CS Health

# Clinical Pathways for Coal Mine Dust Lung Disease Monitoring

## Supporting clinical guidance notes for Medical Practitioners

# Contents




**Clinical pathways for coal mine dust lung disease monitoring – supporting clinical guidance notes for medical practitioners**

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# Purpose

The Coal Services Health (CS Health) *Clinical Pathways for Coal Mine Dust Lung Disease Monitoring* (the Pathways) are designed for approved medical practitioners (AMPs) to use with coal mine workers not already known to have coal mine dust lung disease (CMDLD), or who are currently under investigation for possible disease. The coal mine worker is assessed under 2 pathways: (i) chest imaging, and (ii) spirometry and symptoms.

This supporting clinical guidance document (clinical guidance notes) is designed to assist and support approved medical practitioners assess and follow up the clinical findings, symptoms, and spirometry components of the Pathways.

Positive findings under any Pathway in isolation, or with others, can result in further investigation. If in doubt at any stage, the approved medical practitioner must contact the CS Health Clinical Investigation Team (CIT) to discuss management of the case.

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# TSANZ/CS Health Order 43 spirometry compliance requirements

Compliance with TSANZ Spirometry Standards for CS Health Respiratory Health Monitoring for Order 43 (Order 43) health assessments requires the following:

1. Spirometry report must meet quality assurance (QA) and compliance criteria: patient details, relevant clinical history, findings and medications, and smoking history in pack years, must be correctly recorded on the spirometry report.
2. Bronchodilator responsiveness testing (BRT) must be completed where FEV1, FVC or FEV1/FVC ratio, individually or in combination, are below the lower limit of normal (LLN).
3. Spirometry of at least Grade A or B must be achieved for reliable interpretation and longitudinal monitoring of lung function. This requires:
   - Spirometry with at least three acceptable test manoeuvres, with best FVC and FEV1 values repeatable within 150mls. The best values must be selected from one of the curves displayed on the report.
   - The quality grade for PRE and POST test manoeuvres must be assessed separately and meet A/B grade requirements.
   - Where the results indicate potential abnormality, the AMP must act by arranging further evaluation via the Pathways.
   - Where spirometry results are normal, the AMP must still consider any unexplained significant symptoms, and assess for longitudinal decline (if relevant), as these may trigger escalation via the Pathways.

# Clinical guidance notes

Exposure to coal mine dusts and other contaminants can cause several lung diseases, including:

> obstructive lung disease: chronic bronchitis and emphysema (COPD)

> lung fibrosis or pneumoconiosis: coal workers' pneumoconiosis (CWP) or black lung; mixed dust pneumoconiosis; diffuse dust related pulmonary fibrosis; silicosis; and asbestosis.

Other atmospheric contaminants, like isocyanates and diesel exhaust particulate, can cause occupational asthma or exacerbate existing asthma.

Lung cancer may result from exposure to carcinogens in the mine atmosphere, including respirable crystalline silica dust, diesel exhaust emissions and welding fumes.

Decline in lung function can occur without the development of lung fibrosis, and with normal chest imaging findings. Spirometry may be obstructive, restrictive, or mixed pattern and the result may even be in the normal range if baseline values are supra-normal.

# Use of Z-Scores for spirometry interpretation and severity classification

The Respiratory Health Standard (this Standard) utilises Z-scores for the interpretation of spirometry results and the classification of lung function impairment severity. This management aligns with current international best practices and technical standards, notably the 2022 European Respiratory Society/American Thoracic Society (ERS/ATS) technical standard on interpretive strategies for routine lung function tests.

The Z-score indicates how many standard deviations an individual's results are from the mean value predicted for them based on age, height, sex, and ethnicity, using the Global Lung Function Initiative (GLI) reference equations.

Using Z-scores provides a more statistically robust method, reduces biases related to age and height (particularly at the extremes), and allows for a more accurate assessment of deviation from the mean across the population distribution. The lower limit of normal (LLN) corresponds to a Z-score of -1.65 (representing the 5th percentile).

The severity of impairment is classified using the following Z-score thresholds:

| Lung Function | Z-score |
|---|---|
| Normal | > -1.645 |
| Mild impairment | Between – 1.65 and -2.5 |
| Moderate impairment | Between -2.5 and -4 |
| Severe impairment | < -4 |

