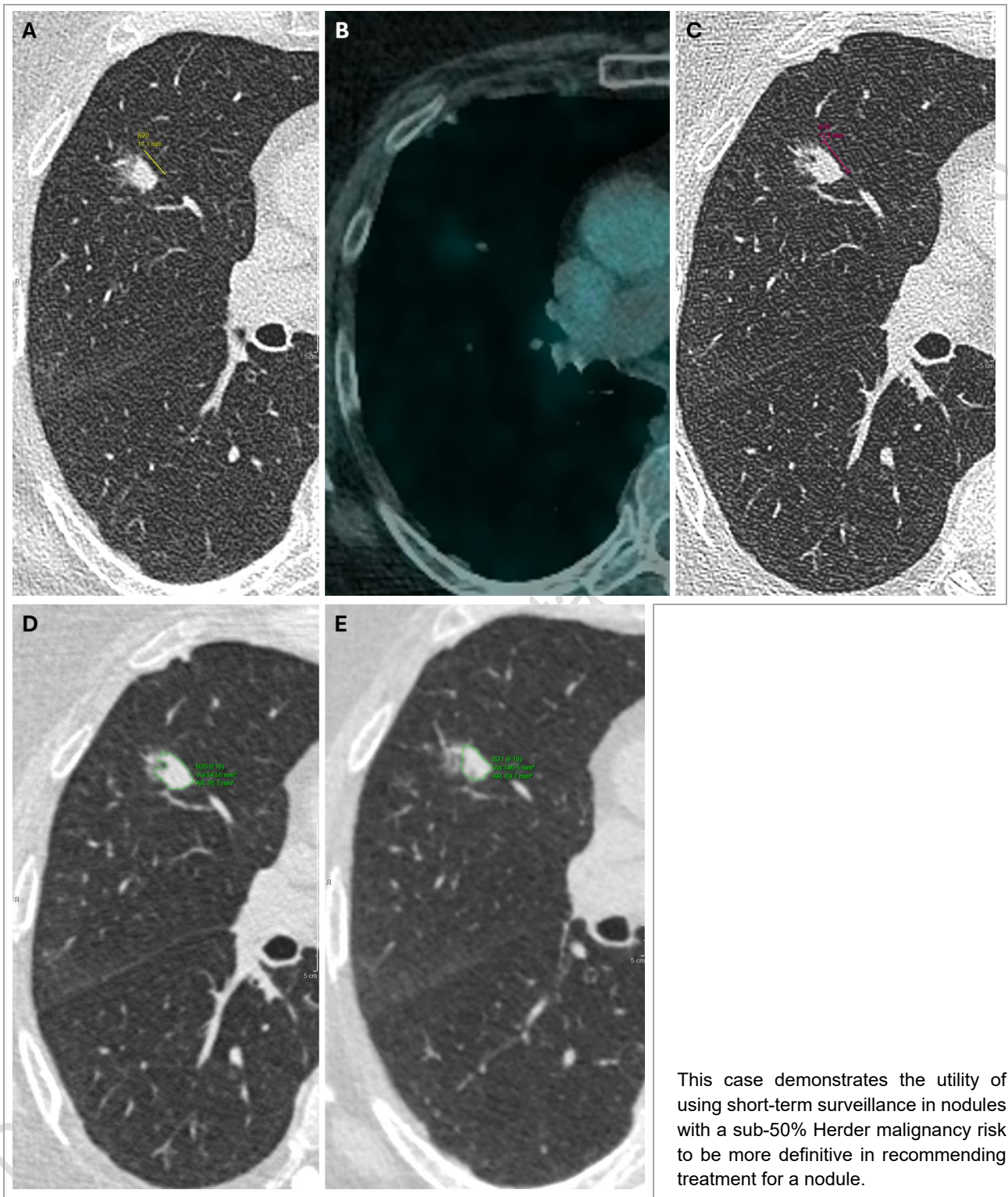
Figure 8: 66-year-old female lung cancer screening participant with a medial right lower lobe subpleural non-calcified solid nodule measuring 10 mm, 335 mm³ at baseline, with a Brock score of 6.8% (A). As such this nodule was followed up at 3 months, where its volume was 251 mm³, a 25% difference which is still within interscan variation (B). At 1 year, this nodule was stable at 296 mm³ (C) and the patient was discharged to the next screening round 2 years later, where the nodule remained stable at 263 mm³ (D). On a different software, the absolute values of the nodule volume at the different time points are 321 mm³ (E), 270 mm³ (F), 269 mm³ (G), and 247 mm³ (H); thus, while the absolute volumes differ by a small degree between these particular software packages, the relative changes in volume, and stability, are consistent despite the software used. However, different software packages can vary more widely and therefore volumetry should be performed on the same software package for the duration of follow-up.

On the other hand, it is acknowledged that the chances of identifying malignancy in nodules 80 to < 100 mm³ is low, and therefore an 80 mm³ threshold could be viewed as increasing the proportion of nodules requiring follow-up. The only study which compared the likelihood of malignancy in nodules using both thresholds in a single lung cancer screening population found that, compared to a 100 mm³ threshold, the 80 mm³ threshold increased sensitivity for lung cancer detection by 1.7% (rising from 85.1% to 86.8%) at the expense of a 7.4% decrease in specificity; four additional cancers were detected by including the 427 additional participants at the lower threshold [27]; in other words, 107 additional patients needed follow-up to diagnose one additional cancer. As sensitivity is prioritised at the outset of this algorithm, the lower threshold has been chosen but concede that, as always, extrapolating data from a high-risk population to all nodules is difficult and this threshold will thus require further validation.

