Health Management Injury Prevention Training Service


01
Successful Spirometry
Part 1
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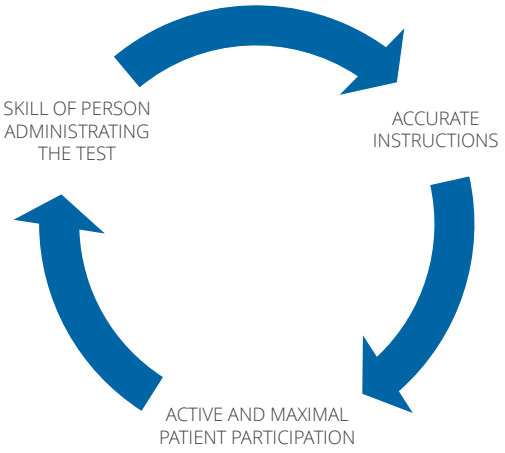
Successful Spirometry



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Successful Spirometry

"Your breathing test results would be normal ... if you were 3'8" and 150 years old."

> "Spirometry is simple but when testing people even the simple is very difficult!"

Spirometry looks simple but the number of possible ways in which it can be performed incorrectly is immense.

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Overall aim is for you to acquire comprehensive knowledge of the application, measurement and interpretation of high-quality spirometry.

On completing the course, you should be able to:

1. Identify the clinical indications for performance of spirometry and the limitations of spirometry
2. Perform high quality spirometry
3. Recognise poor quality spirometry
4. Interpret spirometry in terms of the underlying lung physiology

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OBJECTIVES

- Use spirometry as a tool to assist diagnosis and management
- Incorporate spirometry into routine clinical practice
- Use spirometric readings as a feedback tool for patient education
- Implement a quality assurance program for your spirometry
- Minimise cross-infection risks associated with the measurement of spirometry

Review of Respiratory Component of the Coal Mine Workers' Health Scheme

CLICK HERE TO LEARN MORE

UPDATE – Spirometry Standards in Resource Sector Workers – June 2021

Final Report

- Audit of spirometry equipment and training
- Quality assessment of 256 spirometry tests
  - Less than 50% of spirometry currently performed was undertaken by sufficiently trained and experienced staff.
  - Overall, quality control and quality assurance of spirometry testing is inadequate for more than 50% of sites.

Spirometry Quality and Interpretation

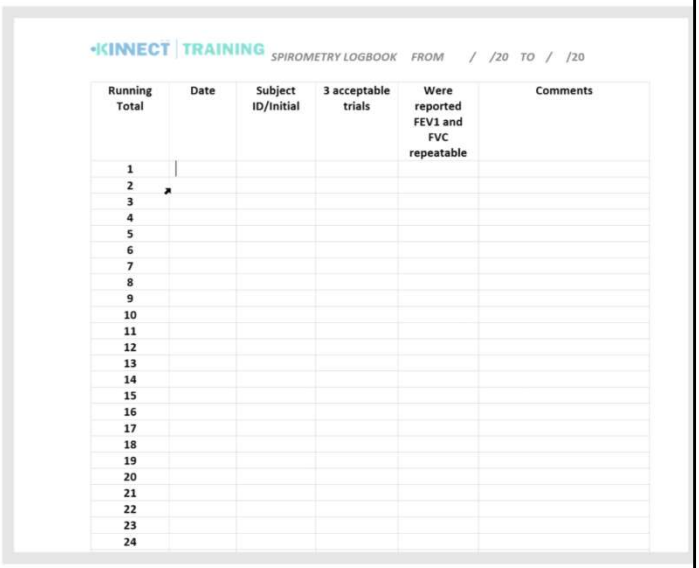
- Audit 40% DID NOT met ATS/ERS standards
- 100/256 reports reviewed accurately reported by NMA's
- Only 2 of the 30 abnormal where accurately identified

Recommendations

If you are performing spirometry for coal board medicals your workplace must be accredited by the TSANZ, or you must have attended a spirometry course which meets the standards of spirometry stipulated be the TSANZ
Refresher training must be completed 12 months after the initial course is completed
Your spirometer must meet a strict quality control program, again this is stipulated in the TSANZ standards for spirometry.
These standards can be found in the resources section of the course

Spirometry Logbook

INSTRUCTIONS



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Running Total	Date	Subject ID/Initial	3 acceptable trials	Were reported FEV1 and FVC repeatable	Comments
1					
2					
3					
4					
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To maintain your competency in spirometry it is mandated by the TSANZ that you must record 100 spirometry tests in your log book prior to registering for the refresher course, in 12 months time. This is a pre-requisite for the refresher course

Introduction to Spirometry Overview

- What and why of spirometry
- What is a spirometer
  - Types of spirometer
- Lung volumes/capacities – Activity 1- Workbook Activity
- Definitions and Graphs
- Contraindications and Test preparation
- Quality Assurance and Equipment maintenance
- Brainstorming- Why do calibrations fail – Activity 2
- Calibration Practical

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Testing during the Pandemic

- Use of disposable mouthpiece/sensor (easy on PC, Spiroscout) not recommended unless in line bacterial filters are in use
- Use of masks in waiting areas
- Maximize the use of single use consumables
- Use of PPE in high risk areas recommended – disposable gloves used at all times during testing
- Hand hygiene policy before and after use as per local policy
- Regular equipment cleaning protocols
- Adequate room ventilation

Bacterial Filters

- Optimal infection control for expiratory and inspiratory testing
- Provides 99.9% bacterial and viral efficiency
- Reduced risk of cross contamination for patients and health care professionals

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What is Spirometry?

Spirometry results are determined by lung size, airway calibre and the driving force of the respiratory muscles.

Therefore, used in conjunction with clinical assessment, spirometry is an invaluable clinical tool to:

- detect diseases that impair ventilatory function;
- assess the severity of any existing impairment; and
- monitor the effects of intervention, occupational exposure or disease progression.

High quality spirometry is vital for accurate interpretation. Lack of adherence to these standards will result in the delivery of poor-quality spirometry, which may compromise clinical diagnosis and management.

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Why Measure Spirometry?

Diagnostic

To see if there is any ventilatory dysfunction or evaluate a known dysfunction.

To evaluate symptoms (chronic cough, SOB, sputum production).

Screening

Screening for early diagnosis in at risk populations (smokers/dust exposure).

What occupations do you think are at risk?

Assessment/Evaluation

Workplace/Pre employment assessments /Disability Evaluation

Assessment of risk for insurance valuation.

Assessment for rehabilitation.

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Why Measure Spirometry?

Public Health

Clinical research.

Derivation of reference values.

Monitoring of Disease

To Measure the response to respiratory therapy.

To measure the response to drugs with potential pulmonary toxicity.

What drugs do you know that are toxic to the lungs?

GOLD

GOLD (Global Initiative for Chronic Obstructive Lung Disease) Guidelines – screening tool for the early detection of COPD in middle aged smokers.

GINA

GINA (Global Initiative for Asthma) Guidelines – measure of airflow limitation and its reversibility to establish a diagnosis of Asthma.

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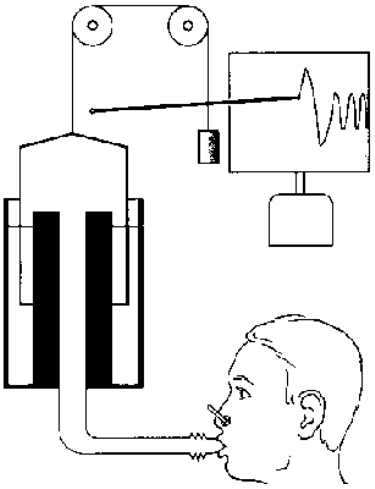
What is a Spirometer?

A spirometer is an instrument used to measure respired volumes and flows.

Many spirometers can measure both inspiratory an expiratory airflow.

There are two general types of spirometers: volume-displacement and flow-sensing spirometers.

The first spirometer was developed by London Surgeon John Hutchinson in the mid 1800's – it was a water sealed volume displacement device, he discovered that there was a linear relationship between height and Vital Capacity (VC) and a link between reduced Vital Capacity and Pulmonary Disease.



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Spirometer Buyers Guide

- List of Australian Distributers
- Comparison of Spirometer features
- GLI Availability
- Consumable cost

www.nationalasthma.org.au

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Flow – Sensing Spirometers

Pneumotach

Ultrasound

Rotating Vane

Mass Flow Sensor

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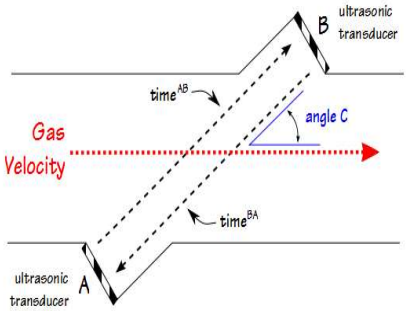
Spirometer – Easy on PC

- Easy on-PC software is installed on a computer to which the Easy on-PC sensor is connected by means of a USB cable.
- The ultrasound flow sensor measures the transit time to determine flow velocity, volume and molar mass of the gas.
- Two ultrasound sensors emit very short ultrasound pulses that travel along the transmission path to the opposite ultrasound transducer.
- Since the measuring principle is based on a digital measurement technique, the sensor requires only one single calibration. The sensor calibration does not change during the sensor's lifetime.



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Accuracy and Quality of Spirometry in Primary Care Offices

Matthew J. Hegewald 1,2, Heather M. Gallo 1, and Emily L. Wilson

- Only 1 of 17 primary care spirometers tested met accuracy criteria.
- Although the accuracy errors were generally small, some errors of potential clinical significance were detected.
- Spirometer performance was notably lacking in the measurement of an obstructed waveform.
- Clinically acceptable spirograms were produced for only 60% of patients.
- These results raise concerns regarding the ability of primary care offices to obtain quality spirometry without greater attention to quality assurance and training.

https://www.atsjournals.org/doi/full/10.1513/AnnalsATS.201605-418OC

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Spirometer Performance

Volume

Capable of accumulating volume for 15 seconds

Range: at least 8 L

Accuracy:
±3% or ±0.05 L, whichever is greater

Flow

Range: 0 – 14 L/sec

Accuracy:
± 5% of reading or ±0.200 L/sec, whichever is greater

Why do you think spirometers should be capable of accumulating volume for 15 seconds?

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Lung Volumes and Capacities Activity
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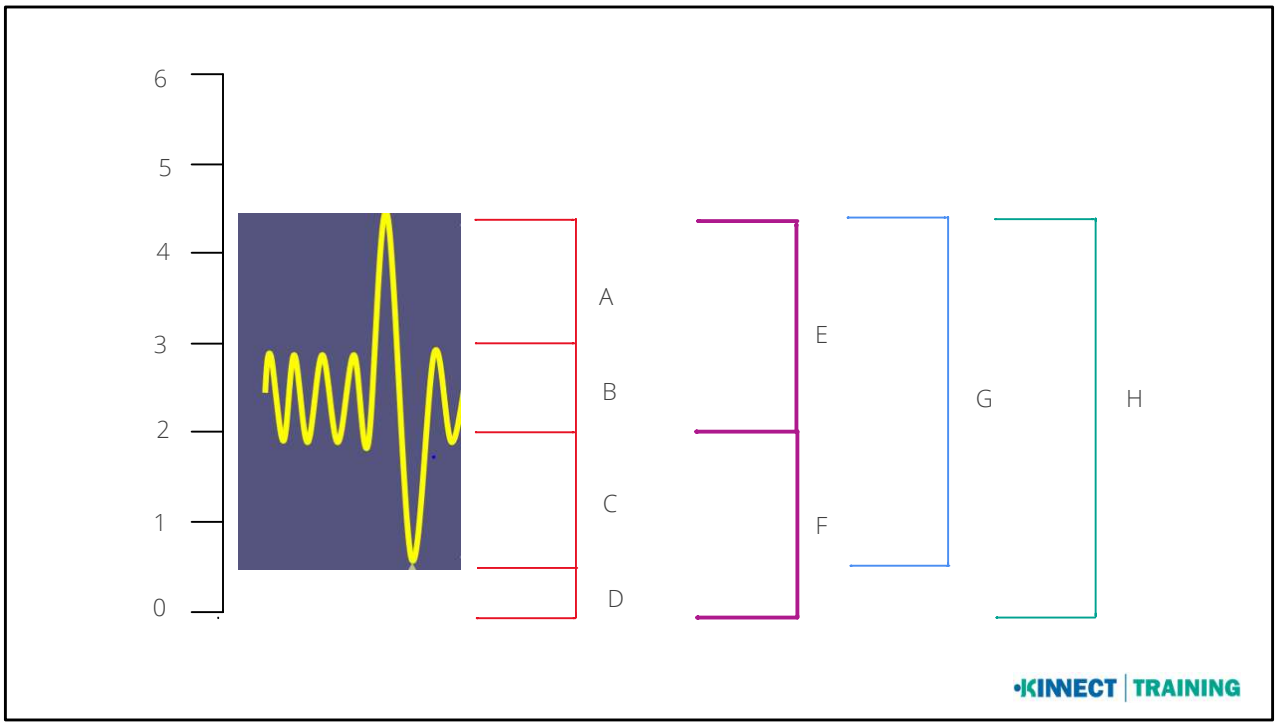
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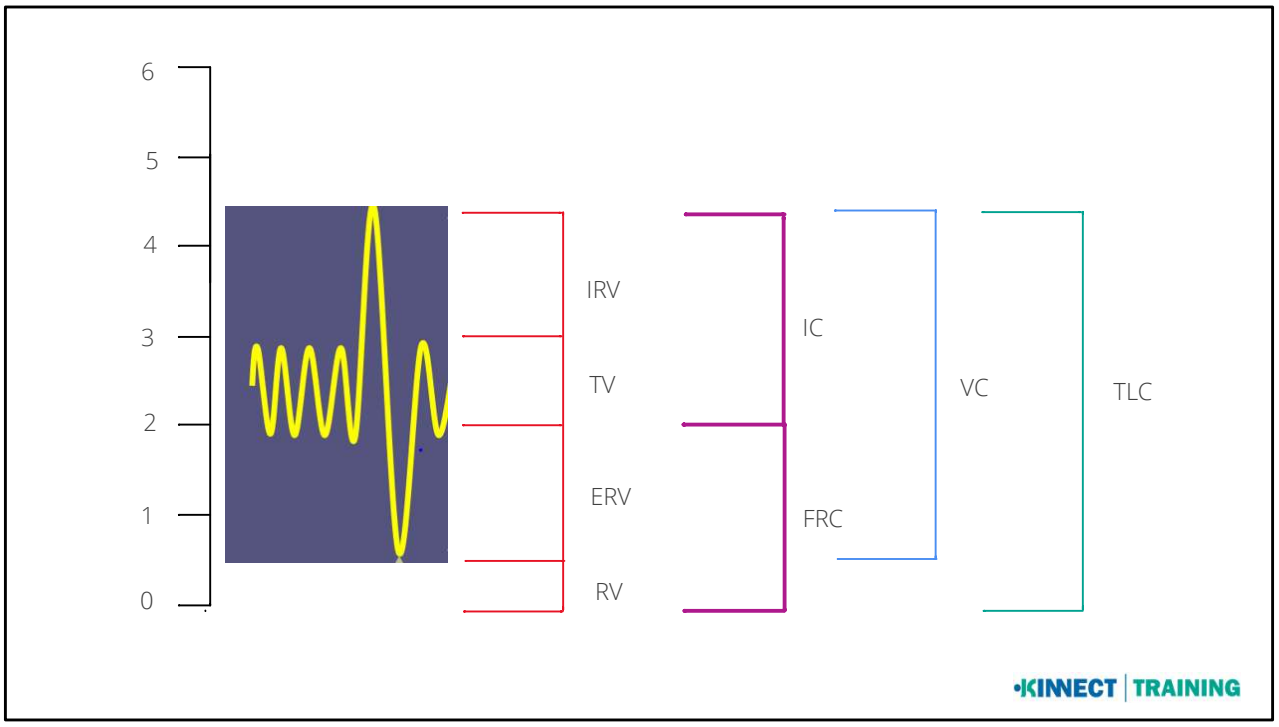
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IRV
TV
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FRC
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TLC
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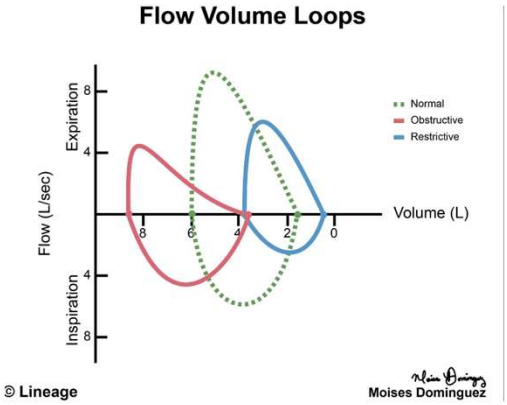
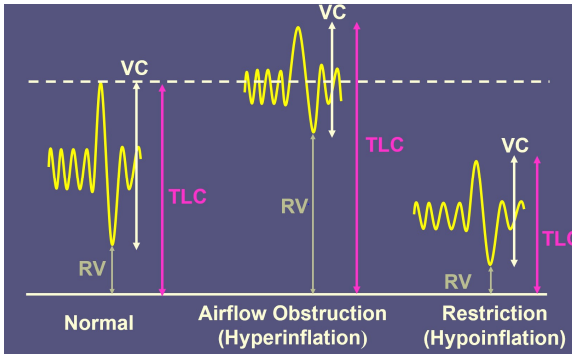
Changes in lung capacities and volumes with disease





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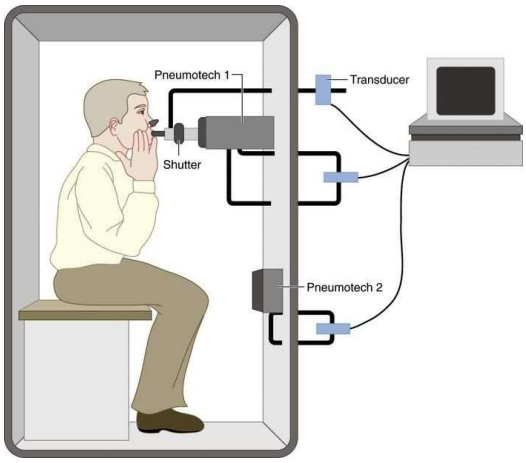
Body Plethysmography - Measuring FRC, RV,TLC