# Spirometry assessment for CS Health clinical pathways

## Step 1: Check details on spirometry report

1. Spirometry must be compliant with *TSANZ Standards for the delivery of spirometry for resource sector workers, 2022* (the TSANZ Standard).
2. The GLI model must be used to determine the lower limit of normal (LLN) and predicted values for interpretation and comparison of test results over time. The "GLI Global" race-neutral equations, recommended by the American Thoracic Society (ATS) and the European Respiratory Society (ERS), may be used in preference to ethnicity-based reference models, when the ethnicity is uncertain.
3. The key spirometry parameters for routine screening of workers exposed to coal mine dust are FVC, FEV1 and FEV1/FVC ratio. These values depend on lung size, airway calibre and the driving force of the respiratory muscles. The best FVC, FEV1 values and the FEV1/FVC ratio will be interpreted using GLI reference equations and will be expressed as both Z-scores and % predicted. The LLN is defined as a Z-score of -1.65 (5th percentile).
4. The variables used in the GLI model to predict and adjust for individual and population differences are height, biological sex, ethnicity and age. It is important they are entered correctly into the spirometer, or the predicted values and interpretation of the result will not be correct.
   - Height: predictor of lung size.
   - Biological sex: an important predictor of lung size, independent of height.
   - Age: predictor of the driving force of respiratory muscles, elasticity of lungs and rigidity of the chest wall/ chest wall muscles changes with the aging process.
   - Ethnicity: traditionally used to adjust for differences in body proportions. The GLI reference populations for historic ethnicity groupings can be seen in Table 1. International societies (ATS/ERS) recommend the use of the race-neutral "GLI Global" equations (Bhakta NR et al 2023 Race and Ethnicity in Pulmonary Function Test Interpretation: An Official American Thoracic Society Statement). If ethnicity-based equations are used, or if switching between ethnicity-based and race-neutral interpretation, this must be done with caution and clearly documented, as classification at the LLN may change. If there is uncertainty about the appropriate ethnicity grouping, the "Other" category or the GLI Global equations should be selected.

**Table 1: GLI reference populations** (Stanojevic et al. (2021), ERS/ATS Technical Standard on Interpretive Strategies for Routine Lung Function Tests)

| GLI group | Typical regions/populations | Considerations |
|---|---|---|
| Caucasian/European ancestry | Europe, Israel, Australia, USA, Canada, Brazil, Chile, Mexico, Uruguay, Venezuela, Algeria, Tunisia, Mediterranean populations | Appropriate for individuals of European descent from other regions (e.g. New Zealand, South Africa) |
| African American/ Black | African American populations in the United States | Non-North American Black populations should be classified as *Other*, unless validated local reference data are available |

| GLI group | Typical regions/populations | Considerations |
|---|---|---|
| North-East Asian (NEA) | Korea, Japan, Northern China | Populations from NEA countries not listed should be classified as *Other.* |
| South-East Asian (SEA) | Thailand, Taiwan, Southern China (including Hong Kong) | Populations from SEA countries not listed should be classified as *Other.* |
| Other/Mixed | Persons not represented in the four main population groups, including Aboriginal and Torres Strait Islander peoples, Sub-Saharan Africans, South Asians (India, Sri Lanka, Pakistan), and Pacific Islanders | Derived as an average of the four main groups. Use when ancestry is mixed or unclear. |

**Note on Race-Neutral GLI Interpretation**

The ATS and ERS recommend use of the GLI Global race-neutral equations, which do not require ethnicity as an input, in preference to traditional ethnicity-based models (Bhakta NR et al 2023 Race and Ethnicity in Pulmonary Function Test Interpretation: An Official American Thoracic Society Statement). Where race-neutral equations are applied, the choice should be consistent and documented.

Caution must be exercised if changing from one reference approach to another, as an individual's LLN may shift, with results reclassifying from above to below the LLN (or vice versa). Any such change should be interpreted in clinical context, considering exposure history, clinical findings, and job demands. Significant changes in determination should be reviewed by the AMP and, if required, escalated to the CS Health CIT.

Importantly, spirometry interpretation must always prioritise longitudinal comparison with the coal mine worker's most recent prior test, as this provides the clearest indication of functional decline or ongoing disease requiring further investigation.

To comply with the TSANZ Standard and assist interpretation of the result, additional information must be recorded by the operator on the spirometry report, including:

- the type and dosage of any inspired, oral, or injected medications that may alter lung function, and when the drugs were last administered
- observed signs or symptoms, such as cough, wheeze, dyspnoea, or cyanosis
- the smoking history in pack/years and vaping history
- relevant clinical history and conditions, e.g. asthma or COPD
- weight: BMI may be relevant in interpreting spirometry results in obese workers.

5. Before proceeding, check the patient's details, clinical history, medications and smoking history are consistent with the responses in the Standardised Respiratory Questionnaire (SRQ), the medical history, and clinical components of the health assessment. All errors must be corrected, and spirometry report regenerated for CS Health Order 43 compliance.