Another key change is the removal of the intermediate-risk category (Herder risk 10–70%). The 2015 BTS Guideline recommended considering nodule sampling, surveillance, or surgical excision for patients in this category.[1] Several factors support revising this approach. Advances in robotic-assisted bronchoscopy now permit sampling of many nodules that were previously inaccessible to CT-guided percutaneous biopsy. Raising the threshold for biopsy helps maintain an adequate prevalence of malignancy in the biopsied cohort, thereby preserving the diagnostic yield of invasive sampling techniques. Biopsy is no longer an option for very low-risk nodules, as it was under the 2015 BTS Guideline.[1] For those nodules with a Herder score of < 50%, a surveillance scan in 3 months is recommended (Figure 9). However, biopsy may still be appropriate below this threshold, depending on patient preferences and multidisciplinary team discussion.

A further implication of removing the intermediate nodule risk category is that there is no longer a defined risk threshold above which patients with solid nodules could proceed directly to treatment without tissue confirmation. In the absence of prior imaging demonstrating growth, and based on the evidence reviewed above, the GDG agreed that histological confirmation should generally be obtained before treatment with

1083 curative intent, particularly lobectomy or stereotactic radiotherapy. However, when the Herder score is very
1084 high ($\geq 85\%$) and the nodule is < 2 cm, the multidisciplinary team may consider definitive treatment (28), with
1085 sub-lobar resection generally preferred for nodules of this size.



This case demonstrates the utility of using short-term surveillance in nodules with a sub-50% Herder malignancy risk to be more definitive in recommending treatment for a nodule.

Figure 9: 68-year-old female lung cancer screening participant with an 11 mm spiculated nodule in the right upper lobe in contact with the horizontal fissure and suspicious for pleural invasion. It had a Brock score of 21% (8 other nodules and emphysema not shown) (A). This was referred for FDG PET-CT, but the nodule only had an SUV max of 1.5 compared to a mediastinal blood pool activity SUV max of 2.9 i.e., faint activity (B), giving it a Herder score of 33%. The patient was not suitable for image-guided biopsy and therefore 3-month CT follow-up was recommended. At 3 months, the nodule had grown by 2 mm to 13 mm (C), but the volumetric analysis demonstrates the growth was much greater, from 341 mm³ (D) to 544 mm³ (E), giving it a volume doubling time of 154 days and providing impetus for treatment. The patient underwent a wide local excision resection with a pathological T2a N0 P11 (extending into the visceral pleura of the horizontal fissure).

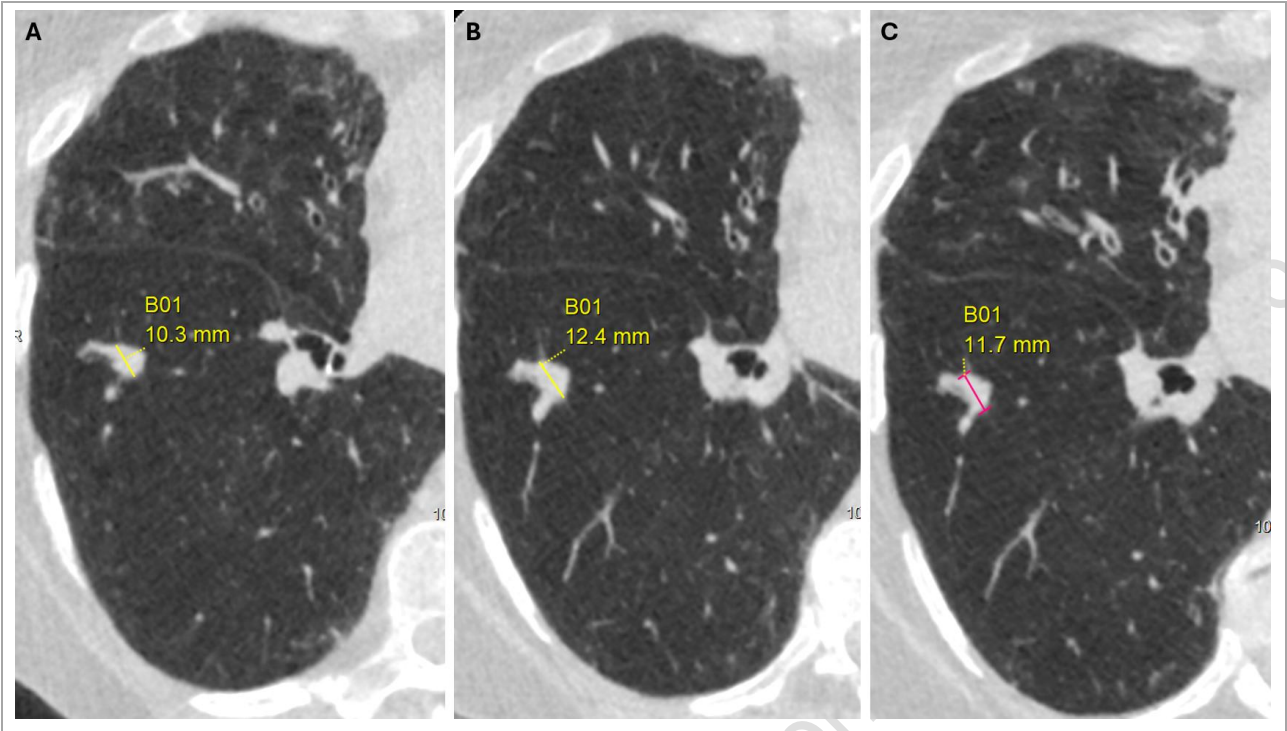


Figure 10: 74-year-old female lung cancer screening participant with a right lower lobe juxtavascular 10 mm solid nodule (A) that is unreliably segmented and therefore managed using diameter. At 1 year, the nodule has apparently grown to 12 mm, giving it a volume doubling time of 492 days (B), and so it was followed for a further year, where it remained stable at 12 mm (C), allowing discharge to the next screening round.