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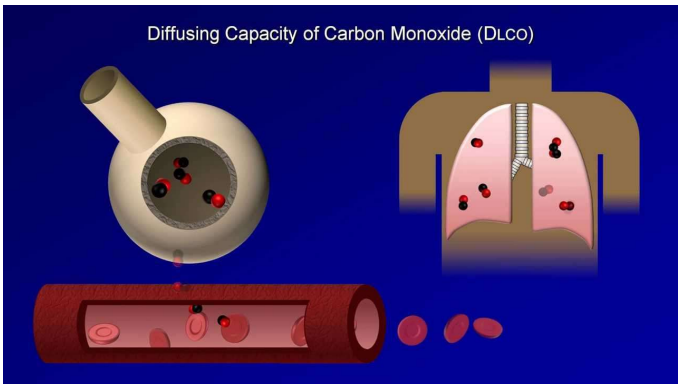
Measuring Tissue Damage in the Lungs

Useful for diseases such as:

- Asbestosis
- Silicosis
- COPD



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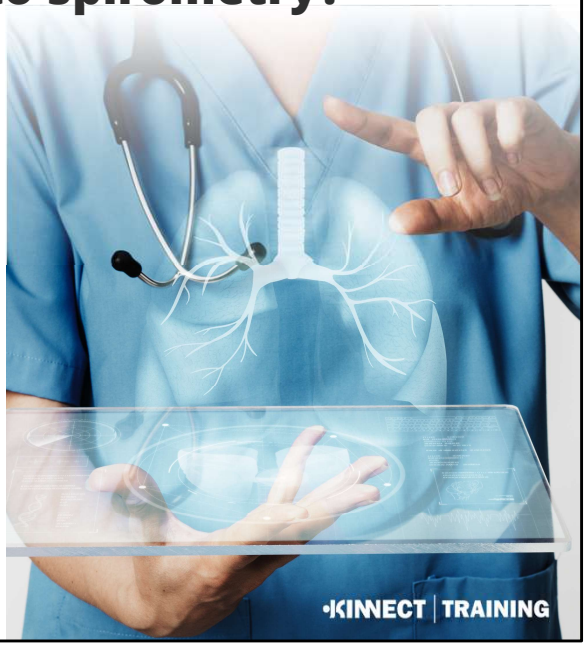
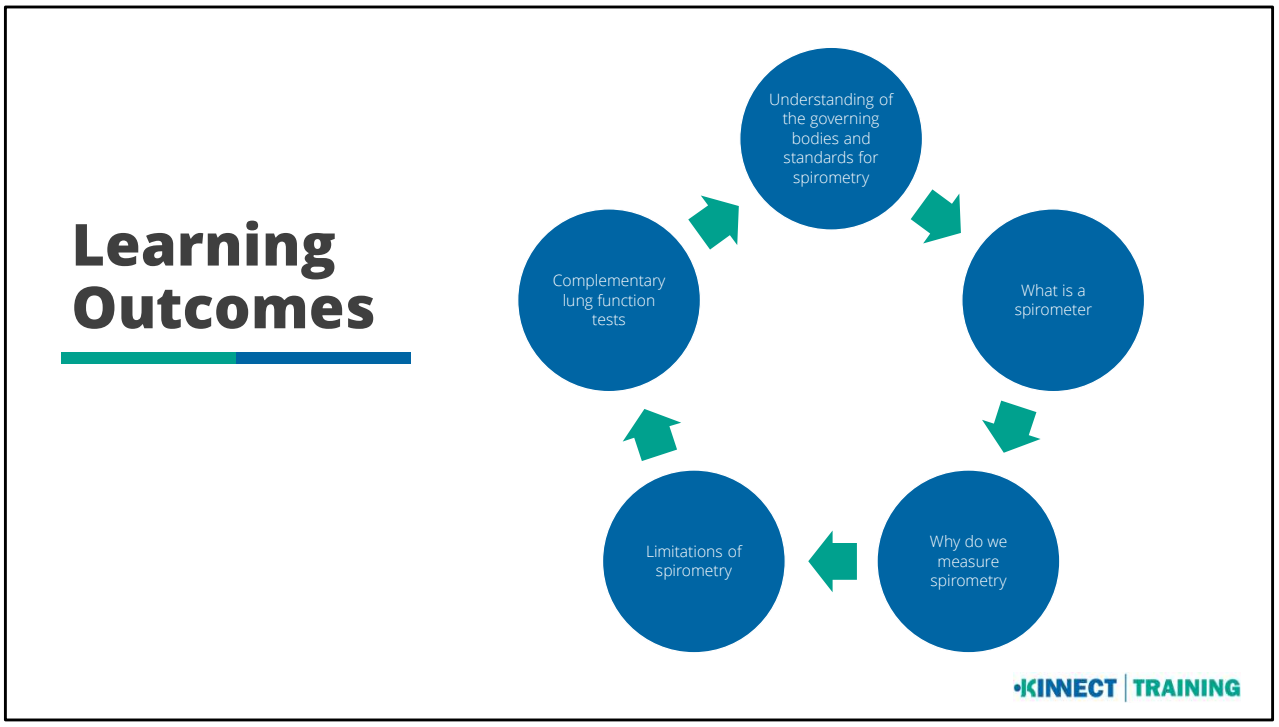
What are the limitations to spirometry?

Although spirometry demonstrates airflow limitations, it does not determine the cause:

- airway obstruction (asthma)
- decreased alveolar elastic recoil (emphysema)
- decreased muscle strength (Muscular Dystrophy)

It is also effort dependent and requires a motivated patient.





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Spirometry Definitions
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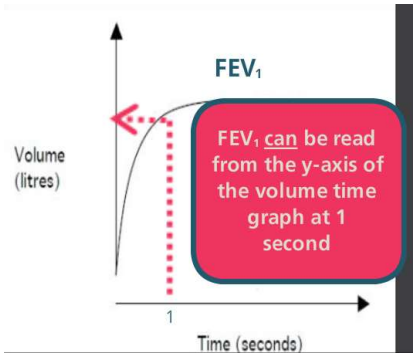
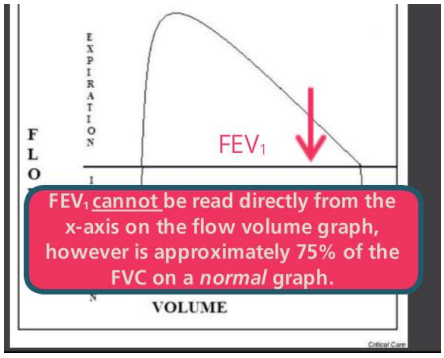
Volume of expired air in the first second of FVC

What is FEV1?





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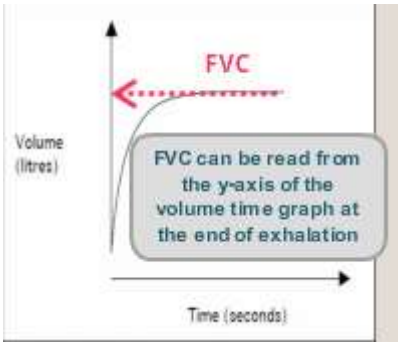
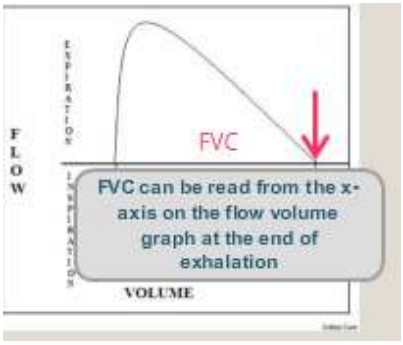
FVC is the total volume of air expired after a full inspiration

What is FVC?





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FEV1/FVC Ratio

- This ratio is the FEV1 expressed as a percentage of the FVC.
- In the Healthy Lung 75-85% of FVC is expired in one second.
- This ratio is a useful index of airflow limitation.

Other Definitions

FET (forced expiratory time):

Time required to perform the FVC manoeuvre

PEF (peak expiratory flow):

Largest expiratory flow achieved during the forced expiratory manoeuvre initiated at full inspiration

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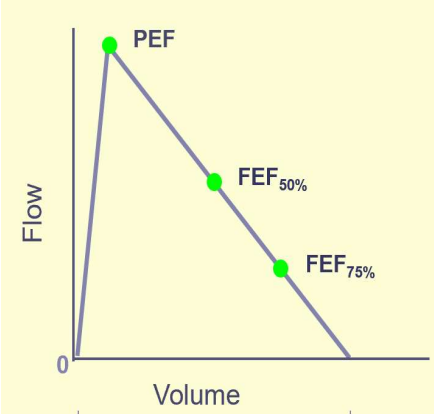
Small Airways Disease (SAD)

- $FEF_{25–75\%}$ (forced expiratory flow between 25% and 75% of FVC):
- $FEF_{50\%}$ (forced expiratory flow at 50% of FVC)
- $FEF_{75\%}$ (forced expiratory flow at 75% of FVC)



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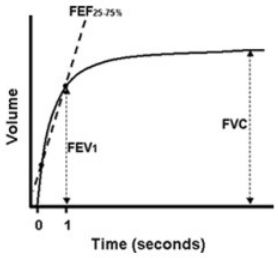
Why Use Both Graphs?

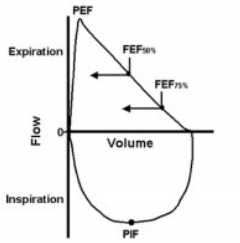
Volume-time curve is useful for assessing the latter stages of the manoeuvre

- Easier to see time of exhalation

Flow-volume curve can be used in the assessment of the first part of the manoeuvre

- Identify client technique





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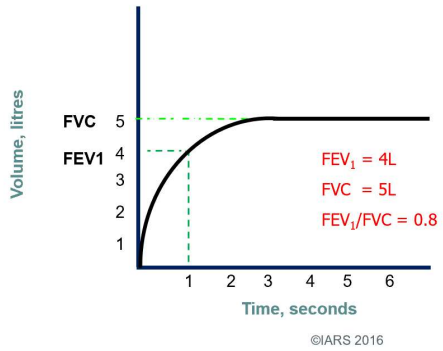
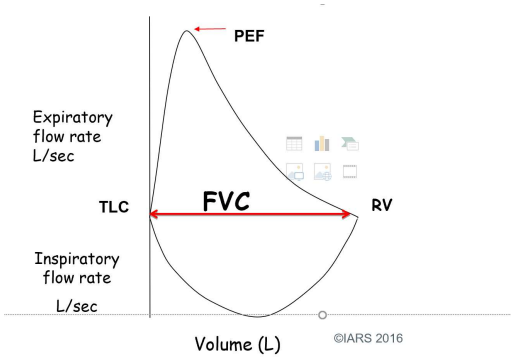
Normal Traces





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Contraindications and Test Preparation
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Contraindications

ATS Standardisation of Spirometry
Update on spirometry Oct 2019

Table 2. Relative Contraindications for Spirometry

Due to increases in myocardial demand or changes in blood pressure
- Acute myocardial infarction within 1 week
- Systemic hypotension or severe hypertension
- Significant atrial/ventricular arrhythmia
- No compensated heart failure
- Uncontrolled pulmonary hypertension
- Acute cor pulmonale
- Clinically unstable pulmonary embolism
- History of syncope related to forced expiration/cough

Due to increases in intracranial/intraocular pressure
- Cerebral aneurysm
- Brain surgery within 4 week
- Recent concussion with continuing symptoms
- Eye surgery within 1 week

Due to increases in sinus and middle ear pressures
- Sinus surgery or middle ear surgery or infection within 1 week

Due to increases in intrathoracic and intraabdominal pressure
- Presence of pneumothorax
- Thoracic surgery within 4 week
- Abdominal surgery within 4 week
- Late-term pregnancy

Infection control issues
- Active or suspected transmissible respiratory or systemic infection, including tuberculosis
- Physical conditions predisposing to transmission of infections, such as hemoptysis, significant secretions, or oral lesions or oral bleeding

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Preparation for Spirometry

- Handwashing
- Bronchodilator medications have been taken.
- Smoking/vaping/ water pipe 1 hour prior
- No intoxicants 8 hours prior
- No vigorous exercise 1 hour prior
- Ensure client is wearing loose comfortable clothing
- Obtain relevant history
  - medical history
  - smoking history
  - work/occupational exposure history
- Obtain clients ethnic origin

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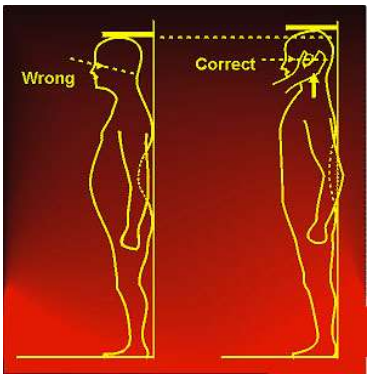
Patient Preparation...Standing Height

Standing height is an important predictor of lung function indices.

DON'T

- Self-reported height
- Shoes on
- Hair accessories not removed
- Equipment not properly installed
- Knees bent
- Head out of position



DO

- Stand straight with heels together without shoes
- Actively stretch to a fully erect position
- Look straight ahead
- Compress the hair as much as possible with the horizontal arm remaining at 90°
- Height should be recorded to the closest mm

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Measuring Height Accurately

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Patient Testing Position

DO NOT let patient bend over during blowing!!!

Sit the patient comfortably, in a chair with arm-rests (safety perspective)

Loosen tight clothing to facilitate chest expansion

Do not cross arms during testing

Patient should sit up straight & have both feet on the floor

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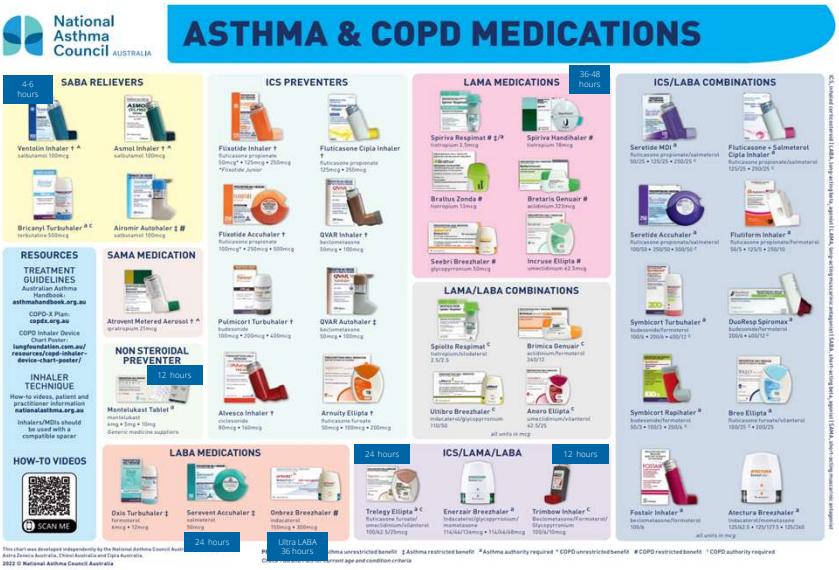
Withholding Medications



Withholding Medications

Bronchodilator Withholding Times	
Bronchodilator Medication	Withholding Time
SABA (e.g., albuterol or salbutamol)	4-6 h
SAMA (e.g., ipratropium bromide)	12 h
LABA (e.g., formoterol or salmeterol)	24 h
Ultra-LABA (e.g., indacaterol, vilanterol, or olodaterol)	36 h
LAMA (e.g., tiotropium, umeclidinium, aclidinium, or glycopyrronium) Withholding Time	36-48 h

Definition of abbreviations:
LABA = long-acting B2-agonist; LAMA = long-acting muscarinic antagonist; SABA = short- acting B2-agonist; SAMA = short-acting muscarinic antagonist.

Note:
Withholding times for post-bronchodilator testing are shorter than those for methacholine challenge testing (147) because the bronchoprotection provided by these agents lasts longer than their bronchodilation effects. In the case of dual bronchodilators, the withholding time for the longer-acting bronchodilator is used.

Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement

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Test Performance

Closed circuit method (Type A)

Instruct the worker to:

- Seal their lips tightly around the mouthpiece.
- Breathe a few "normal" tidal breaths.
- Inspire rapidly, as much air as possible.
- When completely full and without delay (≤2seconds is acceptable) to expire ("blow") as hard and as fast as they can, until no more air can be expired (in one continuous breath with encouragement to "keep blowing").
- Inspire at maximal flow back to maximum lung volume

Now recommended as best practice in ATS 2019 Standards for spirometry

Open circuit method- Type B

Instruct the worker to:

- Inspire rapidly, as much air as possible.
- When completely full, and without any air leak, place lips tightly around the mouthpiece without delay (≤2sec).
- Then, expire ("blow") as hard and as fast as they can, until no more air can be expired (in one continuous breath, with encouragement to "keep blowing").

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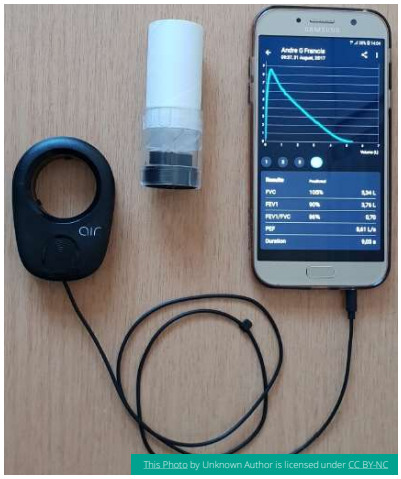
Mobile Spirometry Testing Requirements

When performing mobile spirometry testing the following requirements must be met:

- Spirometer and calibration syringe must be safely secured in appropriately padded transportation equipment to limit any physical impact which could lead to measurement inaccuracies.
- Any spirometer or calibration syringe that has been subject to physical damage during transit (i.e., knocked or dropped) must not be used for testing and will require re-certification from the manufacturer.
- Allow calibration syringe to come to same ambient temperature as the spirometer prior to the spirometer being calibrated and/or verified.
- Update ambient conditions (barometric pressure, temperature and relative humidity) of testing location in spirometer software prior to mobile testing session.
- Calibration and/or verification using a certified syringe must be conducted prior to each mobile testing session as per manufacturer's recommendation.



The Air-Smart Spirometer (Pond Health Care Innovations, Sweden), connected to a standard smartphone.