## Step 2: Assess spirometry quality

1. High quality spirometry is essential for obtaining results that are accurate, reliable and suitable for use in the CS Health respiratory health surveillance programme. Spirometry quality of at least Grade A or B is required for Order 43 compliance.
2. Accurate and reliable test results are crucial for:
   - establishing a baseline for lung function before exposure begins so the effects can be measured with repeat testing over time
   - comparing test results and identifying trends on longitudinal assessment of lung function. Poor quality results may falsely lower the baseline, and obscure detection of accelerated lung function decline over time
   - correctly interpreting and identifying abnormal findings
   - determining the need for additional tests and identifying the correct follow-up within the Pathways
   - poor quality spirometry may affect FEV1 and FVC values and trigger unnecessary additional tests or missed cases for follow-up.
3. Spirometry test quality can only be determined by directly inspecting the flow-volume curves displayed on the spirometry report. The 'session quality' comment on the spirometry report must be ignored, as it is based on test values only and does not consider acceptability criteria for grading.
4. Test quality is based on how many technically acceptable manoeuvres are achieved in the test, and how repeatable the largest FVC and FEV1 values from the selected manoeuvres are. For Grade A spirometry, an acceptable manoeuvre must be achieved at least three times, and the best FVC and FEV1 values must be repeatable within 150mls. The best values must be selected from one of the curves displayed on the spirometry report.
5. A manoeuvre is only acceptable if it achieves **all the criteria** in Table 2.

### Table 2: Spirometry acceptable criteria

- a maximal inspiration prior to the forced expiration.
- fast expiration without delay, creating an observed sharp rise in the flow trace. Back extrapolated volume is to be =<5% of FVC or <0.10L, whichever is greater.
- maximal continuous expiration with a plateau in flow despite continued effort (<0.025L measured over one sec) OR
- achieved expiratory time ≥ fifteen seconds OR
- the individual cannot expire long enough to achieve a plateau and the FVC is within 0.15L of or is greater than the largest prior observed FVC.
- no observed leaks or artefact in the trace.
- If performing inspiratory loops:
- if the maximal inspiration after EOFE is greater than FVC, then FIVC - FVC must be ≤0.100 L or 5% of FVC, whichever is greater.

6. Repeatability is determined by applying the repeatability criteria in Table 3 to the differences between the 2 largest FVC values and the 2 largest FEV1 values, which must come from acceptable manoeuvres.

### Table 3: Spirometry repeatability criteria

A testing session is deemed to be repeatable if the following is achieved:

- ≥2 acceptable FVC values are within 0.15L of each other; and
- ≥2 acceptable FEV1 values are within 0.15L of each other.

7. The largest FVC and FEV1 values are used to calculate the FEV1/FVC ratio and interpret the spirometry result. They may arise from different manoeuvres, but it is essential the values have been selected from one or more of the trials displayed on the spirometry report. The other trials in the test have not been assessed against acceptability criteria and cannot be used for interpretation purposes.
   - Check that the 'best' FVC and FEV1 values used to calculate the FEV1/FVC ratio have been selected from one or more of the trials displayed on the spirometry report.
   - If the 'best' FVC or FEV1 value is not from one of the trials you can see on the report, the other trials need to be deselected and the spirometry report regenerated before proceeding.

8. While the aim is to achieve A-grade spirometry, B-grade is acceptable for establishing a baseline, interpretation, and assessment of longitudinal decline for health monitoring purposes.
   - For A-grade spirometry, at least 3 acceptable manoeuvres are required with the 2 largest FEV1 and FVC values meeting repeatability criteria: within 0.15L of each other. If the difference is >0.15L but <0.2L, the spirometry is C-grade.
   - For B-grade spirometry, at least 2 acceptable manoeuvres are required with the FEV1 and FVC values repeatable within 0.15L. The best FVC and FEV1 values must come from the 2 acceptable trials and must be repeatable.

   Determine the spirometry quality grade based on acceptability and repeatability criteria, and the Spirometry Matrix in Table 4. A separate grade must be determined for both FEV1 and FVC from acceptable manoeuvres.

   **Note:** The AMP must not rely on the system or tester interpretation of the spirometry test quality or result. A separate comment needs to be recorded by the AMP in the medical assessment confirming their own interpretation of the test result as justification for decision-making/escalation via the Pathways.

9. If BRT is required, a separate grade must be determined as per Table 4 for pre-test and post-test results, and recorded by the approved medical practitioner in the spirometry interpretation comment in the medical assessment. The indications for BRT are summarised in Table 5.

### Table 4: Spirometry grading matrix[2]

| | | Repeatability between 2 best trials | | | |
|---|---|---|---|---|---|
| | | ≤0.150L | ≤0.200L | ≤0.250L | ≥0.25L |
| No. acceptable trials | 3 | A | C | D | E |
| | 2 | B | C | D | E |
| | 1 | F | | | |

| Grade | Acceptability and repeatability criteria | Comment |
|---|---|---|
| A | 3 acceptable and 2 repeatable trials within 0.150L | Desirable |
| B | 2 acceptable and 2 repeatable trials within 0.150L | Acceptable |
| C | ≥2 acceptable and 2 repeatable trials within 0.200L | Repeat testing required |