1087

1088 **5.3 Algorithm 3 New solid nodule follow-up pathway**

1089 In answering Question 3 it was evident that, while approximately 55% of new nodules resolve on subsequent
1090 imaging, persistent new solid nodules carry a higher cancer risk than baseline nodules of equivalent size and
1091 therefore warrant lower management thresholds.[31-33]

1092 For new solid nodules detected on follow-up CT, routine follow-up for nodules <30 mm³ is not currently
1093 recommended, as malignancy risk is low. In the NELSON trial, the risk of malignancy was 0.5% for nodules
1094 < 27 mm³, increasing to 3.1% for nodules measuring 27–206 mm³ and 16.9% for nodules ≥ 206 mm³. [31]
1095 These findings have subsequently been validated in a different screening cohort, which reported malignancy
1096 risks of 1.7%, 2.2% and 11.0% for nodules < 30 mm³, 30–200 mm³ and > 200 mm³, respectively. [33]

1097 For new solid nodules measuring 30–200 mm³, 3-month CT follow-up is recommended to determine
1098 persistence, and then follow-up as per [Algorithm 2 Solid nodule follow-up pathway](#) for assessment for nodules
1099 ≥ 200 mm³. For persistent nodules, volumetric growth assessment should be undertaken, with a volume
1100 doubling time (VDT) < 400 days considered indicative of a substantially increased risk of malignancy and
1101 warranting expedited investigation.

1102 Dedicated surveillance of new nodules (of any type) that occur within 6 months of the last CT is not currently
1103 recommended. The limited available evidence suggests that the malignancy risk of such nodules is very low
1104 (approximately 0.6%), despite occurring in around 8% of individuals undergoing short-interval surveillance.[33]
1105 This risk is comparable to that of small baseline nodules for which further follow-up is not routinely
1106 recommended. In the absence of evidence demonstrating clinical benefit, additional dedicated surveillance of
1107 newly detected nodules arising during short-interval follow-up CT is not currently justified. In practice, many of
1108 these new nodules will be opportunistically evaluated at further follow-up performed for the original nodule(s)
1109 that instigated the 3- or 6-month follow-up CT. The GDG expressed concern that even a 6-month cut-off could
1110 lead to excessive CT surveillance of new nodules developing within this short interval. However, given the

1111 absence of evidence quantifying the relative risk versus benefits on alternative intervals, the group could not
1112 currently justify adopting an alternative threshold, such as 12 months.

1113 In contrast, it is recommended that new subsolid nodules are managed using the same approach as baseline
1114 subsolid nodules. As highlighted by Zhong et al., current evidence from NELSON does not support lower
1115 intervention thresholds for incident subsolid nodules [34], as their behaviour and malignancy risk appear
1116 comparable to those detected at baseline [35]. Management should therefore continue to be based on overall
1117 nodule size, the presence and size of any solid component, and interval change in morphology.

1118 Finally, follow-up of new nodules that are confidently classified as benign intrapulmonary lymph nodes is not
1119 recommended. New fissure-attached nodules are uncommon, accounting for approximately 6.5% of incident
1120 nodules in the NELSON study.[36] Although around 4% of all new nodules demonstrated typical or atypical
1121 perifissural nodule (PFN) morphology, none of these proved malignant. However, caution in dismissing such
1122 nodules should be exercised in patients with a history of malignancy that may manifest with pulmonary
1123 metastases.

1124 Of course, in the presence of previous imaging, the nodule must first be determined to be truly new. The GDG
1125 recommends future research should focus on whether it is more beneficial to use the higher size thresholds in
1126 the baseline solid algorithm ([Algorithm 1](#)) rather than the new solid algorithm ([Algorithm 3](#)), when the interval
1127 since the prior CT is long (for example, 5 or 10 years).

1128 The approach to new nodule management is summarised in [Algorithm 3 New solid nodule follow-up pathway](#)
1129 and examples of scenarios where follow-up intervals may need to be adapted are provided in Appendix 2.

1130 **5.4 Algorithm 4 Ground-glass nodule (GGN) pathway**

1131 3-month CT follow-up for GGNs measuring 5-30 mm in maximum diameter is not recommended, reasoning
1132 that the rate of change in these nodules that would herald development of an invasive adenocarcinoma is too
1133 slow to manifest in a 3-month period. In contrast, 3-month CT follow-up for GGNs > 30 mm and definitive
1134 management consideration at 3 months if they persist is recommended given that lung cancers manifesting
1135 as GGNs of this size are considered T1a lung cancers in current lung cancer staging [37] and diagnosing these
1136 at the earliest opportunity is desirable. At the same time, it is recognised that measurement variability inevitably
1137 implies that there may be some variation in management (follow-up versus definitive management) for
1138 persistent GGNs that are just under or over this 30 mm threshold (see example in Figure 11). In such cases,
1139 using the lower measurement is recommended, applying the principle of benefit of doubt inherent to lung
1140 cancer management [38,39] and prioritising specificity for invasive lung cancer diagnosis.