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Learning Outcomes

- Explain and demonstrate spirometry
- Activate/ Zero the spirometer (if required)
- Instruct throughout the test
- Observe
  - Issues
  - Test errors
- Terminate once successful measurement has been achieved/ issues arise
- 3 successful trials required
- A maximum of 8 trials allowed

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Phase 1: Maximal Inspiration

(pg.77 ATS, 2019)

A sub maximal inspiration will cause all subsequent spirometry values

TO BE UNDERESTIMATED!!

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Phase 2:
Rapid Forced Expiration

INSTRUCTION

'Blast' as hard and as fast as you can'

LOOK FOR

- Fast rise to peak flow
- No cough in first second
- No hesitation, slow start
- No obstruction at the mouthpiece (dentures/tongue)

Without a 'blast' the FEV1 and PEF will be underestimated.

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Phase 3:
Continued Forced Expiration

INSTRUCTION

'keep going, keep going,
keep going....forcing all the
air out'

Failure to do so leads to :

Underestimation of FVC and overestimation of FEV1/FVC ratio

LOOK FOR

- Smooth uninterrupted expiration
- Maximal effort on entire manoeuvre
- >1 sec plateau in V-T (EOFE criteria)

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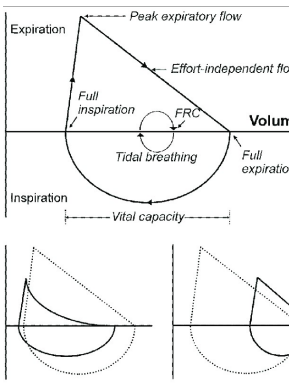
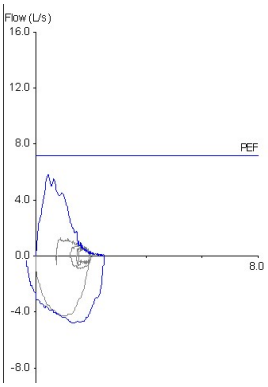
Phase 4:
Full Flow Volume Loop – Inhalation back to TLC

2019 Guidelines state:

- The 2019 Spirometry Standard requires that FIVC be reported. (page e82, table 9).
- The 2019 Standards mandates that the flow-volume loop is an integral part of spirometry. (page e82, column 3, paragraph 2)

FIVC – FVC must be <100ml or 5% of FVC whichever is greater





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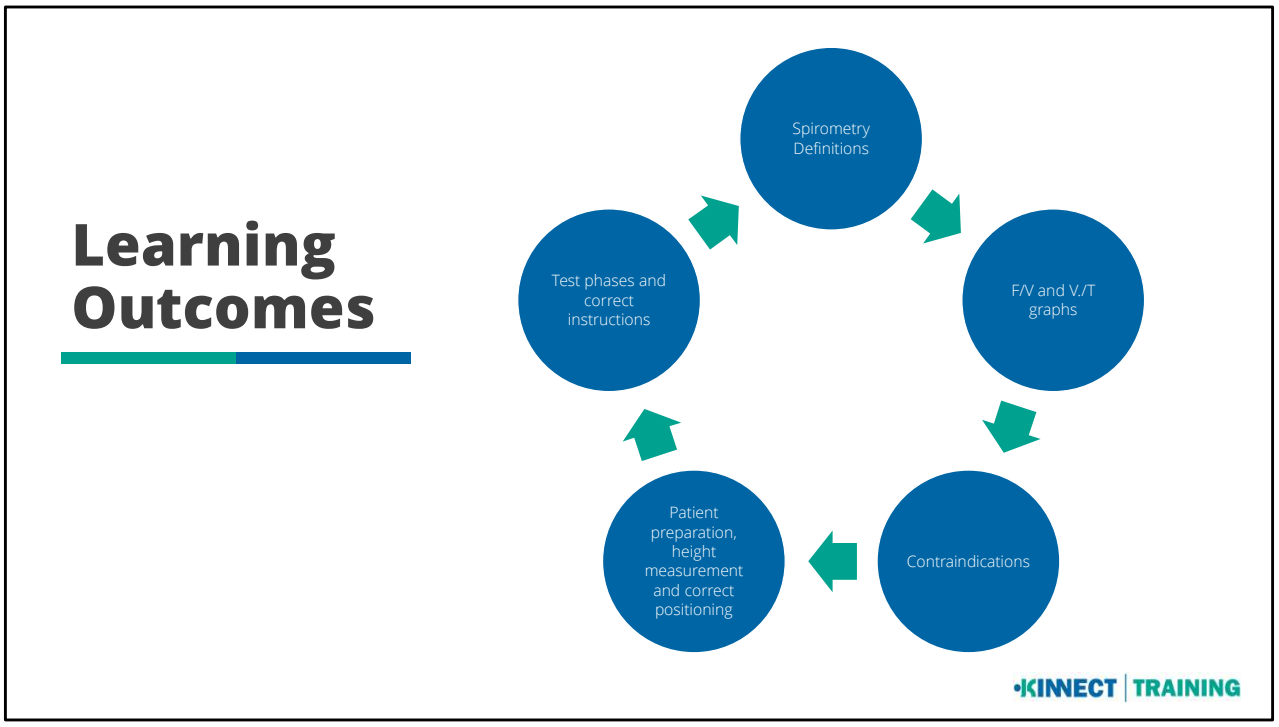

To maintain your competency in spirometry it is mandated by the TSANZ that you must record 100 spirometry tests in your log book prior to registering for the refresher course, in 12 months time. This is a pre-requisite for the refresher course


Quality Assurance
KINNECT | TRAINING

Measuring Ambient Conditions

Weather station in room

- Close to spirometer
- Temperature
  - If room temp changes by 2 degrees – recalibrate
- Barometric Pressure and humidity (760 mmHg and approx. 50%)
- (1.3322387415 hPa = 1mmHg)

http://www.bom.gov.au/qld/observations/qldall.shtml

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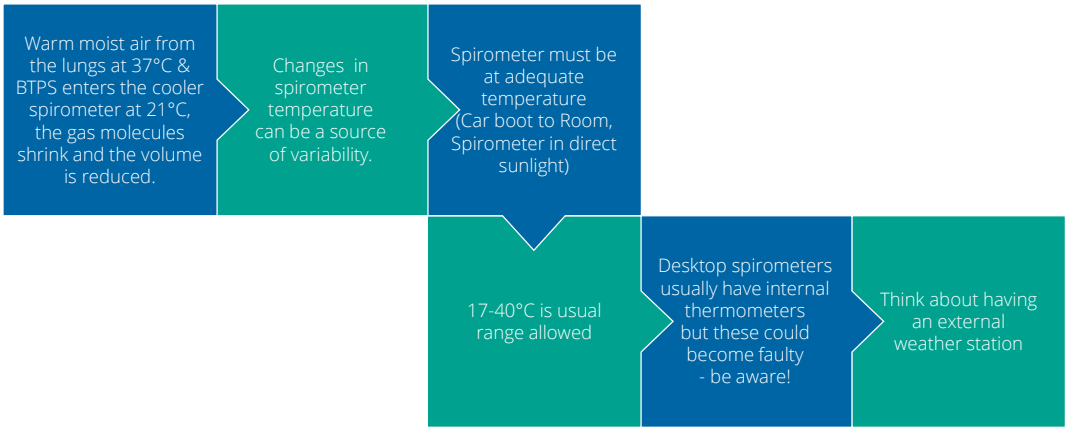
Correcting for Body Temperature, Pressure, Saturated (Water Vapour)



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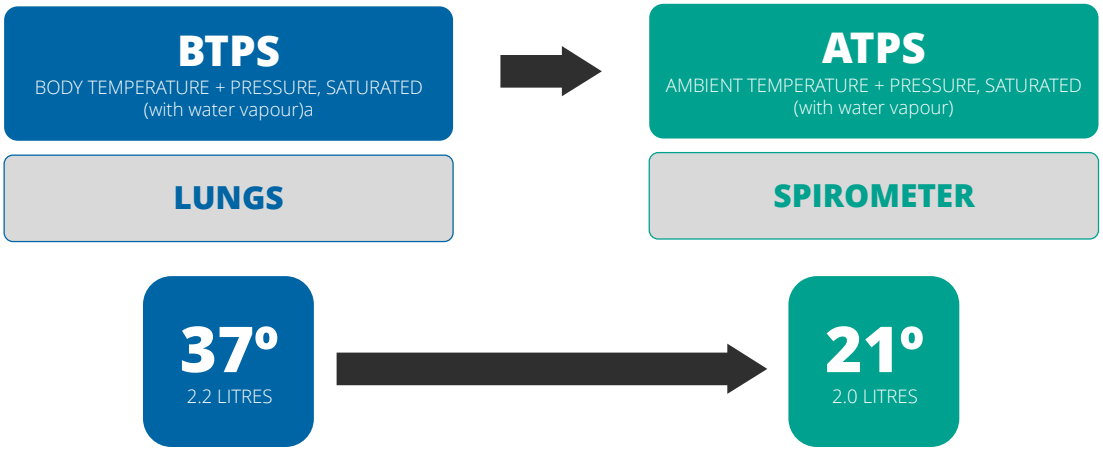
Correcting for BTPS



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Spirometer Quality Control

- Instrument Maintenance
- Linearity Check – Daily
  - After repairs
  - After maintenance
  - After Software changes
- Biological Control testing- Monthly
  - After repairs
  - After maintenance
  - After Software changes

Calibration

- ATS/ERS recommend daily validation
- Empty the syringe at different speeds –low medium and high (MULTIFLOW)
- Calibrate when ambient conditions change
- Every 4 hours when many tests are being performed
- Linearity Quarterly
- Save calibration records indefinitely
- 3 litres should record between 2.91-3.09 (2019 ATS standards)
- 3% spirometer error (2.5% spirometer error)
- 0.5% syringe error
- Store syringe in same room as spirometer

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Syringe Checks

- Syringe re-validation: re-validated on a yearly basis or as specified by the manufacturer.
- Syringe leak test: Tested for leaks and smoothness of operation minimally on a weekly basis.
- The syringe should be tested from a full (drawn back) position by placing a hand over the outlet and depressing the syringe handle gently. No air should escape. Secondly the syringe should be emptied, and in an empty position should be checked by again placing a hand over the outlet, then pulling gently on the syringe handle. No air should enter the syringe. Syringes that leak may not measure proper volume and should be sent for service.
- Syringe smoothness test: Move the syringe handle back and forth to check that the action is smooth, without catching or stuttering. Syringes that do not move smoothly may not deliver proper volume and should be sent for service.

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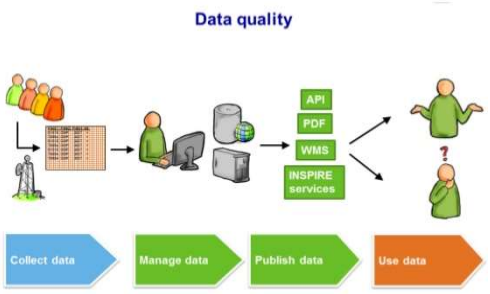
Establishing the BioQC Normal Range

pg. 5 Of spirometry standards for RSW- uses 15% of mean – 2 std is a tighter range and is used in respiratory labs)

- Individuals within a biological control program must be healthy, non-smokers and free of known respiratory disease.
- Spirometry of the biological control should be recorded every working day at approximately the same time of day. A minimum of 10 recordings is required and should be obtained in as short a time as possible, allowing for normal working patterns.
- Calculate the mean (average) for each spirometry parameter: i.e., add up all the readings for that parameter and divide by the number of recordings.
- Calculate 2.5 STD of the mean
- Finally, obtain the normal range for repeated measurements by adding and subtracting this 2.5 std value to the mean value You can now use this individual and this range as a guide to verify the accuracy of your spirometer.
- If used, these data must be recalculated every two years to account for normal age-related decline in lung function



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Quality Assurance Template

CLICK HERE TO ACCESS THE TEMPLATE

Brain Storming

What are reasons why Calibrations might fail?

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What are reasons why Calibrations might fail?

(pg 76 ATS Standards)

- A slight change in spirometer function that requires subsequent recalibration procedure to adjust the calibration factor
- A leak in the connection of the spirometer to the calibration syringe
- Airflow through the spirometer during the zero-flow setting procedure
- Failure to fully fill and empty the calibration syringe in one smooth action
- Calibration syringe malfunction (e.g. piston leak or displacement of the piston stop, or syringe damaged by dropping)
- Spirometer blockage either by debris in the spirometer sensor or by the operator's hand whilst holding the spirometer in place
- Improper assembly of the sensor, mouthpiece, filter and/or breathing tube
- Differences between room temperature and calibration syringe temperature
- Data entry error in ambient temperature and/or pressure

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Measures to take if your calibration is out of range

- Repeat calibration measurement
- Check ambient settings
- Use a different syringe if available, or check syringe on another system
- Replace flow sensor
- Check all components/ parts for leaks, damage etc
- Call supplier for further instruction

MOST IMPORTANTLY REMEMBER NEVER TO USE THE SPIROMETER IF IT FAILS CALIBRATION. TO DO SO WILL LEAD TO INCORRECT RESULTS.

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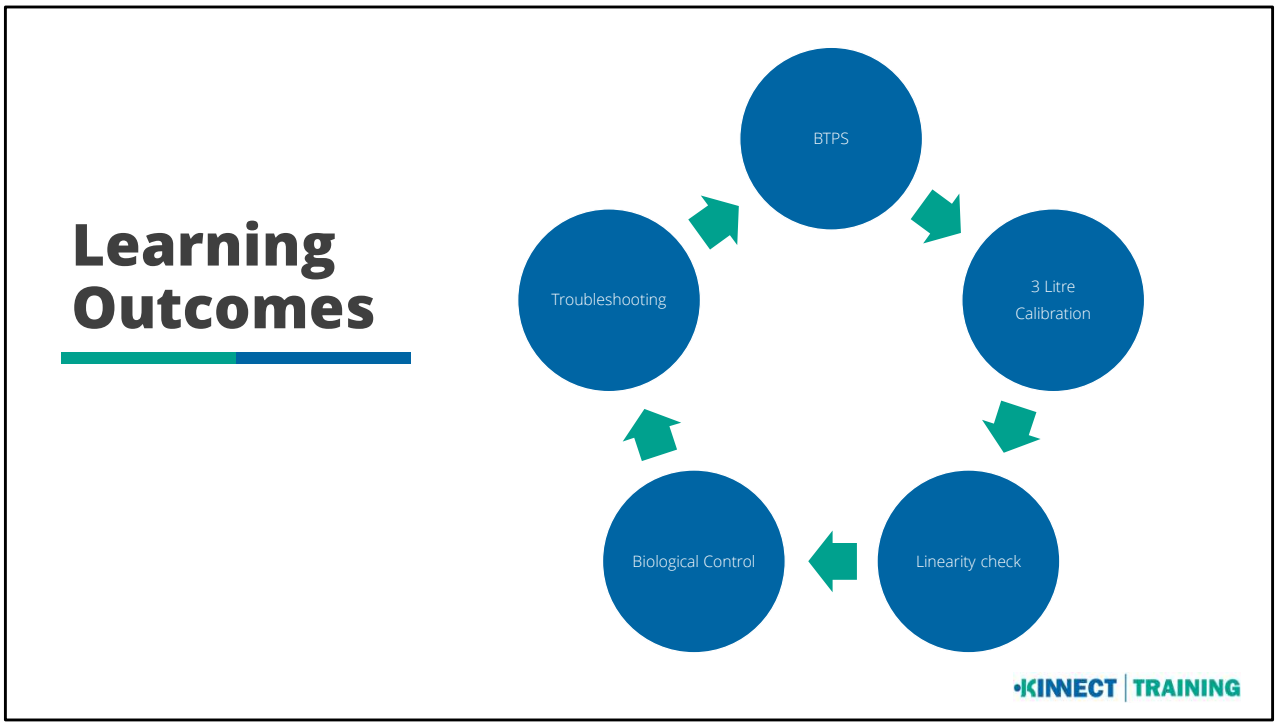

To maintain your competency in spirometry it is mandated by the TSANZ that you must record 100 spirometry tests in your log book prior to registering for the refresher course, in 12 months time. This is a pre-requisite for the refresher course


Calibration Practical Session
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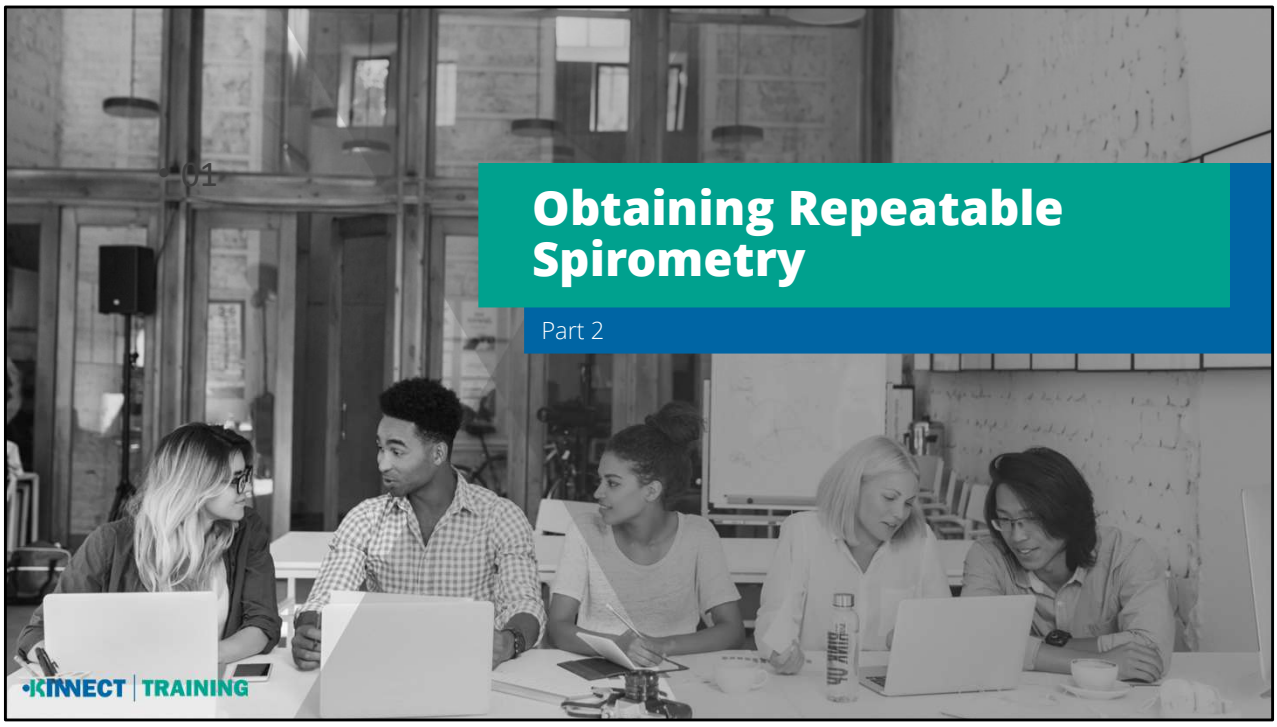
01
Obtaining Repeatable Spirometry
Part 2
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Spirometry Testing Overview

- Start of Test Criteria
- Middle of Test Criteria
- End of Test Criteria
- Repeatability
- Troubleshooting
- Spirometry Induced Bronchoconstriction
- Data Selection/ Grading
- Demonstration of correct technique/ Practical session
- Assessment/ calculation of reversibility
- Reference Values/ GLI

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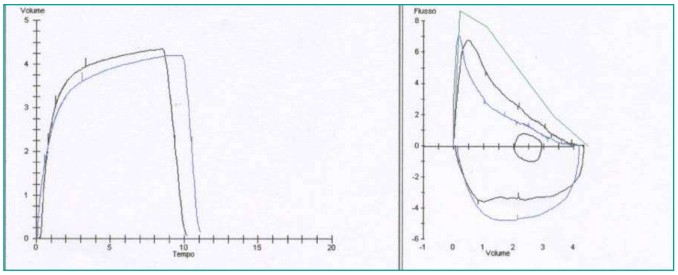
Start of test Criteria

- Begins from full inspiration has a rapid start of test, If the manoeuvre has an obviously hesitant start then the trial should be terminated early to avoid unnecessary prolonged effort.
- Short rise time: What does this mean?