2 Matrix adapted from Workbook V1.0 (May22) Sarah Baum t/a Spirometry Trading Company (Aust) Pty Ltd 2011.

## Step 3: Bronchodilator responsiveness testing (BRT)

1. The interpretation of spirometry is based on values of airflow, lung volumes and gas transfer measurements (where relevant). The LLN, or fifth percentile of the healthy GLI reference population, is the cut-off used to identify abnormal results.
2. The best FVC, best FEV1 and the FEV1/FVC ratio must be compared against the respective LLN. Spirometry is abnormal if any of these parameters, individually or in combination, are below the LLN.
3. The purpose of BRT is to determine if a clinically relevant or treatable component is present in abnormal spirometry. BRT also reduces individual variation between tests in those with asthma or reactive airways.
4. As coal mine dust disease can present with any pattern of impairment on spirometry (obstructive, restrictive, or mixed), BRT is required for all abnormal spirometry results, i.e., where the best FEV1, best FVC or the FEV1/FVC ratio is less than the respective LLN.
5. In addition, BRT is recommended in the following clinical contexts, even if spirometry result is normal:
   - A documented history of lung disease, e.g., asthma.
   - Where asthma or other obstructive lung diseases, e.g., COPD are suspected.
   - Significant or chronic symptoms declared in the Standardised Respiratory Questionnaire in the medical assessment.

### Table 5: Indications for conducting BRT

| Spirometry | Indication | Comment |
|---|---|---|
| Abnormal BRT required | Absolute FVC <LLN | Suggestive of restrictive lung disease – diagnosis established by reduced TLC on complex lung function testing. |
| | Absolute FEV1 <LLN | Reduced in individuals with airway obstruction. |
| | FEV1/FVC ratio <LLN | Airflow obstruction - indicative of obstructive lung disease. |
| Normal BRT recommended | History of lung disease | Reduces intra-individual variation between tests. |
| | Suspected lung disease | Suspected asthma or COPD (smoker, symptoms, history). |

6. Changes in FEV1 and FVC following administration of a bronchodilator should be reported as a change relative to the individuals predicted GLI value. This minimises the effects of sex and height on the magnitude of the response. An example of how this is calculated is shown below:

### Determination of a bronchodilator response (BDR)

$$BDR = \frac{(\text{Post-bronchodilator value (l)} - \text{Pre-bronchodilator value (l)}) * 100}{\text{Predicted value (l)\#}}$$

A change of >10% is considered a significant BDR response.

#Predicted value should be determined using the appropriate GLI spirometry equation.

For example:
A 28-year-old Caucasian male; 175cm in height has a pre-brochodilator FEV1 4.41L and a post-bronchodilator FEV1 of 4.65L. The predicted FEV1 is 4.39L (using the GLI Caucasian equation).

The BDR is calculated as $\frac{(4.65 - 4.41) * 100}{4.39} = 5.5\%$

Therefore, their BDR is reported as an increase of 5.5% of their predicted FEV1 and is classified as not having a bronchodilator response.

*Adapted from the 2022 ERS/ATS Technical standard on interpretive strategies for routine lung function tests.*

7. A pre-post change of more than 10% in the predicted GLI value for FVC or FEV1 indicates a clinically relevant or positive bronchodilator response.
8. Post-test quality must be assessed, and the bronchodilator response reviewed to determine if the result is clinically relevant or positive.
9. BRT must be undertaken where required before final interpretation of the spirometry result and determining escalation in the Pathways.

## General guidelines for spirometry not meeting QA requirements

1. Spirometry of at least Grade A or B is required for Order 43 compliance. This applies to both pre and post spirometry tests, where relevant.
2. Spirometry of Grade-C or lower is not suitable for health surveillance purposes and repeat testing on another day will generally be required.
3. Follow-up requirements will depend on the context (pre-placement assessment vs. periodic assessment), spirometry grade achieved, the result (normal vs. abnormal), availability of past spirometry records (if relevant), the clinical context, and whether there are other findings triggering escalation via the Pathways.
4. In the situation where an adequate spirometry assessment cannot be completed, repeat testing should be completed. If unsuccessful and an existing NSW coal mine worker, refer directly to a respiratory laboratory. New entrants to the NSW coal industry should be referred to their treating doctor to arrange testing at a respiratory laboratory.

### Practical considerations/interim arrangements for spirometry not meeting QA requirements

1. **Periodic assessments**
   - In general, normal spirometry may be used with caution if the result is consistent with past test results for the individual. Repeat testing for QA purposes will be required within 12 months.
   - In general, abnormal spirometry that is consistent with the pattern of past test results for the individual (chronic abnormality), should be escalated via the Pathways. Interim dust restrictions may apply based on the severity of the findings and the role.
   - In general, abnormal spirometry that is not consistent with the pattern of past test results (new finding), should be repeated within 3 months to confirm the result, before determining if escalation via the Pathways is required.

2. **Pre-placement assessments for existing NSW coal mine workers**
   - In general, normal spirometry may be used with caution if the result is consistent with past test results. Repeat testing for QA purposes will be required within 6 months.
   - In general, abnormal spirometry that is consistent with the pattern of past test results (chronic abnormality), should be escalated via the Pathways. Interim dust restrictions may apply based on the nature and severity of abnormality.
   - If the result is abnormal, and not consistent with past results (new finding), repeat testing will generally be required before the determination is finalised. Alternatively, interim dust restrictions may apply. Repeat testing will be required within 3 months.