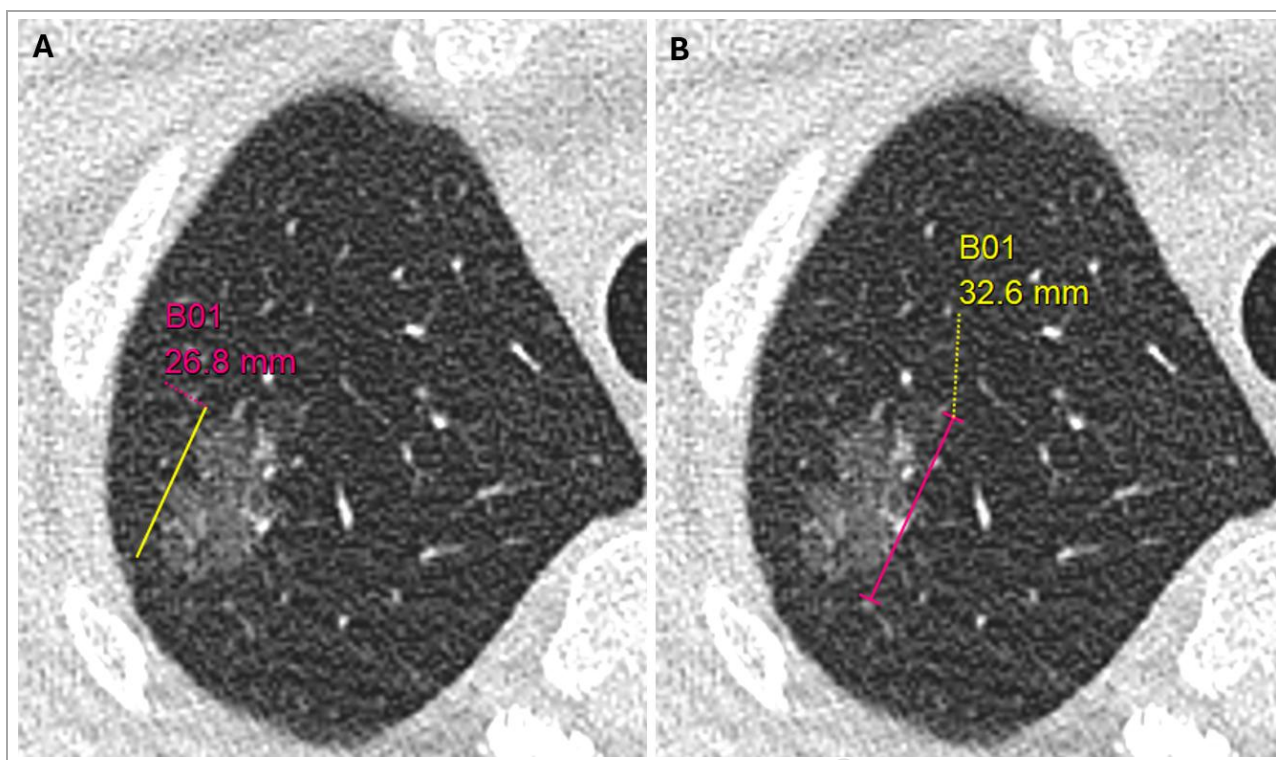


Figure 11: 71-year-old lung cancer screening participant with an apical right upper lobe ground-glass nodule with no solid component or altered morphology, measured at 27 mm by one radiologist (A) and 33 mm by another radiologist (B). The measurement variability arises because of difficulty delineating the border of such lesions.

1141 A distinction is also made between solitary (Figure 12) and multiple GGNs, because data from both screening
 1142 [40] and incidental [41] subsolid nodules (i.e. GGNs and PSNs) indicates that having more than one subsolid
 1143 nodule is associated with an increased lung cancer incidence and a lower probability of lung cancer-free
 1144 survival.

1145 In pure ground-glass nodules, unequivocal altered morphology or growth beyond 30 mm should prompt
 1146 consideration of definitive management (Figure 13). Several morphologic features associated with invasive
 1147 lung cancer were investigated and found that bubble-like lucency and air bronchograms are the most specific
 1148 features heralding invasion; accordingly, “altered morphology” in this context means the unequivocal
 1149 development of these features. Because of heterogeneity in the published data for Questions 5 and 6, an
 1150 algorithm could not be synthesised that could prescribe exactly how to quantify these non-size bases features,
 1151 or in what order to prioritise them particularly in the absence of a solid component (Figure 13). Therefore,
 1152 management decisions in the absence of developing an unequivocal new solid component should be based
 1153 only on unequivocal morphologic change.

1154 The appearance of a solid component should prompt reclassification as a PSN and transitions management
 1155 of a nodule to the PSN algorithm ([Part-solid nodule pathway](#)) (Figure 14), with the size and growth of the solid
 1156 component (the most robustly validated imaging predictor of invasiveness and prognosis) prioritised over other,
 1157 non-size-based, morphologic descriptors in guiding management.