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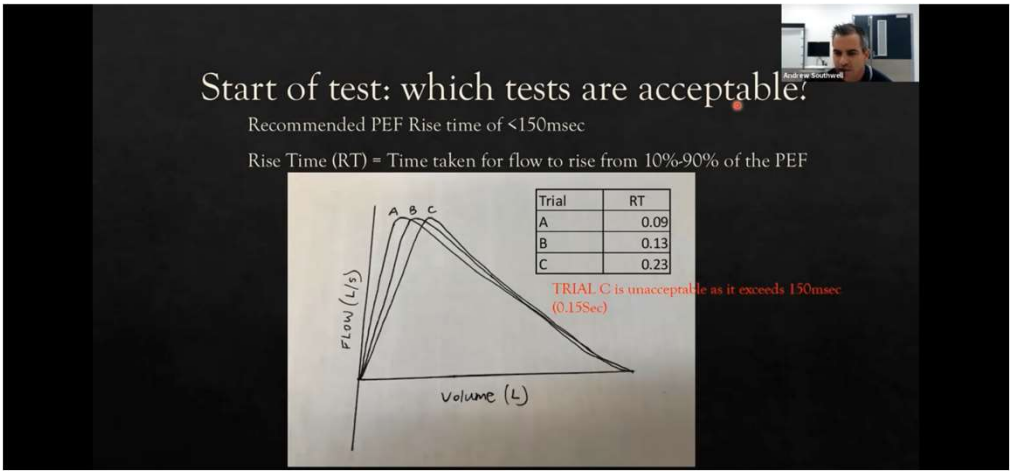
Start of Test – Looking at Rise Time



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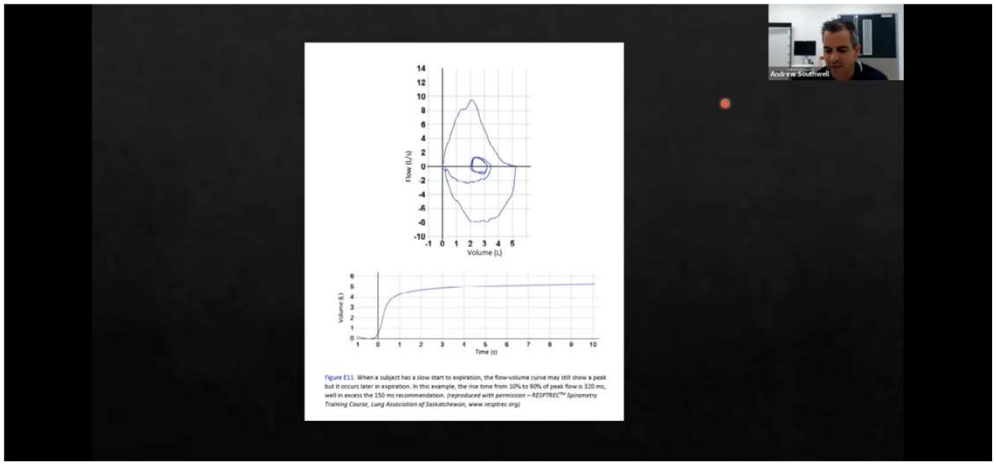
High Rise Time



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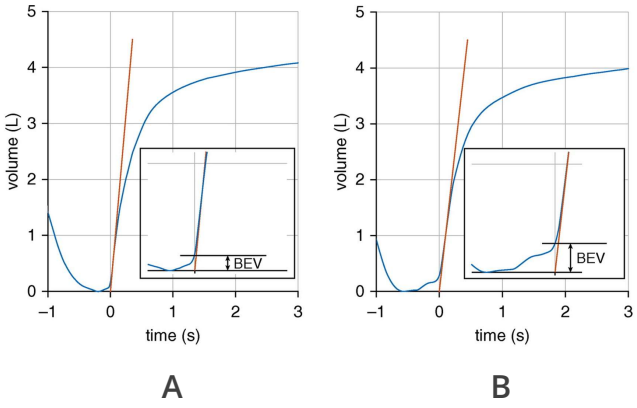
What is Back Extrapolation?

The volume of gas exhaled before time 0.

- Is your client's hesitation acceptable?
- BEV LIMIT (5% of FVC or 100 ml whichever is greatest) =0.225L
- You must have acceptable FVC to determine threshold
- A – acceptable BEV- 0.136 L
- B- unacceptable – 0.248L



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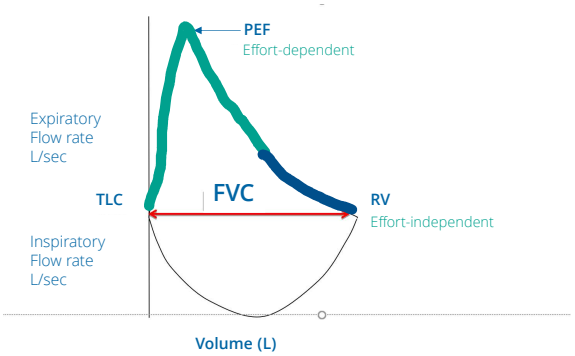
PEF and Expiration Technique

- PEF repeatability of 1 L/sec or ~10% is an indicator of good effort
  - Variable effort changes the shape of the FV curve due to effort dependence.
- Maintained forced expiration = risk of syncope
- Two "regions" of the expiratory FV curve:
  - Effort-dependent – air-flow by mass-flow (Fast)
  - Effort-independent – air-flow by diffusion (Slow)
- Expiration technique after the first 2-3s should not be forced
  - Cannot increase flow rates due to effort independence
  - Increase effort = red in the face and ↑ intracranial/intraocular pressure



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Middle of Test Criteria

No obstruction, hesitation or artefact impeding the blow including:

- Cough during the first second of exhalation
- Glottic closure that influences the measurement
- Early termination or cut-off
- Effort that is not maximal throughout
- Air leaks at mouth
- Obstructed mouthpiece (due to tongue or teeth in front of the mouthpiece, or mouthpiece deformation due to biting).

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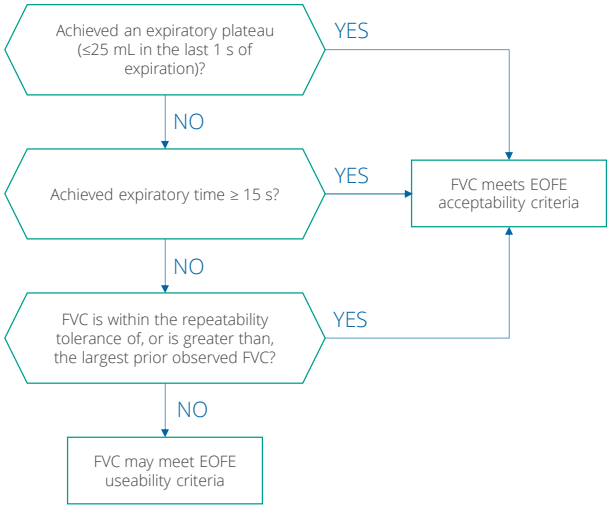
End of Forced Expiration (EOFE)

Pg. 80

Usability criteria can be found on

Pg. 79

Flowchart outlining the end of forced expiration (EOFE) acceptability criteria for FVC. "If there are no prior observed FVC values in the current pre- or post-bronchodilator testing set, then th FVC provisionally meets EOFE acceptability criteria.



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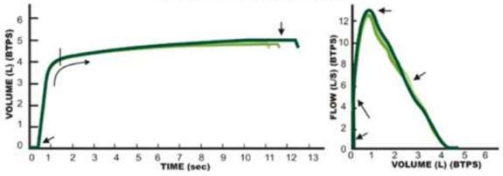
FVC is within Repeatability....

- Because the minimum FET has been eliminated increased vigilance by the operator and the interpreter is required in the assessment of whether expiration was complete or there was early termination
- FOCUS ON
  - Repeatability
  - Plateau
- Plateau may not be achieved:
  - Children or young adults with high elastic recoil
  - Patients with restrictive lung disease
  - Subject comes off before plateau

Valid Normal Test

Trial	FVC (L)	FEV_1 (L)	PEF (L/sec)
1	4.81	4.09	12.1
2	4.74	4.07	12.0
3	**4.87**	**4.14**	**12.5**
Repeatability	0.06	0.05	

4.87-4.81 = 0.06 4.14-4.09 = 0.05



2012 NIOSH Spirometry Quality Assurance: Common Errors and Their Impact on Test Results 8

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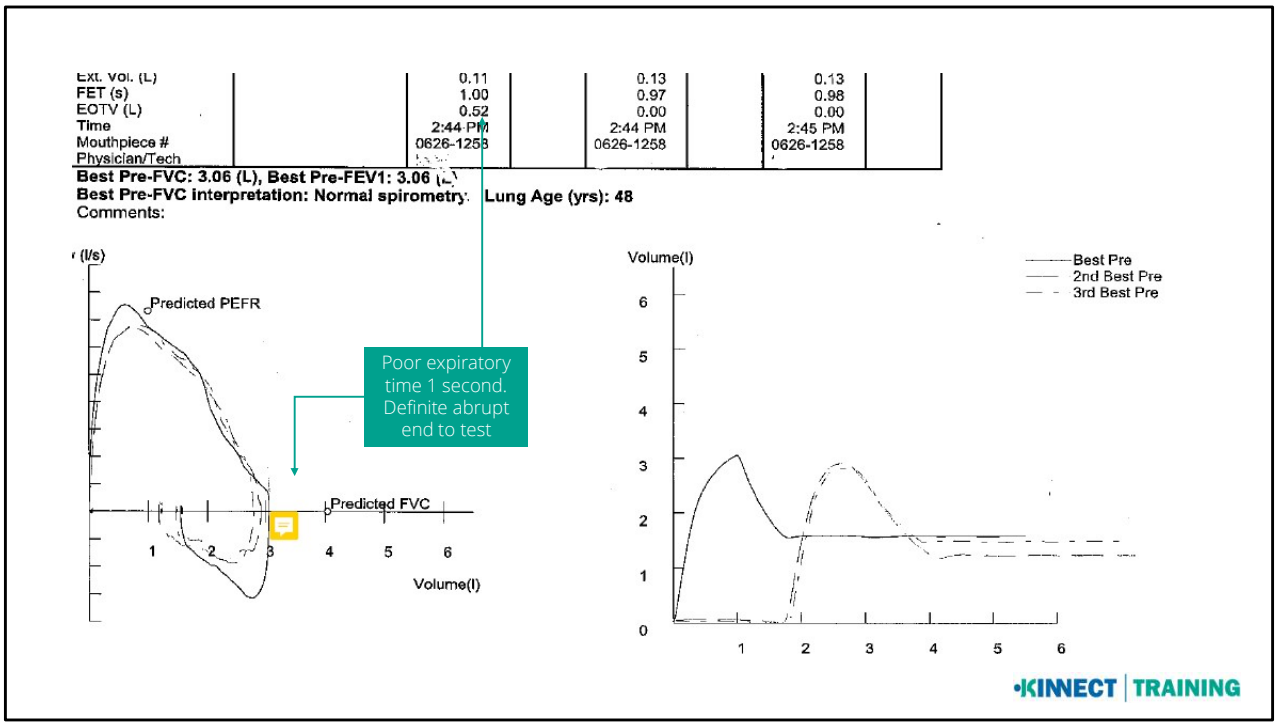
Ext. Vol. (L) 0.11 0.13 0.13
FET (s) 1.00 0.97 0.98
EOTV (L) 0.52 0.00 0.00
Time 2:44 PM 2:44 PM 2:45 PM
Mouthpiece # 0626-1258 0626-1258 0626-1258
Physician/Tech
Best Pre-FVC: 3.06 (L), Best Pre-FEV1: 3.06 (L)
Best Pre-FVC interpretation: Normal spirometry. Lung Age (yrs): 48
Comments:
(l/s)
Predicted PEFR
Predicted FVC
1 2 3 4 5 6
Volume(l)
Poor expiratory time 1 second. Definite abrupt end to test
Volume(l)
Best Pre
2nd Best Pre
3rd Best Pre
0 1 2 3 4 5 6
1 2 3 4 5 6
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Repeatability Criteria

After three acceptable spirograms have been obtained, the following checks are used to assess for repeatability:

- The two largest values of FVC or VC must be within 0.150L of each other
- The two largest values of FEV1 must be within 0.150L of each other
- For patients with an FVC or VC of ≤1.0L the two largest FVC or VC and FEV1 values must be within 0.100L of each other

A minimum of three acceptable manoeuvres should be saved and utilised for analysis/interpretation.

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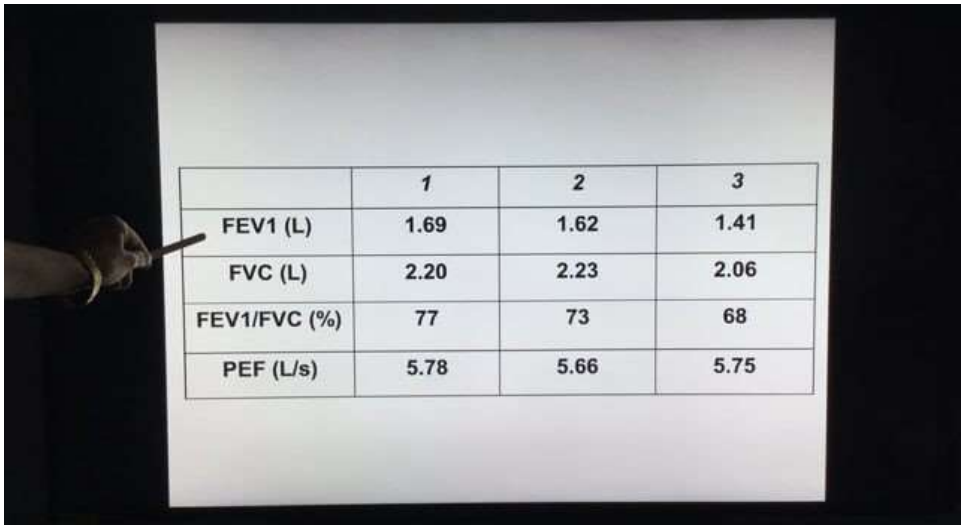
How to calculate Repeatability Criteria



	1	2	3
FEV1 (L)	1.69	1.62	1.41
FVC (L)	2.20	2.23	2.06
FEV1/FVC (%)	77	73	68
PEF (L/s)	5.78	5.66	5.75

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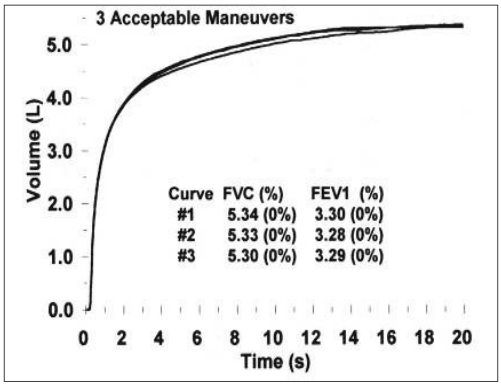
Between Manoeuver Acceptability

REPEATABLE

Acceptable repeatability:

Difference between largest and next largest FVC and FEV_1 ≤ 150 ml (100 ml if FVC ≤1.0 L)



Trial 1	FVC	FEV_1
1	5.34	3.30
2	5.33	3.28
3	5.30	3.29

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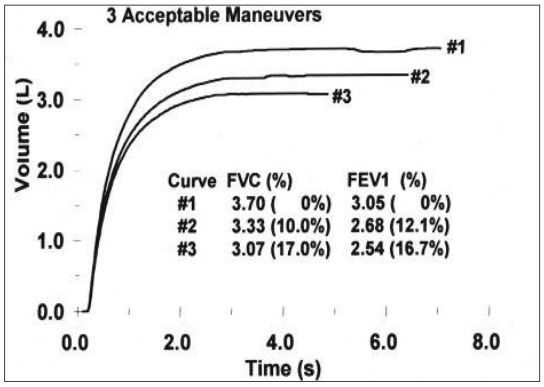
Between Manoeuver Acceptability

NON REPEATABLE

Acceptable repeatability:

Difference between largest and next largest FVC and FEV_1 ≤ 150 ml (100 ml if FVC ≤1.0 L)