3. **Pre-placement assessments for new entrants to the NSW coal industry**
   - In general, spirometry quality Grade C or lower will require repeat testing/QA compliance before finalising the assessment.

## Step 4: Interpreting the BRT result

1. Within the context of coal mine dust exposure, a bronchodilator response cannot be used in isolation to determine risk and management of abnormal spirometry through the Pathways. A positive response does not necessarily exclude disease from coal mine dust or other exposures, and the result needs to be interpreted in the context of the medical and exposure history.
2. A bronchodilator response is commonly seen in workers with COPD, caused by occupational and non-occupational exposures. In some cases the response may be <10% with post-spirometry values within the normal range. In other cases the response may be >10% with persisting obstruction on spirometry. This is strong evidence of COPD and not diagnostic of asthma in the setting of coal mine dust exposure.
3. Where results show a positive bronchodilator response (>10%), the approved medical practitioner needs to determine if a presumptive diagnosis of asthma can be made, and whether the worker requires further evaluation through the Pathways.
4. In general, abnormal spirometry in individuals with past dust exposure (coal, mineral mines, tunnelling, construction, quarry work, stone benchtop industry) and/or current/past smokers, will require escalation via the Pathways, regardless of the size of the bronchodilator response and whether post-spirometry is normal.

#### Example 1: past dust exposure and/or smoking history

Individuals with abnormal pre-bronchodilator spirometry meeting the following criteria should be escalated via the Pathways based on pre-spirometry values:

> a bronchodilator response of any amount; and
> the post-spirometry result is normal or abnormal; and
> there is a significant smoking history; and/or
> there is a significant dust exposure history.

### Example 2: periodic assessment, known asthmatics with abnormal post spirometry

In general, known asthmatics in the context of periodic assessments should be escalated through the Pathways where:

- the bronchodilator response is greater than 10%; and
- the post-spirometry result is abnormal, i.e. FEV1, FVC or FEV1/FVC ratio below the LLN.

There may be two underlying causes for the spirometry abnormality – asthma and impairment from coal mine dust exposure. The result needs to be considered in the context of the medical and exposure history, and longitudinal assessment of spirometry results. The coal mine worker may also be referred to their treating doctor for review of their asthma management plan.

### Example 3: periodic assessments, known asthmatics with normal post spirometry

Known asthmatics in the context of periodic assessments may be referred to their treating doctor for review of their asthma management plan where:

- the bronchodilator response is greater than 10%; and
- the post-spirometry result is normal, i.e. FEV1, FVC and FEV1/FVC ratio are all above the LLN.

These findings may indicate that treatment is sub-optimal. The result still needs to be considered in the context of the medical and exposure history, and longitudinal assessment of spirometry results, as they may require escalation in the Pathways. The coal mine worker may also be referred to their treating doctor for review of their asthma management plan.

### Example 4: Presumptive asthma

A presumptive diagnosis of asthma may be made if all the following criteria apply:

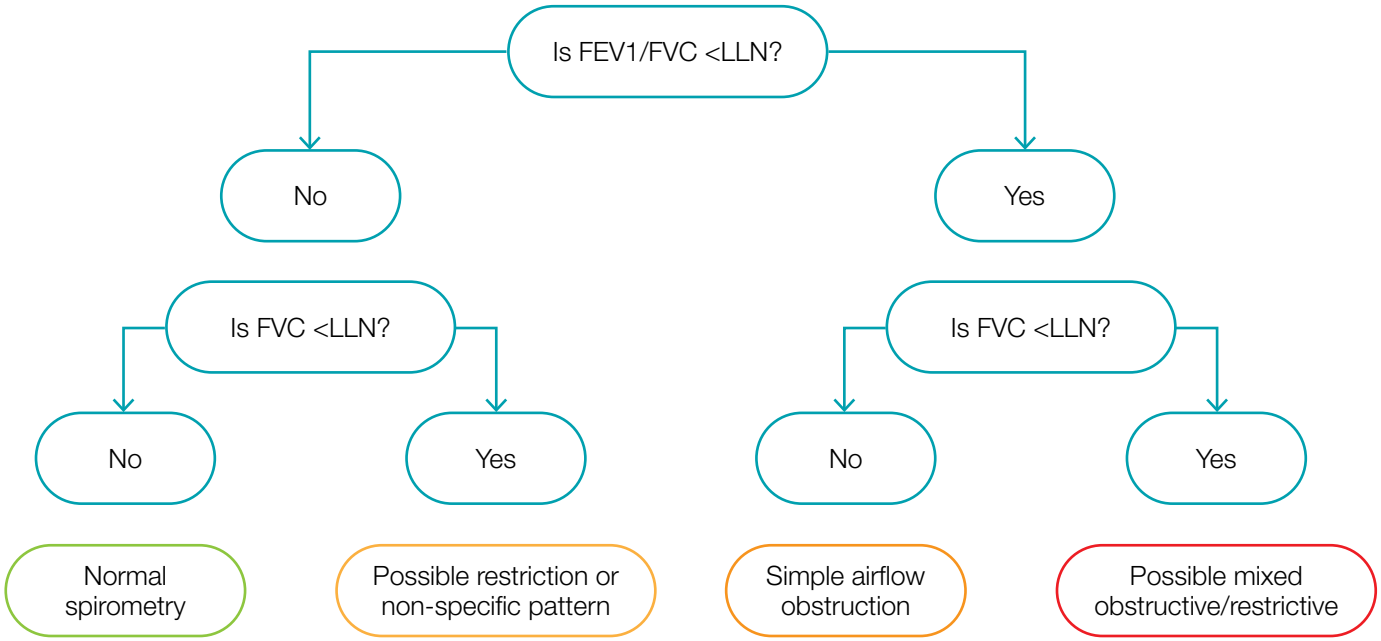
- the bronchodilator response is greater than 10% (clinically relevant, positive); and
- the post-spirometry result is normal, i.e. FEV1, FVC and FEV1/FVC ratio are all above the LLN; and
- there is no significant smoking history; and
- there is no significant dust exposure history.