1158

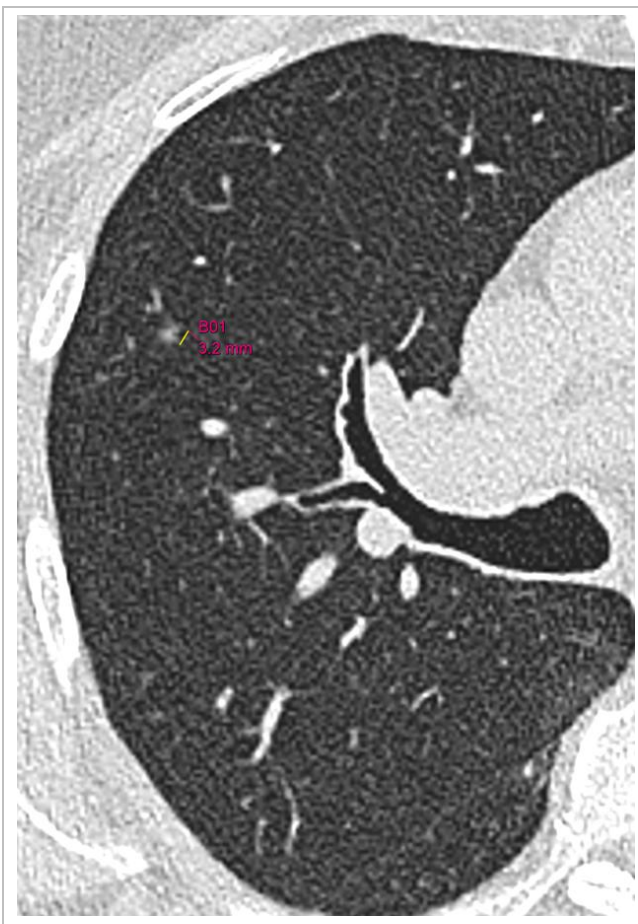


Figure 12: 61-year-old male lung cancer screening participant with a solitary 3 mm right upper lobe ground-glass nodule, requiring no follow-up.



Figure 13: 66-year-old male lung cancer screening participant with a 37 mm ground-glass mass in the left upper lobe demonstrating bubble-like lucency suspicious for invasive pulmonary adenocarcinoma, despite the absence of a solid component.

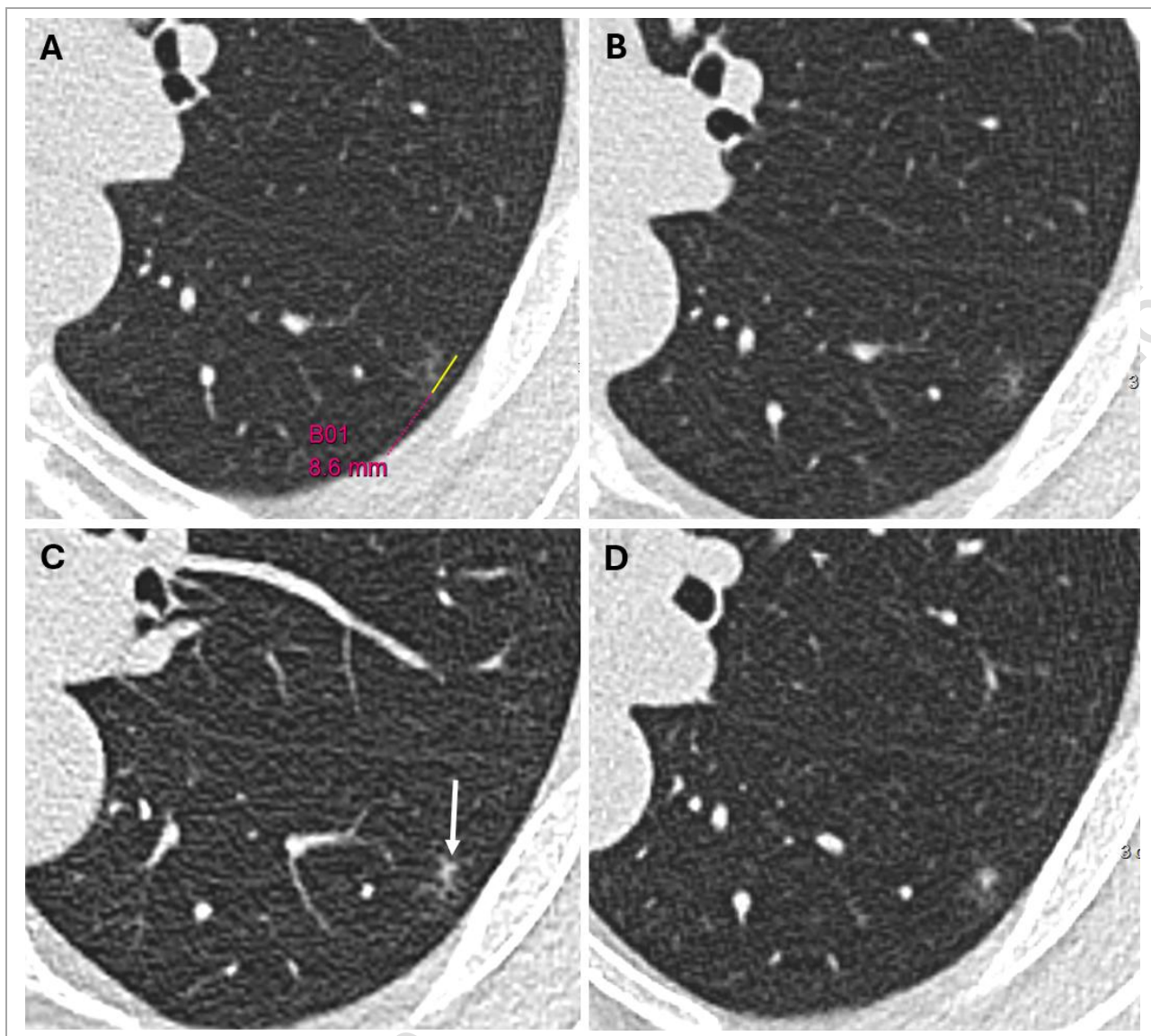


Figure 14: 62-year-old male lung cancer screening participant with a 9 mm ground-glass nodule in the apical left lower lobe at baseline (A), that remained stable at 1 year (B) but then developed a 3 mm solid component 2 years from baseline (C). Less than 6 mm, further annual surveillance CT was planned, whether nodule remains stable (D). As the new solid component was < 6 mm, further surveillance in another year, rather than immediate intervention, was planned, where the nodule remained stable in size, density and morphology (D).