Trial 1	FVC	FEV_1
1	3.70	3.05
2	3.33	2.68
3	3.07	2.54

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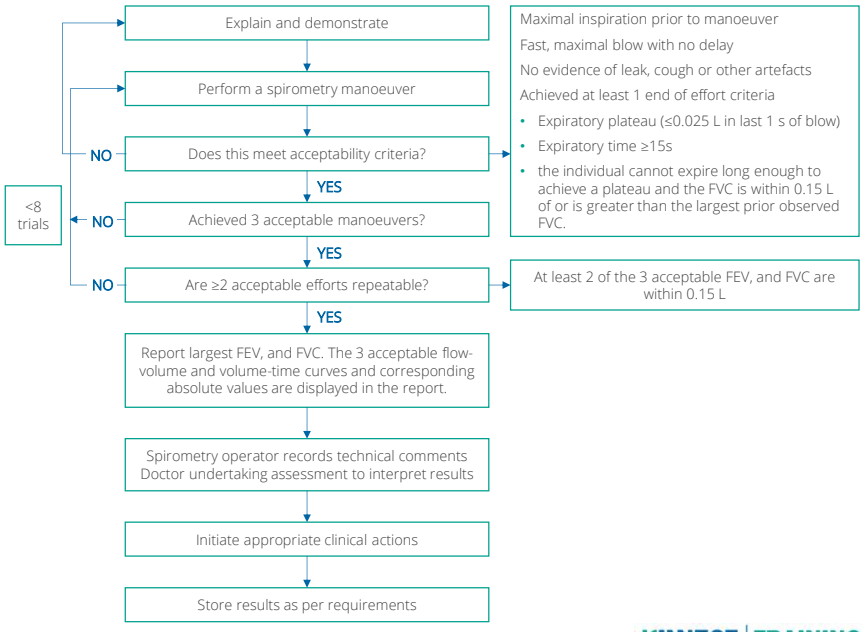
Process for Performing Spirometry for Resource Sector Workers

Page 11 from Spirometry Standards for Resource Sector Workers- April 2022



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Spirometry demonstration
and Practical Session
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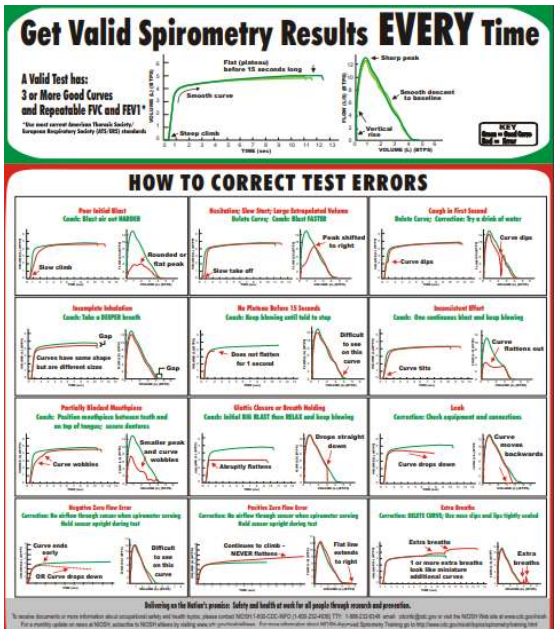
NIOSH

The National Institute for Occupational Health and Safety



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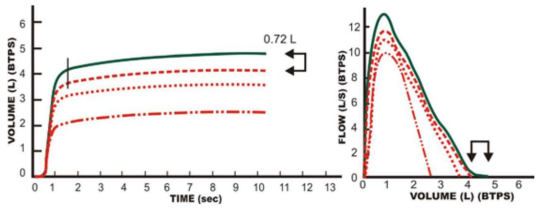
Sub Maximal Inhalation

- Identify by Gap between FVC plateaus and space between ending points of FV curve
- Curves of different sizes
- ↓FVC falsely indicates restriction
- Solution: Coach the subject to FILL THEIR LUNGS, taking the deepest possible breath.
- Spirometer Error Message: "FVC variable", "FEV1 variable", or "Take a deeper breath."

Error #1: Sub-maximal Inhalation

	FVC (L)	FVC % Pred	FVC LLN (L)	FEV_1 (L)	FEV_1 % Pred	FEV_1 LLN (L)
Good Effort	4.90	96	4.17	4.17	103	3.29
Error	4.18	82	4.17	3.60	88	3.29

4.90-4.18 = 0.72



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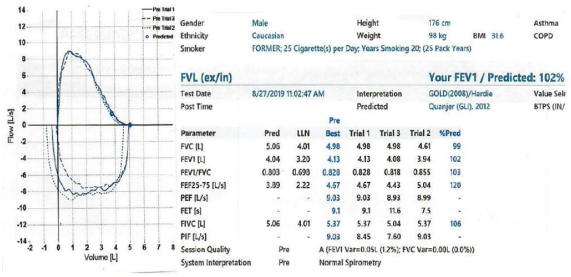
How to know your subject has taken a maximal breath

(TEST DONE BEFORE SMILEY FACE UPGRADE)

- If the volume of the maximal inspiration (FIVC) after EOFE is greater than FVC, then the patient did not start the manoeuvre from TLC. FEV1 and FVC measurements from a manoeuvre with
- FIVC-FVC > 0.100L or 5% of FVC whichever is greater, are not acceptable, but usable (pg.79 of 2019 standards)
- Trial 1:FIVC (5.37) FVC (4.98)=390 ml greater

  4.98 x 1.05 = 5.23

  The FIVC is 5.37 and therefore > 5% of FVC making it a usable trial
- Trial 3: Acceptable
- Trial 2 : Usable (4 .61 x1.05 =4.84)
- Using FIVC reduced ratio from 82% to 77%- still Normal spirometry
- In this case not much affect on the FEV1 and FVC



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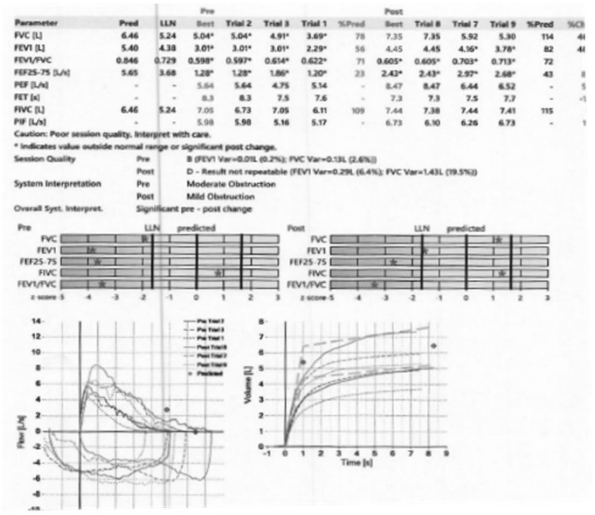
Acceptable/Usable

- PRE-TRIALS
- FVC X 1.05 – gives what 5% greater allowance is
- Trial 2
- 5.04 x 1.05 = 5.29 . FIVC = 7.05 USABLE
- Trial 3
- 4.91 X 1.05 = 5.16. FIVC = 6.73 = USABLE
- Trial 1
- 3.69 X 1.05 = 8.87. FIVC = 6.11 = USABLE
- POST TRIALS
- TRIAL 8 – BEST – FIVC similar
- Is reversibility likely to be accurate?
- PEF variable (10% rule –highest two within 10%)



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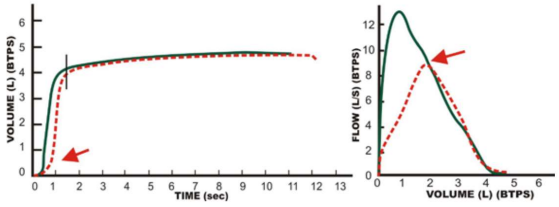
Excessive Extrapolated Volume

- Identify by displaced FV curve- it shifts to the right
- Extrapolated volume unacceptable –exceeds 0.15 or 5% of FVC whichever is larger
- Falsely ↑ FEV1, Occasionally↓
- **Solution:** Coach the subject to blast FASTER or IMMEDIATELY.
- **Spirometer Error Messages:** Most spirometers label this error with "Hesitation," "Large extrapolated volume," or "Start faster."

	FVC (L)	FEV_1 (L)	FEV_1 % Pred	PEF (L/sec)	Vext (L)	Vext (%)
Good Effort	4.79	4.12	86	12.2	0.12	2.5
Error	4.78	3.95	82	8.5	0.55	11.5



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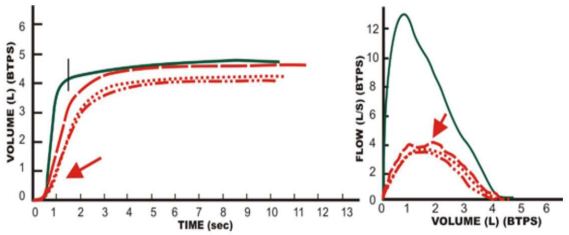
Sub Maximal Effort

- Problem seen more clearly on FV curve
- The weaker the blast the lower the PEF
- ↓FEV1 and FEV1/FVC ratio
- **Solution:** Coach the subject to blast the air out HARDER.
- **Spirometer Error Messages:** Spirometers may not label these curves as errors, so health professionals must recognize these patterns.
- A repeatable test may occur with sub maximal effort

	FVC (L)	FEV_1 (L)	FEV_1 % Pred	PEF (L/sec)
Good Effort	4.69	4.08	86	12.6
Error	4.57	3.36	71	4.1



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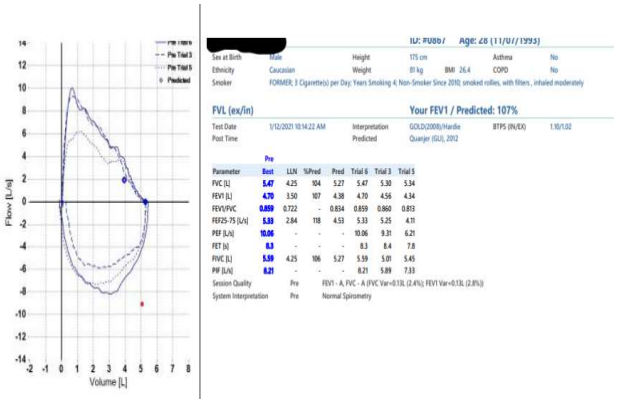
Is this test acceptable?

- 6 Trials Attempted – utilise maximum of 8 if client can – otherwise document in notes
- Trial 5 – poor PEF
- Aim for best two PEF to be within 10% of each other

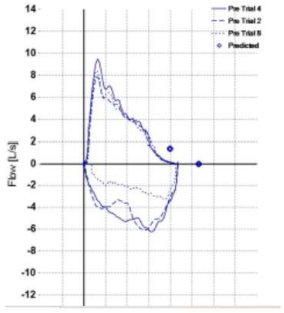
9.31 x1.10 = 10.24

YES – trial 3 and 6 are within 10%

ONLY 2 acceptable trials due to trial 5 having a submaximal exhalation with a reduced PEF



PEF within 10% (Best two)?



8.51 x 1.10=9.36
9.51 is above this so not within 10%
Encourage blast

ID: #0857 Age: 46 (13/02/197

Sex at Birth	Male	Height	181 cm		Asthma
Ethnicity	Caucasian	Weight	85 kg	BMI 25.9	COPD
Smoker	No				

FVL (ex/in) — **Your FEV1 / Predicted: 83%**

Test Date	25/11/2021 10:28:48 AM	Interpretation	GOLD(2008)/Hardie	BTPS (IN/EX)
Post Time		Predicted	Quanjer (GLI), 2012	

	Pre						
Parameter	Best	LLN	%Pred	Pred	Trial 4	Trial 2	Trial 8
FVC [L]	4.37	4.17	82	5.30	4.35	4.37	4.27
FEV1 [L]	3.47	3.29	83	4.19	3.47	3.39	3.45
FEV1/FVC	0.793	0.687	-	0.793	0.798	0.776	0.809
FEF25-75 [L/s]	3.42	2.15	88	3.87	3.42	3.10	3.54
PEF [L/s]	9.51	-	-	-	9.51	7.92	8.51
FET [s]	11.3	-	-	-	10.1	11.3	9.6
FIVC [L]	4.46	4.17	84	5.30	4.36	4.39	3.91*
PIF [L/s]	6.74	-	-	-	6.25	6.09	3.25

* Indicates value outside normal range or significant post change.

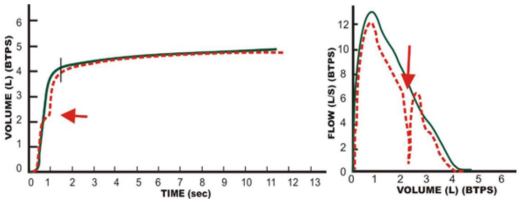
Session Quality	Pre	FEV1 - A, FVC - A (FVC Var=0.03L (0.6%); FEV1 Var=0.02L (0.5%))
System Interpretation	Pre	Normal Spirometry

KINNECT | TRAINING

Cough in the First Second

- Identify as jagged interruption in curve
- FEV1 will be affected
- Can be used to validate FVC if consistent with others
- Easier to see on FV curve
- ↓↑ FEV1 depending on strength of cough
- Significant coughing affects FVC also. FEV1/FVC may be inaccurate
- Solution: Coughing is difficult to manage. Offering a drink of water before the manoeuvre may help.
- Spirometer Error Message: Some spirometers label this error with "Cough."
- Report trial with best PEF

	FEV_1 (L)	FEV_1 % Pred
Good Effort	4.12	88
Error	3.96	84



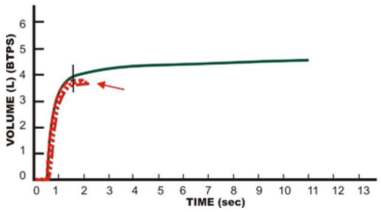
KINNECT | TRAINING

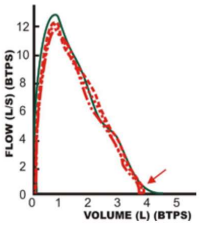
Early Termination

- Identify as lack of plateau on the VT curve
- Healthy>6 and obstructed patients longer (15 sec max)
- Falsely ↓FVC indicating restriction
- Falsely ↑ FEV1/FVC may cause true obstruction to be missed
- **Solution:** Coach the subject to KEEP BLOWING until told to stop.
- **Spirometer Error Message:** Spirometers may label this error as "Early termination" or "Keep blowing"

Remind subject that they will feel empty before they are, and that you can see when they are empty.

	FVC (L)	FVC % Pred	FEV_1 (L)	FEV_1 % Pred	FEV_1/FVC%
Good Effort	4.54	83	3.91	87	86
Error	3.81	67	3.76	84	98



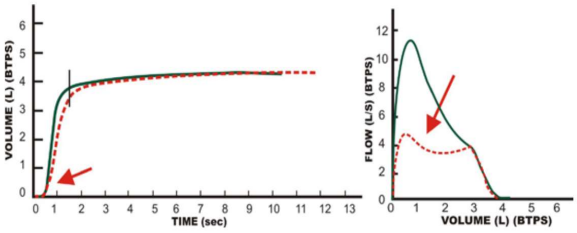


KINNECT | TRAINING

Variable Effort

- Identify as a dip on the VT curve. The more variable the larger
- Falsely ↓ FEV1 and FEV1/FVC misinterpreted as obstruction
- Shape and ↓ PEF = poor effort
- Solution: Coach the subject to blast one breath out HARD and FAST and KEEP BLOWING out.
- Spirometer Error Message: Many spirometers do not label this error, so health professionals must recognize these patterns

	FEV_1 (L)	FEV_1 % Pred	FEV_1/FVC%	PEF (L/sec)
Good Effort	3.73	86	88	10.8
Error	3.49	80	82	4.8



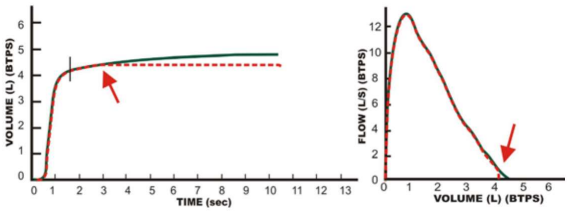
KINNECT | TRAINING

Cessation of Airflow

GLOTTIC CLOSURE OR BREATH-HOLDING

- VT curve shows an abrupt horizontal line , FV curve drops sharply to zero flow
- FVC ↓ indicating restriction. FEV1/FVC ↑ therefore obstruction may be missed
- Solution: Glottis closure may be involuntary and should be documented. However, for breath holding, coach the subject to blow UNTIL TOLD TO STOP.
- Spirometer Error Message: Some spirometers will label this error with "Blow out longer" or "Abrupt stop."

	FVC (L)	FVC % Pred	FEV_1 (L)	FEV_1/FVC %
Good Effort	4.90	91	4.16	85
Error	4.40	82	4.16	96



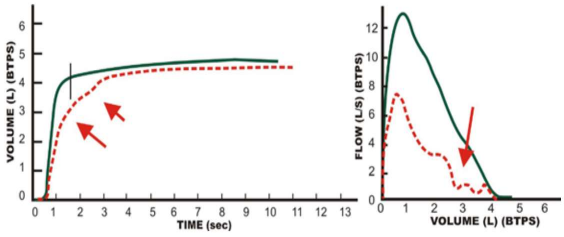
KINNECT | TRAINING

Partially Obstructed Mouthpiece

- Identify by ↓PEF, portions of curve are flattened
- FVC↓ and FEV1/FVC↓ falsely indicating obstruction
- **Solution:** Mouthpiece between teeth and on top of tongue. Secure/remove dentures
- Lightly bite mouthpiece
- **Spirometer Error Message:** Many spirometers will not label these curves as erroneous, so health professionals must recognize these patterns

  (You may hear a flutter like sound)

	FEV_1 (L)	FEV_1 % Pred	FEV_1/FVC%	PEF (L/sec)
Good Effort	4.08	101	87	12.4
Error	3.09	77	68	7.2

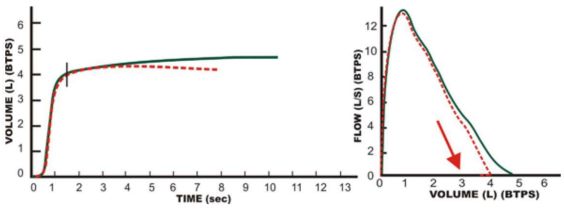


KINNECT | TRAINING

Leak

- Leak in spirometer, hose or at the mouth
- Identify by descent in VT curve
- FV curve backtracks towards zero
- Affect on FVC is profound, FEV1 unaffected
- FEV1/FVC falsely ↑. May mask true obstruction or misinterpreted as restriction
- Solution: Leak test (volume spirometers)
- Calibration and Linearity (low flow)
- Ensure tight lip seal. LISTEN!
- Spirometer Error Message: Spirometers do not label this error; it must be detected during a calibration check.