5. Individuals meeting all the above criteria may have undiagnosed asthma and can be referred to their GP for confirmation of diagnosis and an asthma management plan, with a 6-month spirometry review. In general, for pre-placement assessments for new coal mine workers, confirmation of diagnosis with CLFT will be required before the determination can be finalised. Post-spirometry values may then be used for follow-up in the Pathways, provided there are no other clinical findings requiring escalation. Refer to the CS Health CIT for advice.

## Step 5: Interpreting the spirometry result

1. Spirometry escalation triggers through the Pathways are based on pre-bronchodilation test values, as are dust restrictions for individuals with respiratory impairment.
2. The best FVC, best FEV1 and the FEV1/FVC ratio must be used for interpretation of results and classification of respiratory impairment pattern.
   - If FEV1, FVC and FEV1/FVC ratio are all >LLN, spirometry result is classified as normal.
   - If any of these parameters, individually or in combination, are <LLN, spirometry is abnormal, and the relevant functional pattern of impairment is identified as per Table 6.

### Flow chart: Functional classification of spirometry impairments




### Classification of spirometry impairment pattern and severity:

1. Identify the functional pattern based on FEV1/FVC ratio and FVC compared to LLN (Z-score -1.65) as per Table 6.
2. Determine the severity of any identified impairment (obstructive, restrictive, or mixed) based on the Z-score of the relevant parameter(s) (primarily FEV1 for obstruction/mixed, FVC for restriction), using the ERS/ATS 2022 recommended thresholds:
   - Normal: Z-score > -1.65
   - Mild Impairment: Z-scores between -1.65 and -2.5 (approx. ≥ 70% predicted)
   - Moderate Impairment: Z-scores between -2.5 and -4.0 (approx. 60-69% predicted)
   - Severe Impairment: Z-score <-4.0 (approx. < 60% predicted)

*(Note: The previous definitions numbered 1-4 under 'Spirometry criteria for mild lung function impairment category' based on % predicted FEV1 ≥70% are superseded by this Z-score classification).*

## Practical considerations and interim arrangements for abnormal spirometry

Periodic assessments

1. New finding: Repeat BRT spirometry at CS Health clinic within 3 to 6 months to confirm result and determine if escalation via the pathways is required.
2. Chronic finding, with early or mild abnormality/impairment:
   - Refer for a HRCT and medical information in 3 months.
   - No interim dust restrictions if FEV1 >LLN or Mild Impairment (FEV1 Z-score between -1.65 and -2.5).
3. All other cases (Moderate or Severe Impairment (FEV1 or FVC Z-score <-2.5), new or chronic findings) must be referred to the CS Health CIT for case management/determination advice in the context of the medical and exposure history. Interim dust restrictions consistent with published guidelines may apply during the investigation phase, dependent on the role and severity of the abnormality.

Pre-placement assessments

*New entrants to the NSW coal industry*

In general, all pre-placement assessments for new entrants to the NSW coal industry will need to complete all required investigations before a determination is made.

*Existing coal mine workers*

1. New finding:
   - Repeat spirometry with BRT within 3 to 6 months at CS Health clinic.
   - Use 'Amber 1' for monitoring, no interim dust restrictions if FEV1 >LLN (and there are no other clinical findings requiring escalation via the Pathways).
2. Chronic finding with early or mild abnormality:
   - Refer for a HRCT and medical information in 3 months.
   - Amber 1 for monitoring, no interim dust restrictions if FEV1 >LLN (and there are no other clinical findings requiring escalation via the Pathways).
   - Amber 1 & 2 for monitoring and restrictions, interim dust restrictions Mild Impairment (FEV1 or FVC Z-score between -1.65 and -2.5) as outlined in Appendix F.