1161 Defining the duration of follow-up is an essential component of both the optimal strategy for image utilisation
 1162 and for detecting change in subsolid nodules. Most persistent subsolid nodules that ultimately demonstrate
 1163 growth do so within the first three years of surveillance. In one series, all growing lesions exhibited detectable
 1164 growth within three years of initial observation [42], supporting follow-up at 1, 2 and 4 years to encompass this
 1165 higher-risk period. However, long-term stability does not eliminate the possibility of subsequent progression.
 1166 After five years of stability, further growth has been reported in approximately 5–13% of GGNs during extended
 1167 follow-up, although the clinical impact appears limited.[43,44] In the largest recent series, only 3.8% of nodules
 1168 demonstrated stage progression and just 0.9% progressed to T1a/T1b disease, with no metastatic events
 1169 observed. It has been suggested that CT surveillance could be extended to 5-year intervals after an initial 5
 1170 years of stability.[42] Given the desire to detect progression before stage upshifting occurs, continued
 1171 surveillance to 10 years appears reasonable, particularly as simulation modelling has demonstrated minimal
 1172 differences in outcomes when follow-up intervals are extended from 1 to 3 years for stable ground-glass
 1173 nodules.[45] To pragmatically align with current biennial lung cancer screening recommendations, we have
 1174 recommended further scanning at 2-year intervals (i.e. 6, 8 and 10 years from baseline) after 4 years initial
 1175 follow-up and stability.

1176 5.5 Algorithm 5 Part-solid nodule pathway

1177 Management of part-solid nodules (PSNs) is primarily determined by the size and behaviour of the solid
 1178 component. The guideline group found insufficient evidence to support recommendations based on changes
 1179 in any single subsolid nodule parameter for the diagnosis of malignancy. However, in keeping with the Good
 1180 Practice Points (GPPs), interval changes in additional radiological features may suggest invasive malignancy
 1181 in subsolid nodules, including fissural distortion, development of air bronchograms, emergence of bubble-like
 1182 lucencies, and increasing CT attenuation.

1183 For PSNs, the threshold for intervention was set at a solid component diameter of 6 mm (Figures 15 and 16).
 1184 This approach aims to support conservative management where appropriate and aligns with the IASLC
 1185 (International Association for the Study of Lung Cancer) definition of cT1a disease.[37] It also approximates
 1186 the lower limit at which biopsy techniques may achieve acceptable diagnostic reliability. The guideline group
 1187 recognised that pathological staging frequently exceeds clinical staging in PSNs because imaging may
 1188 underestimate the extent of the invasive solid component. Adoption of a 6 mm threshold is therefore likely to
 1189 ensure that many lesions remain within the pT1a category at treatment.

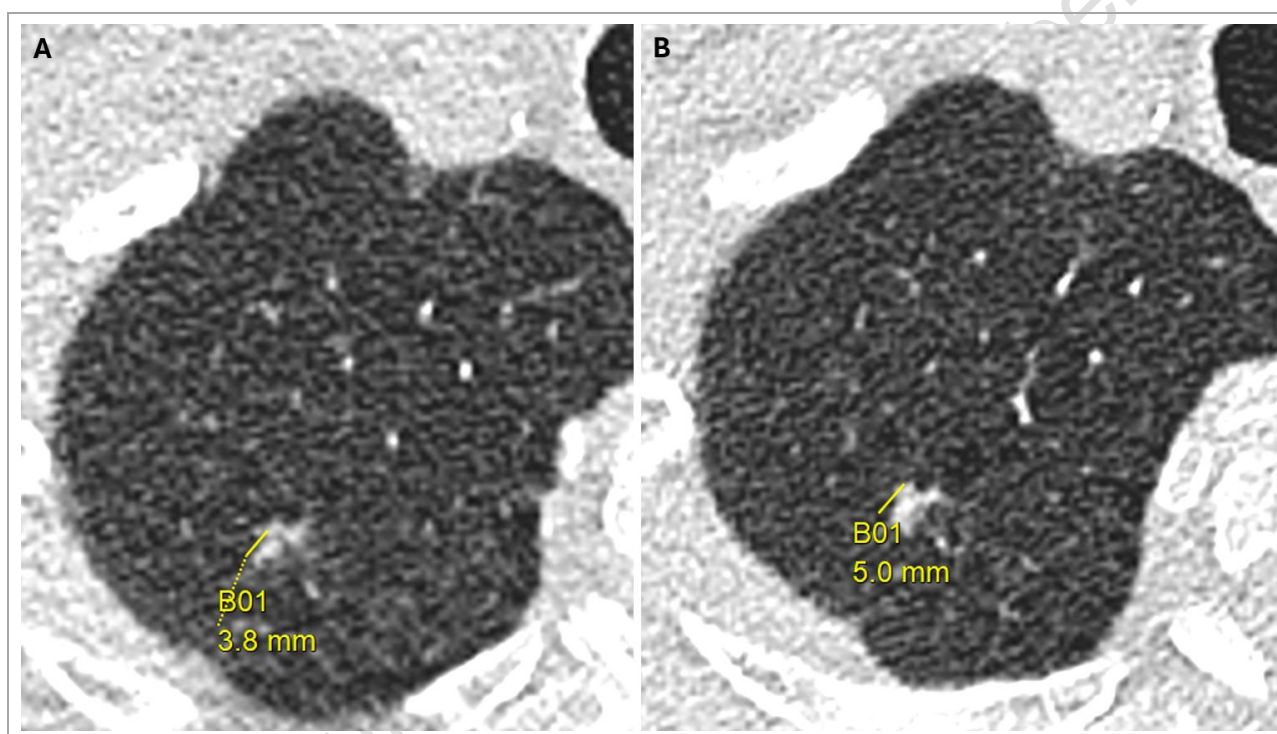


Figure 15: 66-year-old male lung cancer screening participant with a 9 mm part-solid nodule in the right apex, demonstrating a 4 mm solid component at baseline (A). The solid component slowly increased to 5 mm after 3 years of annual follow-up (B); as the solid component increase was less than 2 mm, and the overall solid component remains under 6 mm, the nodule remains under further surveillance.