	FVC (L)	FVC % Pred	FEV_1 (L)	FEV_1/FVC%
Good Effort	4.71	80	4.05	86
Error	4.35	74	4.05	93

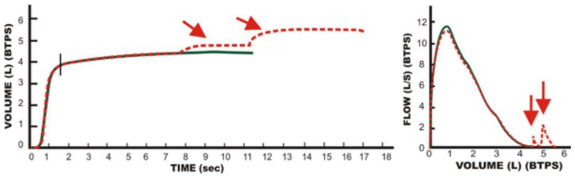


KINNECT | TRAINING

Extra Breath

- Leak in Extra breath taken through nose or around mouth
- Seen on both displays, as steps in curve
- FVC↑, FEV1 not affected
- FEV1/FVC ↓ misinterpreted as obstruction
- Solution: Use nose clip, keep tight seal around mouthpiece
- Curves must be deleted otherwise they could be included with results
- Spirometer Error Message: Spirometers do not label this error, so health professionals must recognize these patterns.

	FVC (L)	FVC % Pred	FEV_1/FVC%
Good Effort	4.43	97	88
Error	5.55	122	69

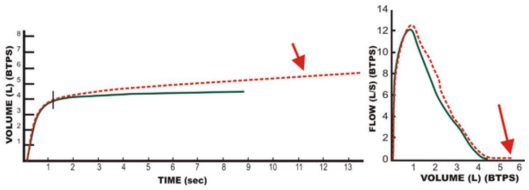


KINNECT | TRAINING

Positive Flow Error

- Zero flow reference point set incorrectly
- VT curve to rise at a constant rate and never plateau
- FVC ↑ FEV1/FVC ↓ - falsely indicating obstruction
- Solution: Block sensor to prevent air motion. Hold upright and still
- Delete curves with zero flow errors
- Spirometer may not recognise!

	FVC (L)	FVC % Pred	FEV_1 (L)	FEV_1 % Pred	FEV_1/FVC%
Good Effort	4.41	85	3.87	95	88
Error	5.68	109	3.93	96	69

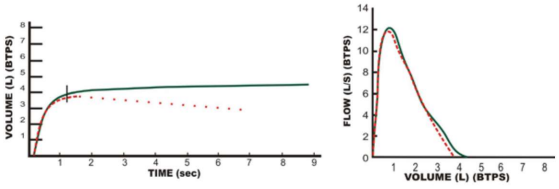


KINNECT | TRAINING

Negative Flow Error

- A negative zero-flow error may cause the VT curve to end abruptly, or it might drop gradually toward zero volume (left), like a large leak.
- FVC ↓ FEV1/FVC ↑ - falsely indicating restriction or might hide true obstruction
- Solution: Block sensor to prevent air motion. Hold upright and still
- Delete curves with zero flow errors
- Spirometer may not recognise!

	FVC (L)	FVC % Pred	FEV_1 (L)	FEV_1 % Pred	FEV_1 /FVC%
Good Effort	4.41	85	3.87	95	88
Error	3.81	73	3.63	89	95



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Other Errors

Vocalisation
You will hear vocal sounds during exhalation

Solution: Demonstrate manoeuvre with puffed cheeks " like blowing candles out"

Opening mouth
Noticeable as no trace or very small trace

Solution: Remind subject to seal mouth, or use a flanged mouthpiece

Uncooperative patient
At times subjects can not or will not perform test. May be due to mental health or possible lack of trying

Solution: The harder you blow the more damage we can see in the lungs

If acceptability criteria is not met after 8 trials document it " Poor patient technique, best effort selected. Interpret with care!

REMEMBER TECHNICAL COMMENTS HELP WITH INTERPRETATION

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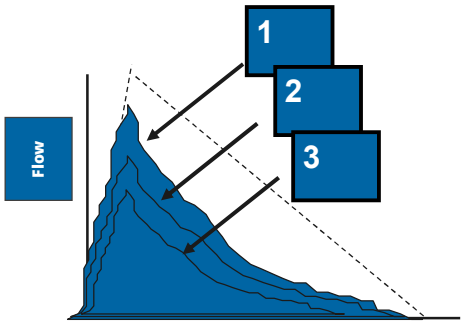
Spirometry Induced Bronchospasm

Airway Hyper-reactivity (asthma)

- Relieve with bronchodilator
- Note observation so physician can approve treatment for asthma
- Compliance



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Data Selection

- FEV1 from loop with best PEF
- FVC – Largest VC. It can be selected from inspiratory or expiratory loop, or if obstructed perform an SVC
- "The largest FVC and the largest FEV1 (BTPS) should be recorded after examining the data from all of the usable curves, even if they do not come from the same curve."
- All other parameters and loop should be selected from loop which has the largest combined FVC and FEV1

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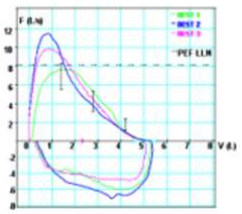
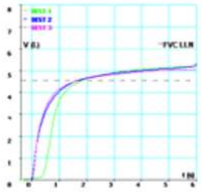
Importance of PEF on selecting FEV1!

	BEST	1	2	3
FVC	5.30	5.30	5.38	5.11
FEV1	4.30	4.30	4.18	4.19
RATIO	80%	80%	76%	82%

Don't always rely on your spirometer – look at your loops!!!





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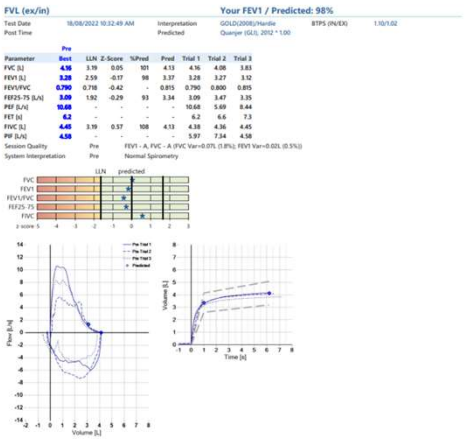
Repetable PEF is important!

- Not A grade
- Inconsistent effort
- Encourage more on the breath out – BLAST!
- Use incentives if necessary
- REMEMBER – A submaximal blow makes a test unacceptable regardless of what the spirometer says!!!

ISSUES:

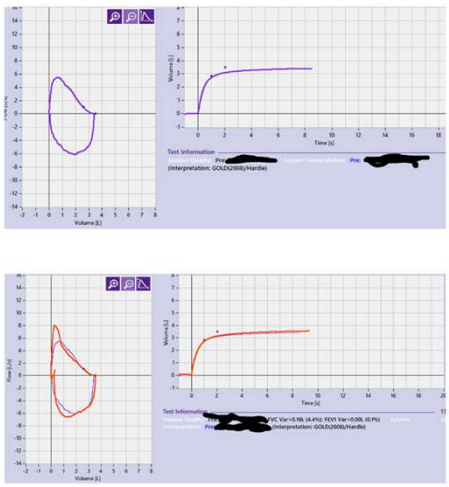
2 x unacceptable curves – inconsistent/submaximal effort
Trials 2 and Trial 3 Peak Flow 8L/s and 5.5L/s which is less than Trial 1 10.5L/s



Things can change with each blow…

- Purple trial looks good
- Until next attempt
- Look for
  - sharp peak
  - good rise time

ACCEPTABLE CURVE



Variable effort in trials – poor initial blast in purple – no longer acceptable

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Grading your Spirometry

Table 10. Grading System for FEV_1 and FVC (Graded Separately)

Grade	Number of Measurements	Repeatability: Age >6 yr	Repeatability: Age ≤6 yr*
A	≥3 acceptable	Within 0.150 L	Within 0.100 L*
B	2 acceptable	Within 0.150 L	Within 0.100 L*
C	≥2 acceptable	Within 0.200 L	Within 0.150 L*
D	≥2 acceptable	Within 0.250 L	Within 0.200 L*
E	≥2 acceptable	>0.250 L	>0.200 L*
	OR 1 acceptable	N/A	N/A
U	0 acceptable AND ≥1 usable	N/A	N/A
F	0 acceptable and 0 usable	N/A	N/A

Definition of abbreviation: N/A = not applicable.
The repeatability grade is determined for the set of prebronchodilator maneuvers and the set of post-bronchodilator maneuvers separately. The repeatability criteria are applied to the differences between the two largest FVC values and the two largest FEV_1 values. Grade U indicates that only usable but not acceptable measurements were obtained. *Although some maneuvers may be acceptable or usable at grading levels lower than A, the overriding goal of the operator must be to always achieve the best possible testing quality for each patient.* Adapted from Reference 114.
*Or 10% of the highest value, whichever is greater; applies for age 6 years or younger only.

Coal board medicals require A grade quality

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Summary of Acceptability, Usability, and Repeatability Criteria for FEV1 and FVC

Table 7. Summary of Acceptability, Usability, and Repeatability Criteria for FEV_1 and FVC

Acceptability and Usability Criterion	Required for Acceptability		Required for Usability	
	FEV_1	FVC	FEV_1	FVC
Must have BEV ≤5% of FVC or 0.100 L, whichever is greater	Yes	Yes	Yes	Yes
Must have no evidence of a faulty zero-flow setting	Yes	Yes	Yes	Yes
Must have no cough in the first second of expiration*	Yes	No	Yes	No
Must have no glottic closure in the first second of expiration*	Yes	Yes	Yes	Yes
Must have no glottic closure after 1 s of expiration	No	Yes	No	No
Must achieve one of these three EOFE indicators:	No	Yes	No	No
1. Expiratory plateau (≤0.025 L in the last 1 s of expiration)				
2. Expiratory time ≥15 s				
3. FVC is within the repeatability tolerance of or is greater than the largest prior observed FVC†				
Must have no evidence of obstructed mouthpiece or spirometer	Yes	Yes	No	No
Must have no evidence of a leak	Yes	Yes	No	No
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‡	Yes	Yes	No	No
Repeatability criteria (applied to acceptable FVC and FEV_1 values)				
Age >6 yr: The difference between the two largest FVC values must be ≤0.150 L, and the difference between the two largest FEV_1 values must be ≤0.150 L				
Age ≤6 yr: The difference between the two largest FVC values must be ≤0.100 L or 10% of the highest value, whichever is greater, and the difference between the two largest FEV_1 values must be ≤0.100 L or 10% of the highest value, whichever is greater				

Definition of abbreviations: BEV = back-extrapolated volume; EOFE = end of forced expiration; $FEV_{0.75}$ = forced expiratory volume in the first 0.75 seconds; FIVC = forced inspiratory VC.

The grading system (Table 10) will inform the interpreter if values are reported from usable maneuvers not meeting all acceptability criteria.

*For children aged 6 years or younger, must have at least 0.75 seconds of expiration without glottic closure or cough for acceptable or usable measurement of $FEV_{0.75}$.

†Occurs when the patient cannot expire long enough to achieve a plateau (e.g., children with high elastic recoil or patients with restrictive lung disease) or when the patient inspires or comes off the mouthpiece before a plateau. For within-maneuver acceptability, the FVC must be greater than or within the repeatability tolerance of the largest FVC observed before this maneuver within the current prebronchodilator or the current post-bronchodilator testing set.

‡Although the performance of a maximal forced inspiration is strongly recommended, its absence does not preclude a maneuver from being judged acceptable, unless extrathoracic obstruction is specifically being investigated.

Dealing with Syncope during Spirometry

How to recognise syncope

- The following are signs that syncope is about to occur
- Colour drains from the face
- Patient appears to convulse slightly; this will then lead to patient losing consciousness and becoming flaccid. Patient will come around and may not be aware of "what just happened."
- Chair
- Monitor closely
- Slow Vital Capacity – SVC
- Best spirometry technique – exhale forcibly for 3 seconds then relaxed exhalation for rest of blow
- Increase rest period – 1 minute
- Document on the subject's test result:

  "Syncope occurred during spirometry, FVC may be underestimated" or
  "Syncope occurred during spirometry; VC taken from an SVC manoeuvre"
  Ensure to place a note on subjects file, so that future assessors are aware that the subject may experience syncope upon testing.

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Predicted Reference Values

Depend on accurate evaluation of:

- Height or arm span
- Age (natural aging effect)
- Sex (Women have smaller lungs)
- Race (often 10-20% less for non-Caucasians)
- Adult (>18 years)
- Pediatric (5-17 years)
- Obesity status (not essential but useful for interpretation)

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Global Lung Initiative (GLI)

01

The most recent comprehensive study was published in 2012

- First global multi-ethnic reference equations for spirometry that span all-ages.
- Endorsed by five international societies.

02

74,187 healthy non-smokers

(57.1% females)

40 countries

Aged 3-95 years

03

Multi-ethnic reference equations using modern statistical methods, including development of age dependent lower limits of normal.

04

Previously each hospital selected their own preferred reference equations with which to interpret spirometry results.

05

However, since use of different equations has been shown to lead to different interpretation, this meant that results from any given individual could differ depending on where they were assessed.

06

These predicted values have been endorsed by all international Respiratory Societies including the Australian and New Zealand societies.

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Interpretation with GLI

01

The ATS/ERS guidelines recommend that the interpretation of spirometry measurements use the lower limit of normal (LLN) to detect an abnormality. The LLN represents data below the lower fifth percentile from a large healthy reference group.

02

A simple way to present spirometry results and their relationship to LLN is to express the results as Z-scores both numerically and using a pictogram

03

The Z-score represents how many SD the measured value is away from the mean predicted value (i.e. a Z-score of 0 represents the mean predicted value, while a Z-score of −1 would be one SD below the mean predicted value).

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What is a Z-score?

The chance the observed result falls within the distribution of values in healthy individuals

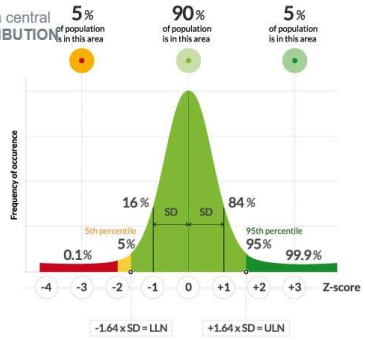
At the 5th percentile(z score -1.645) there is a 5% chance that the results in a healthy individual would be below this level

In spirometry the LLN is the 5th percentile

This means 5% of healthy individuals will have a false positive result

When the data tend to be around a central value we have a **NORMAL DISTRIBUTION** with a bell–shaped curve.

Relationship between **STANDARD DEVIATION (SD)** and percentage of data under the curve in the case of a normal distribution.



The central line is the position of the **MEAN** value

- 50% of population is above this value
- 50% is below this value

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Z-scores

The 5th percentile is a trade-off between incorrectly classifying a low value in a healthy person and missing a clinically significant reduction in lung function.

The LLN does not necessarily indicate a pathophysiological abnormality, nor is it a clinically meaningful threshold to diagnose disease. It provides an indication of whether the observed result can be expected in otherwise healthy individuals of similar

- age
- sex
- and height

A result within the expected range for a subject does not exclude the presence of a disease process impairing function.

Results close to the LLN should be interpreted with caution and the individual's medical history, physical findings, and pre-test probability of disease taken into consideration during interpretation.

This further emphasizes that the interpreter should be informed of the patient's clinical notes and not solely rely on the numbers generated in the report

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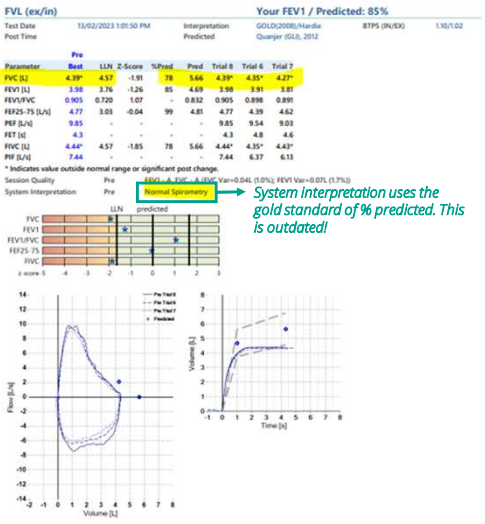
Move away from % predicted to LLN

- Using % predicted the system interpretation is NORMAL
- Using LLN the FVC of 4.39 is below the LLN of 4.57 and therefore interpretation of restriction is likely
- Ratio is > LLN AT 0.905
- Z score of 1.91 =mild although best to use z score from TLC during lung volumes