**All other cases (Moderate or Severe Impairment (FEV1 or FVC Z-score <-2.5) must be referred to the CS Health CIT for case management/determination advice in the context of medical exposure history. Interim dust restrictions consistent with published guidelines may apply during the investigation phase, dependent on the role and severity of abnormality.**

# Longitudinal decline assessment for CS Health clinical pathways

1. Mine dust exposure may be associated with rapid decline in FEV1 and impairment in lung function (obstructive, restrictive, or mixed patterns). The magnitude of decline is proportional to cumulative mine dust exposure and of the same order of magnitude as that caused by exposure to tobacco smoke.
2. Longitudinal spirometry assessment is important for detecting clinically meaningful changes from baseline and identifying individuals potentially experiencing rapid or excess decline related to coal mine dust exposure.
3. Regardless of whether spirometry result is normal or abnormal, a comparative assessment of past spirometry results must be undertaken for all periodic assessments, and pre-placement assessments for existing coal mine workers, where results are available.
4. When looking for meaningful decline in lung function, the recommendation is to assess the change in lung function from baseline, which is the earliest reliable record available for the individual.
5. Rapid decline is defined as more than 15% decline in GLI predicted %FEV1 or %FVC, over any period, compared with baseline spirometry values.
6. As past spirometry tests may have used different predictive models, the absolute values obtained for FEV1 and FVC need to be converted to GLI % predicted values using the online GLI lung function calculator before assessing for rapid decline.
7. The GLI has made available an online assessment of spirometry at ERS lung tracker which is recommended for use and is based on the most up-to-date evidence
8. For obstructive lung disease, serial FEV1 decline is usually assessed, whereas for other lung diseases, this may not be the most appropriate parameter (FVC and DLCO can also be used)

### Process for converting past spirometry records using the GLI reference range

1. Obtain and review past spirometry records. These may be requested from csh@coalservices.com.au (if not already saved to the client files).
2. Confirm quality and reliability of baseline record chosen by reviewing flow-volume curves, calibration and accuracy check dates on the original spirometry report.
3. If the GLI reference range has not been used for the original record chosen as the baseline or reference spirometry, or the height is inconsistent versus the current spirometry record, these must be converted/ corrected using the online GLI calculator https://gli-calculator.ersnet.org/
   - Enter absolute FEV1 and FVC values, selecting appropriate height, age (at time of original test), sex and ethnicity to calculate new LLN and predicted values for FEV1 and FVC. Use the height recorded on the latest spirometry record as the reference height for this comparison (height may have varied by up to 5cms or more for spirometry tests across the years).
4. Enter absolute spirometry values into a table, with the recalculated LLN and percent predicted values for FEV1, FVC and FEV1 ratio to facilitate assessment of decline.
5. Calculate % change in FEV1 and FVC from the difference between GLI predicted values for FEV1 and FVC at baseline and current values. Examples from the Standard using this methodology for calculating % GLI decline are provided below:

## Interpretation of changes in spirometry over time

The following worked example illustrates how to appropriately determine a change in spirometry over time in an individual. The use of appropriate alignment with robust predicted equations allows for changes with age to be accounted for. This example highlights that a significant decline in lung function can occur in individuals whose lung function remains within the normal range of the broader population.

A female worker, of Aboriginal ancestry, 170.5cm tall, enters the resource sector workforce at age 25.5 years. The Global Lung Function Initiative Spirometry 'Other' predictive equations are used as per ANZSRS recommendations.

Her lung function on entering the workforce was:

| | |
|---|---|
| $FEV_1$ | 3.48L (103.1% predicted, LLN = 2.74L) |
| FVC | 3.94L (100.8% predicted, LLN = 3.16L) |
| $FEV_1$/FVC | 0.88 (101.7% predicted, LLN = 0.762) |

Her spirometry is within normal limits. She does not report taking any respiratory medications.

At age 30.0 her respiratory health is reassessed. There are no reported symptoms, she does not report taking any respiratory medications and her lung function is:

| | |
|---|---|
| $FEV_1$ | 3.31L (95.1% predicted, LLN = 2.64L) |
| FVC | 3.87L (99.4% predicted, LLN = 3.15L) |
| $FEV_1$/FVC | 0.81 (95.2% predicted, LLN = 0.750) |

Her lung function remains within normal limits. Her change in $FEV_1$ (% predicted) over the five-year period is 8.0% (103.1% - 95.1%) and within acceptable limits.