1190 Another important change is that PET-CT is no longer routinely recommended for either nodule discrimination
 1191 or staging in PSNs where the solid component measures < 10 mm. This reflects both the high likelihood of
 1192 malignancy in enlarging PSNs and their relatively low propensity for metastatic spread. This recommendation
 1193 differs from current NICE (National Institute for Health and Care Excellence) guidance, although the NICE
 1194 guideline did not specifically address the management of PSNs.

1195 While some guidelines and studies have proposed managing predominantly solid nodules (e.g. those with a
 1196 $\geq 90\%$ solid component) as solid nodules [24,46], there is currently insufficient evidence to support this
 1197 approach. In particular, some slow-growing part-solid nodules may present with a predominant solid
 1198 component at initial detection despite following the biological behaviour of subsolid lesions. Classifying such
 1199 nodules as solid could result in erroneous discharge after one- or two-year stability and no planned long-term
 1200 surveillance, potentially missing the delayed growth patterns characteristic of subsolid adenocarcinoma-
 1201 spectrum lesions.

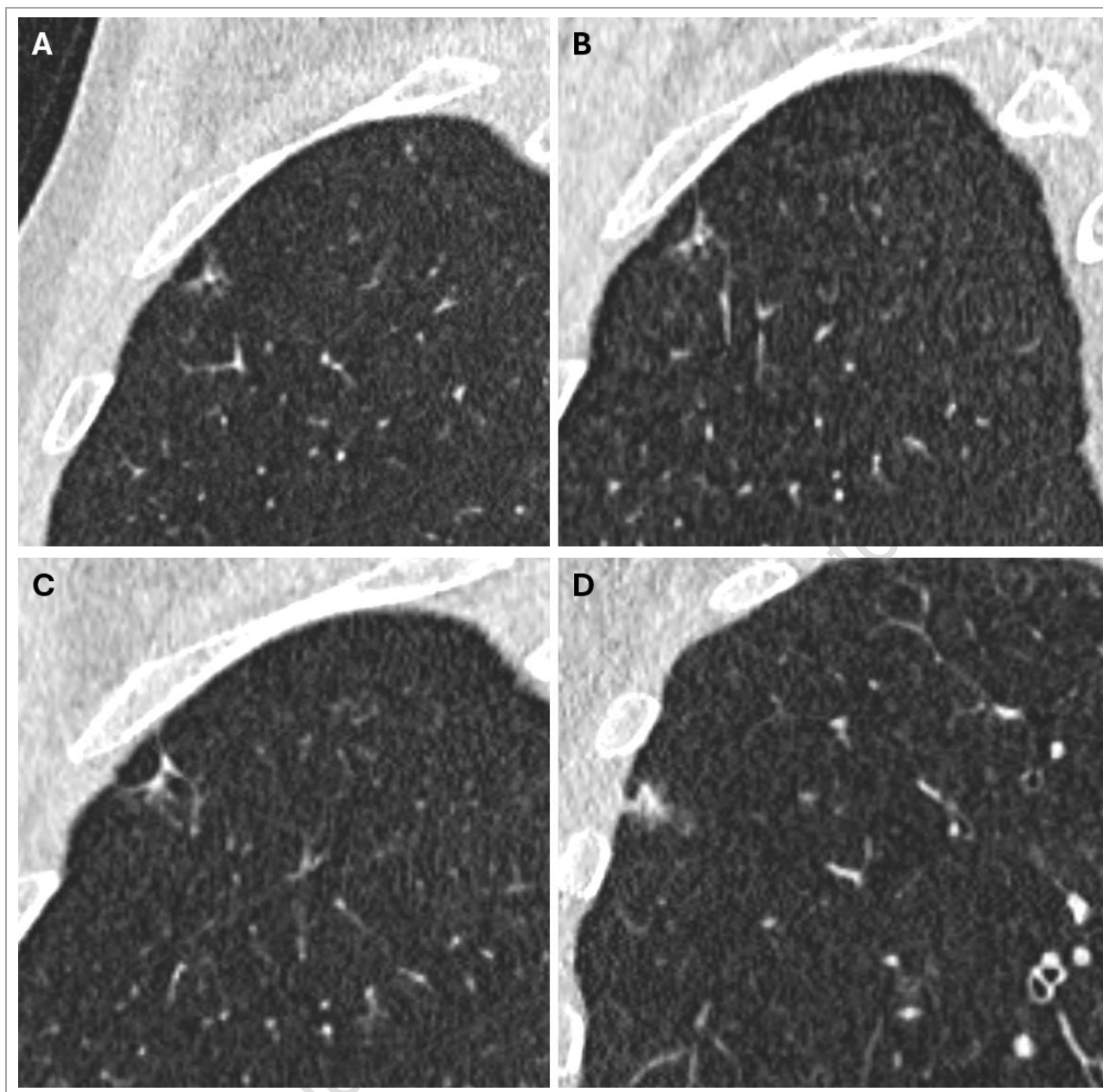


Figure 16: Sagittal reconstructions from the low-dose CT of a 64-year-old male lung cancer screening participant with a part-solid nodule, measuring 12 mm overall, associated with some air bronchograms, but a solid component of only 2 mm at baseline (A). This remained stable over 1 year (B), but the solid component then increased to just under 6 mm after 2 years from baseline (C). Further annual CT 3 years from baseline revealed an unequivocal growing solid component, now 8 mm (D), consistent with an invasive adenocarcinoma.