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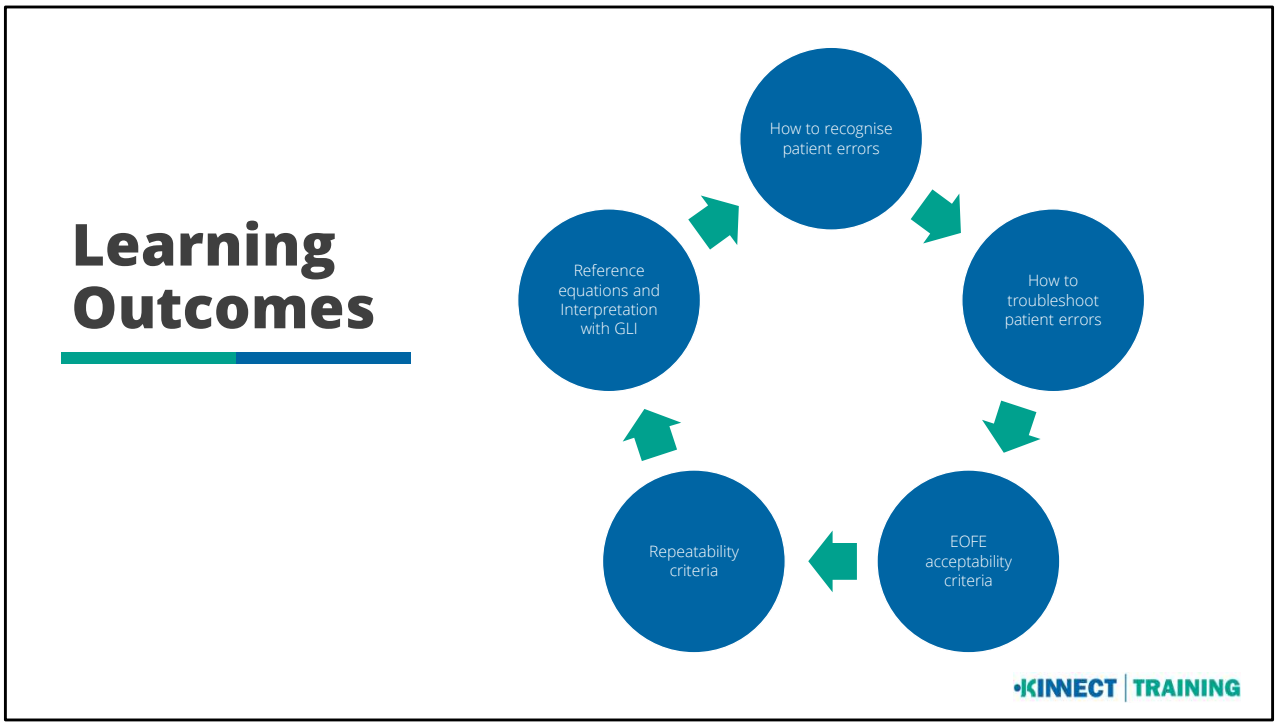
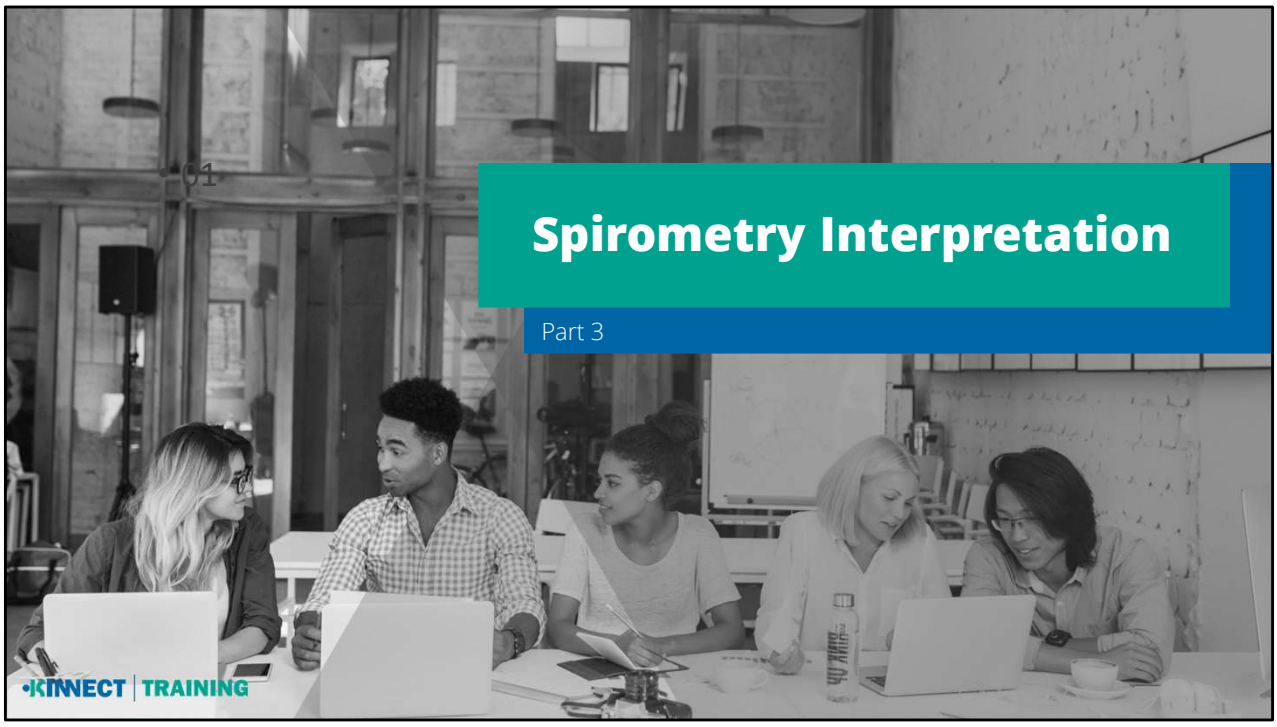


To maintain your competency in spirometry it is mandated by the TSANZ that you must record 100 spirometry tests in your log book prior to registering for the refresher course, in 12 months time. This is a pre-requisite for the refresher course


01
Spirometry Interpretation
Part 3
KINNECT | TRAINING

Spirometry Interpretation Overview

- Normal Pattern
- Types of ventilatory defects
- Algorithms for interpreting results
- Obstructive pattern
- Restrictive pattern
- Mixed pattern
- CWP/Silicosis – Video
- Quiz and case studies

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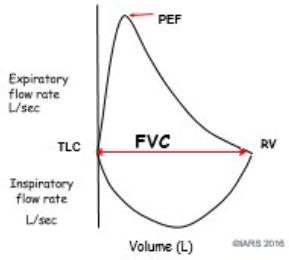
Normal Spirometry



- Triangular shape
- A steep and rapid vertical rise
- Observe the sharp point of the peak
- This is an important indicator of the subject's effort.
- Smooth continuous descent at a 45 degrees angle.
- Note the shape of the curve follows the predicted shape or the dots.

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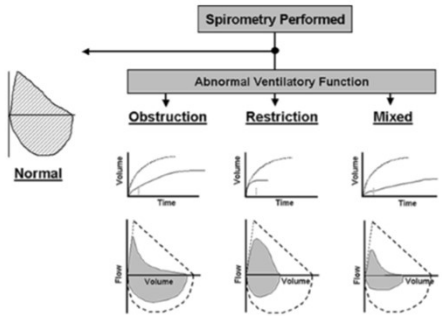
Interpretation of Results

Classification Of Ventilatory Abnormalities by Spirometry

	OBSTRUCTIVE	RESTRICTIVE	MIXED
FEV_1	↓	↓ or Normal	↓
FVC	↓ or Normal	↓	↓
FEV_1/FVC	↓	Normal or ↑	↓



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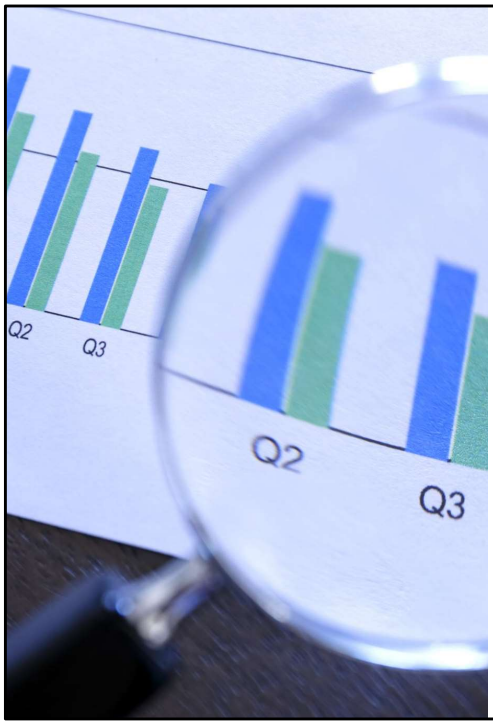

Spirometry Interpretation

- Spirometry results must be interpreted in line with any clinical guidelines mandated within the worker's jurisdiction. Otherwise, the most recent ATS/ERS Pulmonary Function testing Interpretation guidelines should be followed
- The doctor responsible for reporting on the health assessment must use the appropriate guidelines to determine the appropriate process for follow-up investigation and referral as clinically appropriate.
- A clinical interpretation of the spirometry assessment must be included in the spirometry report or linked clinical records [as mandated within the worker's jurisdiction].

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Spirometry Interpretation

These TSANZ Standards recommend that:

1. Spirometry of lower quality (ATS/ERS graded C or lower) is generally not be suitable for interpretation. Providers should consider retesting workers to ensure appropriate spirometry results are available.

2. Individuals should be referred to a respiratory and/or occupational physician as appropriate to the clinical findings if the following conditions are met:

3. Absolute FEV1, forced vital capacity (FVC) or FEV1/FVC is less than the lower limit of the normal (LLN) as determined using the GLI reference equations, or

4. FEV1 or FVC, expressed in GLI % predicted, declines by > 15% predicted from baseline test over any period.

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Z- score Classification

ERS/ATS Interpretative Strategies in pulmonary Function Tests 2022

	z-score Lower Range	z-score Upper Range
Normal	-1.645	
Mild	-1.65	-2.5
Moderate	-2.5	-4.0
Severe	>-4.0	

The benefit is that Z–SCORE is completely independent of:

- Age
- Height
- Sex

For example, if the Z–SCORE for any parameter is –1.64, this signifies in males, females, children, and adults that the measured value is at the 5th percentile. In lung function testing this is regarded as the LLN.

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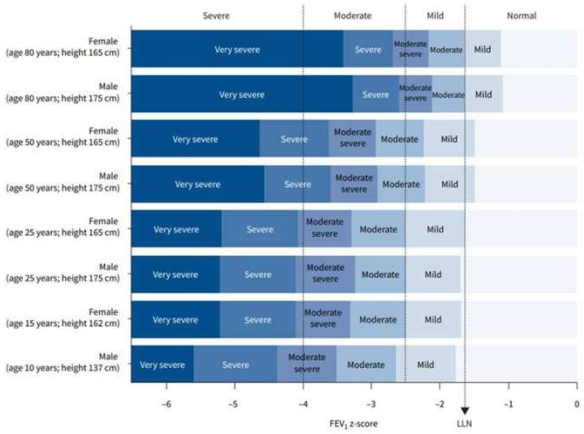
Why the change?

- % predicted values overestimated obstruction in the older population
- % predicted values underestimated obstruction in the younger population



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Restriction Classification

Severity of restriction ideally by TLC z-score by FEV_1 or FVC?

- FEV_1 affected by obstruction
- FVC defined by changes in TLC & RV

	Sex	Age	Htcm	zTLC		ppTLC		zRV		ppRV		zFVC		ppFVC	
1	Male	54	164	-3.3	Mod.	61	Mod.	-1.7	Mild	58	Mod. Sev.	-2.7	Mod.	63	Mod.
2	Female	48	161	-4.5	Severe	55	Mod. Sev.	-3.6	Mod.	25	Very Sev.	-1.8	Mild	78	Mild

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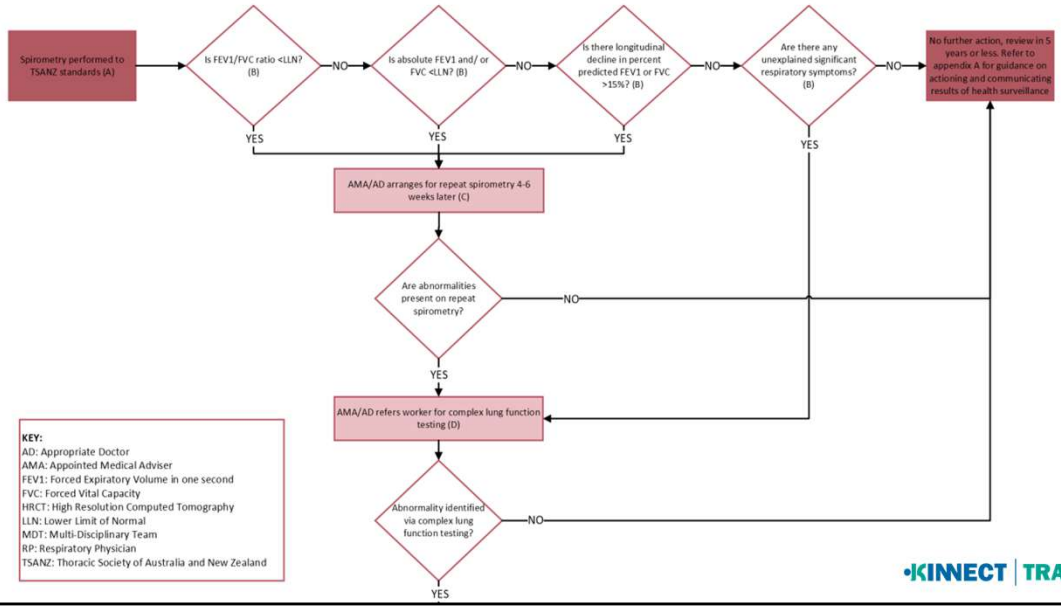
Mine Dust Lung Disease – Clinical Pathways Guideline: Spirometry



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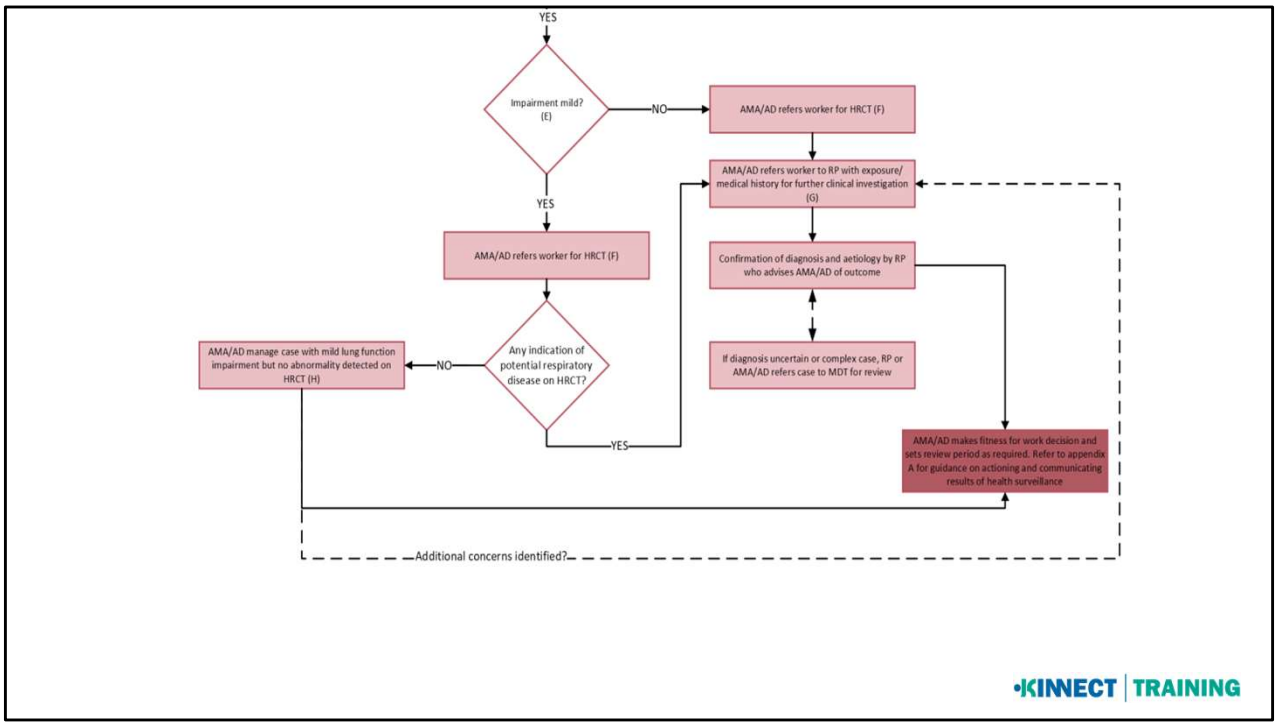

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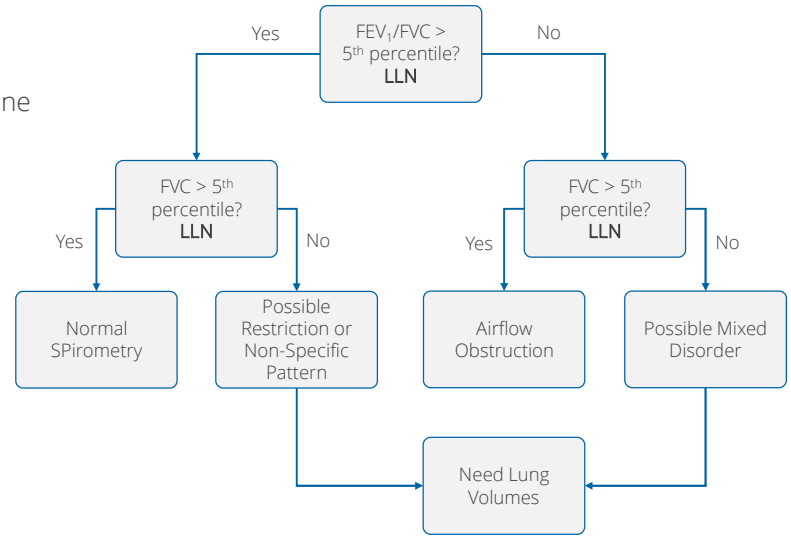
Interpretation of Spirometry

The interpretation of spirometry should align with the ERS / ATS interpretative standards for routine lung function tests.