At age 33.6 years she changes employers and undergoes a repeat assessment. She has no reported symptoms and does not report taking any respiratory medications. Her spirometry is:

| | |
|---|---|
| $FEV_1$ | 2.85L (87.6% predicted, LLN = 2.599L) |
| FVC | 3.79 (98.0% predicted, LLN = 3.131L) |
| $FEV_1$/FVC | 0.75 (87.9% predicted, LLN = 0.741) |

Her spirometry is within normal limits. Her change in lung function since entering the resource sector workforce at age 25 years is 15.5% (103.1% to 87.6% – after adjusting for age-related changes by using the GLI predicted equations). Based on the recommendations (above) her age-related longitudinal decline over the 8.1 years of employment exceeds 15.0%. She should be referred for a HRCT.

## Interim arrangements and practical considerations - excess decline in FEV1 or FVC >15% predicted since baseline:

1. **Periodic assessments**
   - Refer for HRCT and medical information in 3 months.
   - Interim dust restrictions may apply, dependent on the role, severity of the decline and if spirometry is abnormal. Results need to be interpreted in the context of the medical and exposure history. Refer to the CS Health CIT for case determination advice.

2. **Pre-placement assessments for existing coal mine workers**
   - Refer for HRCT and medical information in 3 months.
   - Amber 1 & 2, interim dust restrictions as per published guidelines for rapid decline.
     - Mild category restrictions if longitudinal decline since baseline in percent predicted FEV1 or FVC >15% and FEV1 Z-score of ≥-2.5.
   - If spirometry abnormality is moderate or severe (FEV1 or FVC Z-score of <-2.5) refer to the CS Health CIT for case determination advice.

3. **Pre-placement assessments for new entrants to the NSW coal industry**

For coal mine workers with a history of dust exposure in other states or industries it may not be possible to identify cases of rapid or longitudinal decline unless baseline spirometry records are made available.

Therefore, all new entrants to the NSW coal industry with a work history including:

- Stonemasonry; or
- Working with engineered stone; or
- Tunnelling; or
- Coal, mineral mine, or quarrying work of 10 years duration or more; and
- No evidence of health monitoring, or past spirometry records (baseline) are not available to rule out a decline in spirometry of 15% or more require a baseline HRCT scan regardless of their chest imaging and spirometry findings. Any HRCT findings that may be consistent with a mine dust lung disease require a CLFT.

These investigations need to be completed before clearance.

Note: Guideline Recommendations are from the *National Guidance for Doctors Assessing Workers Exposed to Respirable Crystalline Silica Dust.*

# Respiratory symptom assessment for CS Health clinical pathways

Exposure to coal mine dusts can cause chronic bronchitis and emphysema (COPD) and other mine exposures can cause or exacerbate asthma in susceptible individuals. Symptoms of chronic bronchitis in miners, including cough and sputum production and infective exacerbations are associated with significant declines in the FEV1 in both smokers and non-smokers.

The aim of further investigation of unexplained significant symptoms is the early detection of potential adverse effects of mine dust and other exposures, so that further exposures can be managed and health effects minimised.. The approved medical practitioner needs to consider any **unexplained significant symptoms** and should refer these for further evaluation as per the Pathways.

## Recommended process for determining if symptoms are significant and unexplained

Respiratory symptoms may be reported by the worker in the Standardised Respiratory Questionnaire (SRQ) or observed and recorded during spirometry testing or the clinical examination process. These components of the assessment need to be considered by the approved medical practitioner in determining whether escalation is required via the Pathways.

1. Review the clinical history, findings and SRQ responses. If significant or chronic respiratory symptoms are reported or observed, a comprehensive symptom history needs to be obtained from the individual. Past SRQ responses and records should also be reviewed for comparison and to identify trends (if available). The most common cause of an increase in respiratory symptoms is a recent respiratory infection, and sufficient time should elapse in order to enable the worker to recover (between 4-6 weeks) before deciding whether a symptom is significant.
2. Where the symptoms are explained, no escalation is required and a referral to the GP can be made where clinically indicated. In these cases, symptoms will typically be (i) consistent with the medical history, e.g., chronic asthmatic, heavy smoker or vaper; and (ii) of a stable pattern, i.e. not worsening or progressing over time; and (iii) with no significant change at work versus home.
3. Where symptoms are significant and not explained, escalation via the Pathways is required. In these cases symptoms will typically be (i) inconsistent with the medical history; (ii) excessive or worsening over time; and (iii) may show significant change at work versus home. Excessive or worsening symptoms in coal mine workers with a significant smoking and dust exposure history should also be escalated via the Pathways.

## Interim arrangements and practical considerations

**Periodic and pre-placement assessments for existing coal mine workers**

> For excessive, unexplained symptoms:
  - Refer coal mine worker for a HRCT and AMP to review medical information within 3 months.
  - No dust restrictions are relevant unless spirometry is abnormal.

> For excessive/worsening symptoms in coal mine workers with a significant smoking and dust exposure history, or for cases with abnormal spirometry and extensive exposure history, refer to the CS Health CIT for advice.

**Pre-placement assessments for new entrants to the NSW coal industry**

In general, all pre-placement assessments for new entrants to the NSW coal industry will need all required investigations completed before health certification.