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1328 **Appendix 2 Example scenarios where nodule follow-up intervals require modification**

1329 **Scenario 1: Delayed follow-up**

1330 An Indeterminate solid nodule, reliable volume of 135 mm³ is detected on a baseline scan performed on 15
1331 January 2025.

1332 Follow-up for this nodule is planned on 15 April 2025, 3 months from baseline (Algorithm 2).

1333 However, the participant does not attend follow-up at 3 months and only attends on 15 October 2025 (9 months
1334 from baseline). The nodule measures 140 cubic mm³ (3.7% difference from baseline, within the 25% allowed
1335 for inter-scan variation) and so is considered stable at 9 months.

1336 If the patient had attended in April 2025 and the nodule had been stable, the next follow-up timepoint for this
1337 nodule should have been January 2026, i.e. 1 year from baseline. However, as they have attended their follow-
1338 up 9 months from baseline, they have not yet had a minimum of 1 year follow-up for volumetric stability, while
1339 January 2026 would only be in another 3 months and so be too short an interval. It is sensible in this case to
1340 perform the next follow-up CT in April 2026, i.e. 6 months from the first follow-up scan and 15 months from the
1341 baseline scan, to allow a longer and more reliable assessment of VDT.

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1343 **Scenario 2: New nodule on a follow-up scan**

1344 Indeterminate solid nodule (nodule 1), reliable volume of 85 mm³ on a baseline scan performed on 1 June
1345 2024. A follow-up CT in 6 months is planned (Algorithm 2).

1346 On the 6-month follow-up CT for this nodule on 01 December 2024, the nodule measures 90 mm³ (5.9%
1347 difference from baseline, within the 25% allowed for inter-scan variation) but there is a new 43 mm³ solid
1348 nodule (nodule 2) in another lobe. A further follow-up CT on 01 March 2025 is thus performed (3 months from
1349 the occurrence of the new nodule, as per Algorithm 3, and 9 months from the baseline scan).

1350 On 1 March 2025, nodule 1 remains stable at 88 mm³, and nodule 2 persists but is stable at 47 mm³.

1351 The next scan for nodule 1 should be on 01 June 2025 (1 year from baseline, Algorithm 2), but this would only
1352 be 3 months from the most recent CT.

1353 The next scan for nodule 2 should be on 01 December 2025 (1 year from first occurrence, Algorithm 3).

1354 As Nodule 1 has already been stable for 9 months, while the new nodule 2 has only had 3 months of follow-
1355 up, it makes sense to perform the next CT on 01 December 2025, 1 year from first occurrence of the new
1356 nodule and 18 months from baseline. If both nodules are then stable, no further follow-up CT is required.

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1370 **Appendix 3 Guideline Development Group (GDG) members**

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Mr Paul Holland	Radiographer Nottingham University Hospitals NHS Trust
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Dr Kay Por Yip	Respiratory Registrar University of Birmingham, Birmingham

1371 **Appendix 4 Clinical Questions**

- 1372 **Q1** In adults, is there a difference in the likelihood of diagnosing lung cancer in pulmonary nodules
1373 detected by low dose computed tomography (CT) screening compared to those detected on CT scans
1374 done for other reasons?
- 1375 **Q2** In adults with pulmonary nodules, is there a difference in the likelihood of diagnosing lung cancer
1376 between patients with or without a previous history of non-lung cancer?
- 1377 **Q3** What is the diagnostic accuracy of imaging tests, and the optimal strategy for image utilisation for
1378 diagnosing lung cancer in a solid pulmonary nodule?
- 1379 **Q4** In adults with solid pulmonary nodules, what is the diagnostic accuracy of strategies used to detect
1380 change between interval computed tomography (CT) scans for diagnosing lung cancer?
- 1381 **Q5** What is the diagnostic accuracy of imaging tests, and the optimal strategy for image utilisation for
1382 diagnosing lung cancer in a sub-solid pulmonary nodule?
- 1383 **Q6** In adults with sub-solid pulmonary nodules, what is the diagnostic accuracy of strategies used to detect
1384 change between interval computed tomography (CT) scans for diagnosing lung cancer?
- 1385 **Q7** In adults with pulmonary nodules, what is the diagnostic accuracy of biopsy of a pulmonary nodule for
1386 diagnosing lung cancer?
- 1387 **Q8** In adults with pulmonary nodules being considered for treatment for lung cancer with curative intent,
1388 does pre-treatment biopsy provide the same clinical outcomes as no biopsy?
- 1389 **Q9** In adults with pulmonary nodules being considered for treatment with curative intent, does FDG
1390 positron emission tomography computed tomography (PET-CT) staging provide the same clinical
1391 outcomes as no PET-CT staging?

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1409 **Appendix 4 Stakeholders**

Royal College of Radiologists

British Society of Thoracic Imaging

Royal College of Physicians

British Nuclear Medicine Society

British Thoracic Oncology Group

Society for Cardiothoracic Surgery

British Thoracic Oncology Group

Lung Cancer Nursing UK

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