Page 13 of Standards for Delivery of Spirometry in Resource Sector Workers



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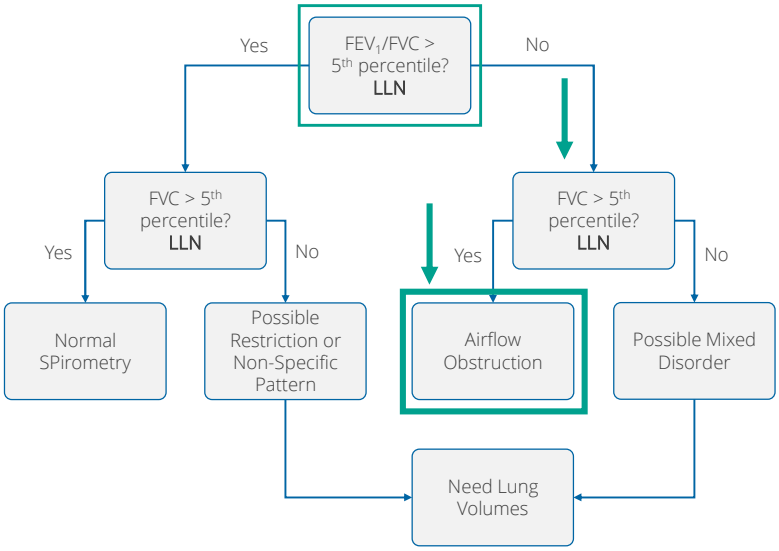
Classic Obstruction

- Ratio is not above LLN
- FVC is above LLN



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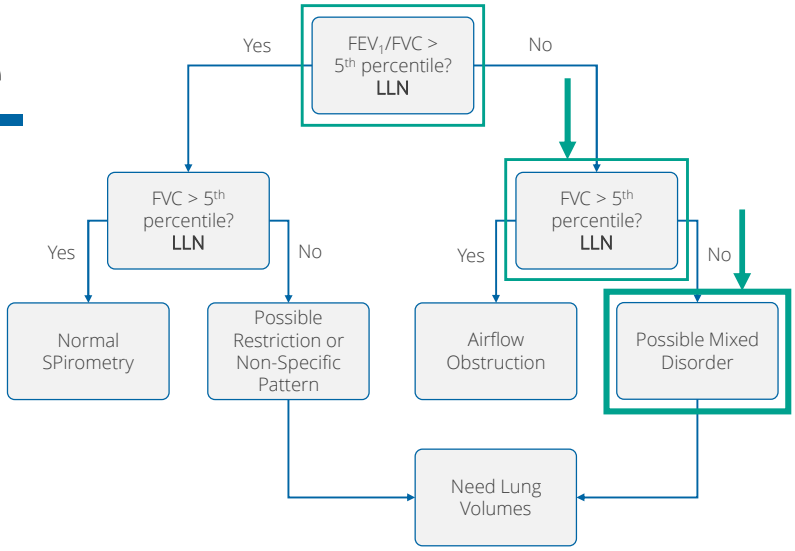
Mixed Disease

- Ratio and FVC not above LLN



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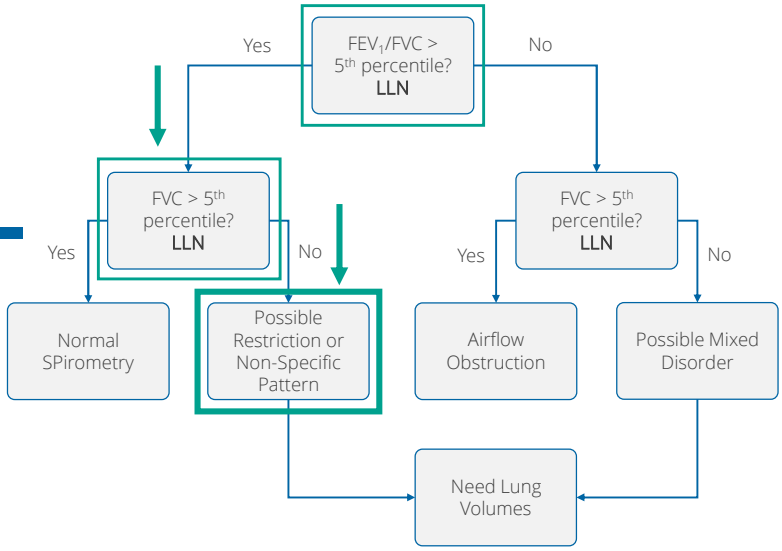
Restriction or non-specific pattern

- Ratio is above the LLN
- FVC is below the LLN



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Longitudinal Monitoring of Lung Function

It is critical to evaluate an individual's lung function over time rather than an assessment of a single point in time compared against reference equations. This includes monitoring known abnormalities or assessing the effect of an intervention or occupational exposure.

A meaningful change over time must be greater than the inherent variability of the measure, which tends to be greater over weeks to months, than daily in biological controls.

Measures of FEV1 or FVC, expressed in GLI % predicted, that **decline by > 15% from baseline test over any period should be considered to be outside the normal longitudinal variability of spirometry**

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Longitudinal Example

A female worker, or Aboriginal ancestry, 170.5 cm tall enters the resource sector workforce at a 25.5 years. The GLI spirometry 'other' predictive equations are used as per ANZSRS recommendations.

Her lung function on entering the workforce was:

FEV_1	3.48 L	(103.1% predicted, LLN = 2.74 L)
FVC	3.94 L	(100.8% predicted, LLN = 3.16 L)
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	3.31 L	(95.1% predicted, LLN = 2.65 L)
FVC	3.87 L	(99.4% predicted, LLN = 3.15 L)
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	2.85 L	(87.6% predicted, LLN = 2.599 L)
FVC	3.79 L	(98.0% predicted, LLN = 3.131 L)
FEV_1/FVC	0.75	(81.9% 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 to an occupational and/or respiratory physician for further assessment.

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Obstructive Defect - Disease of the Airways

Asthma or COPD

Characterized by reduced expiratory flow rates, due to airway narrowing caused by either:

- Airway muscle constriction
- Increased mucus, or
- Airway inflammation

Concave shape- air can only be expelled slowly

Usually steep and rapid vertical rise, this can often match the predicted peak except in advanced disease.

Volume of air within the lungs can still be normal but it takes longer to exhale through the narrowed airways.

Advanced disease the small airways can collapse with exhalation and trap the remaining air in the lungs – causing a reduction in the air that is able to be exhaled. Reduced FVC seen

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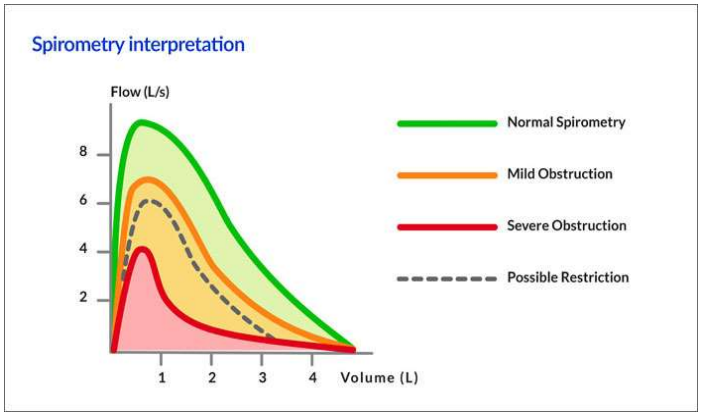
Mild Versus Severe Obstruction

- Concavity increases
- Time to reach RV increases



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Differentiating Asthma and COPD

- In COPD mechanism of obstruction due to airway collapse
- In Asthma it is due to:
  - Bronchoconstriction
  - Inflammation in the airway wall
  - Mucous plugging

Asthma = Reversible

COPD = Not reversible

Clinical Hx is important!

Normal spirometry does not exclude asthma

Further challenge testing should be completed if clinical history points to allergy exercise factors

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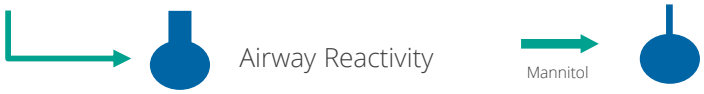
Types of Ventilatory Defect

1. Normal (?)



2. Obstruction
(Cannot blow out quickly)

3. Restriction (Small lungs)

4. Mixed Defect (Small lungs + cannot blow out quickly)

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Assessment of Bronchodilator Responsiveness

- Spirometry is repeated at least 15 minutes following the administration of standardised bronchodilator therapy.
- 4 separate doses of 100µg of SABA be administered by a metered dose inhaler (MDI) via a spacer at approximately 30 second intervals.
- After a gentle and incomplete expiration, actuate the SABA metered dose inhaler at the beginning of a slow inhalation to TLC from a spacer. The breath is then held for 5–10 seconds before the patient exhales

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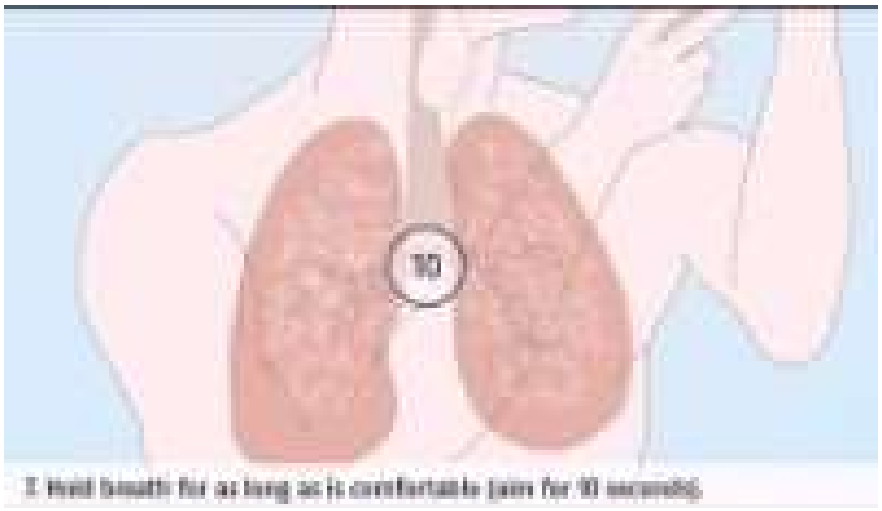
How to Administer Bronchodilator



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Trigger for performing BD testing

If BEST Value (FEV1 or FVC or FEV1/FVC) is < LLN.
AND
If FEV1/FVC ratio is <80%
(KINNECT if it can be accommodated clinically)

- A low ratio and FEV1 indicates obstruction
- A low FVC could indicate gas trapping- performing a BD test will allow the interpreter to see if there is a response to BD which can assist in determining disease:
- Asthma - reversible
- COPD – non-reversible

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Updates to Bronchodilator Testing

2019

A 12% improvement in FEV1 (and/or FVC) and an absolute improvement of at least 200ml.

The percentage improvement in FEV1 can be calculated as follows:

$$\frac{\text{Post BD Value} - \text{Pre BD Value}}{\text{Pre BD Value}} \times 100$$

2022

The recommended criteria for a significant improvement in spirometry is at least:

A change of >10%

The percentage improvement is calculated as following:

$$\frac{\text{Post BD Value} - \text{Pre BD Value}}{\text{Predicted GLI Value}} \times 100$$

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Bronchodilator Responsiveness Testing

In line with the 2022 ERS / ATS interpretative standards for lung function testing changes in FEV1 and FVC should be reported as a change relative to the GLI predicted value.

This approach minimises the influence of sex and height on the magnitude of the bronchodilator response.

Determination of a bronchodilator response

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

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; 175 cm in height has a pre-bronchodilator FEV_1 4.41 L and a post-bronchodilator FEV_1 of 4.65 L. The predicted FEV_1 is 4.39 L (using the GLI Caucasian equation).

The bronchodilator response 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 FEV_1 and is classified as not having a bronchodilator response.

Adapted from the 2022 ERS/ ATS Technical standard on interpretative strategies for routine lung function tests[3]

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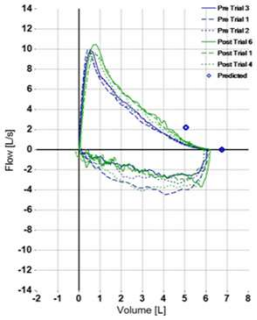
How to Perform the Calculation

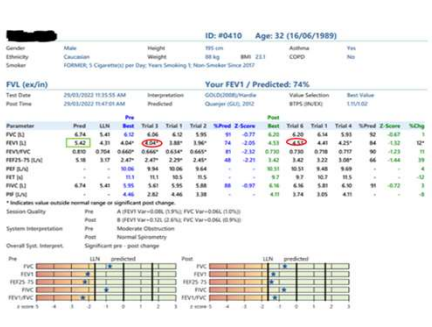
$$\frac{\text{Post BD Value} - \text{Pre BD Value}}{\text{Pre BD Value}} \times 100$$

$$\frac{4.53 - 4.04.}{5.42} \times 100$$

Not significant using the 2022 BDR equation

- Post BD FEV1 = 4.53
- Pre BD FEV1 = 4.04
- Predicted GLI value = 5.42





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Why the Change?

Bronchodilator Responsiveness

change in FEV1 (or FVC) as % of its predicted value

Old criteria was 12% change relative to start value + 200 ml:

- favoured those with lower FEV1 start value
- 200ml favoured males

Change in FEV1 of:

> 8% predicted	anchors to a survival advantage over non-responsive [1]
> 10% predicted	separates responders from the normal population
> 4% predicted	separates patients who were peer reviewed as improved [2]

1. Ward H, et al. Chest. 2015; 148 (4): 877-86. 2. Redelmeier DA, et al. Chest. 1996; 109: 1163–8.

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The Outcome of the change

3051 patients (54% male) with FEV1/FVC z-score <-1.645

Old criteria (>12% start FEV 1+200mls)	1070 responsive (60% male)
New criterion (>10% predicted FEV1)	768 responsive (52% male)
	302 fewer responsive (28% drop)
	25 new responders (64% female)
	327 no longer responders (77% male)

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Old Calculation Method

Using the new recommendation

0.75-0.58/2.57 X 100 = 7%

No longer a significant BDR in FEV1

Baseline					Post BD			
Pred	Range	Pre	%Pred	Z-Score Pre	Post	%Pred	Z-Score Post	%Chg
2.57	> 1.95	0.58	23	-5.06	0.75	29	-4.68	29
3.24	> 2.47	1.66	51	-3.54	1.93	60	-2.91	16
3.24	> 2.47	2.01	62	-2.72	2.56	79	-1.48	27
0.80	> 0.67	0.29		-4.99	0.29		-4.99	
2.41	> 1.26	0.17	7	-4.43	0.21	9	-4.25	24
5.78	> 3.13	2.35	41	-2.14	2.74	47	-1.9	17

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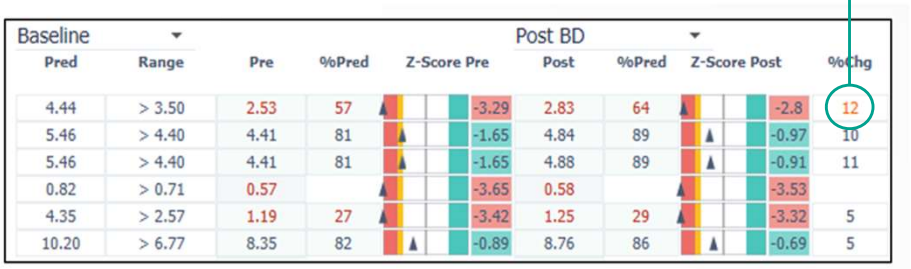
Old Calculation Method

Using the new recommendation

2.83-2.53/4.44 X 100 = 7%

No longer a significant BDR in FEV1



Baseline					Post BD			
Pred	Range	Pre	%Pred	Z-Score Pre	Post	%Pred	Z-Score Post	%Chg
4.44	> 3.50	2.53	57	-3.29	2.83	64	-2.8	12
5.46	> 4.40	4.41	81	-1.65	4.84	89	-0.97	10
5.46	> 4.40	4.41	81	-1.65	4.88	89	-0.91	11
0.82	> 0.71	0.57		-3.65	0.58		-3.53	
4.35	> 2.57	1.19	27	-3.42	1.25	29	-3.32	5
10.20	> 6.77	8.35	82	-0.89	8.76	86	-0.69	5

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Does this test show bronchodilator response?

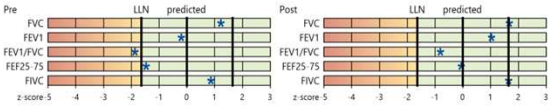
Sex at Birth	Male		Height	177.5 cm		Asthma	No
Ethnicity	Caucasian		Weight	73 kg	BMI 23.2	COPD	No
Smoker	Yes; 8 Cigarette(s) per Day; Years Smoking 7; (2 Pack Years)						

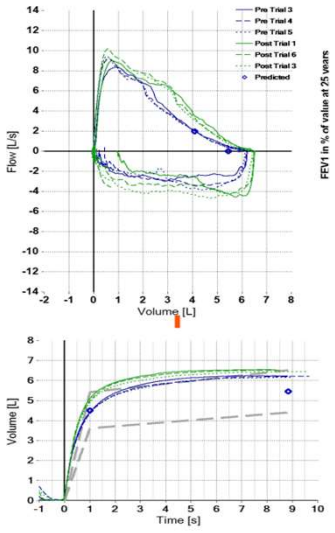
FVL (ex/in) — **Your FEV1 / Predicted: 98%** — **Your Lung Age: 28**

Test Date	11/05/2023 1:32:46 PM				Interpretation	GOLD(2008)/Hardie				BTPS (IN/EX)	1.10/1.02				
Post Time	11/05/2023 1:57:16 PM				Predicted	Quanjer (GLI), 2012									
	Pre								Post						
Parameter	Best	LLN	Z-Score	%Pred	Pred	Trial 3	Trial 4	Trial 5	Best	Z-Score	%Pred	Chg	%Chg	Trial 1	Trial 6	Trial 3
FVC [L]	6.24	4.39	1.22	114	5.45	6.24	6.21	6.15	6.53	1.68	120	0.29	5	6.53	6.52	6.45
FEV1 [L]	4.40	3.60	-0.20	98	4.51	4.40	4.35	4.33	5.07	1.03	113	0.68*	15*	5.07	4.98	4.89
FEV1/FVC	0.705*	0.720	-1.87	-	0.831	0.705*	0.701*	0.703*	0.777	-0.80	-	0.072	10	0.777	0.763	0.759
FEF25-75 [L/s]	3.09	2.89	-1.46	67	4.62	3.09	3.00	3.02	4.58	-0.04	99	1.49	48	4.58	4.24	4.15
PEF [L/s]	9.45	-	-	-	-	8.37	9.20	9.45	10.22	-	-	0.77	8	9.01	10.22	9.34
FET [s]	8.8	-	-	-	-	8.8	9.7	9.0	8.4	-	-	-0.5	-6	8.4	8.6	9.6
FIVC [L]	6.01	4.39	0.88	110	5.45	6.00	5.75	6.01	6.51	1.65	119	0.50	8	5.55	6.49	6.51
PIF [L/s]	3.87	-	-	-	-	2.95	3.42	3.87	4.68	-	-	0.80	21	4.60	4.21	4.68

* Indicates value outside normal range or significant post change.

Session Quality	Pre	FEV1 - A, FVC - A (FVC Var=0.03L (0.5%); FEV1 Var=0.05L (1.1%))
	Post	FEV1 - A, FVC - A (FVC Var=0.01L (0.1%); FEV1 Var=0.09L (1.9%))
System Interpretation	Pre	Normal Spirometry
	Post	Normal Spirometry
Overall Syst. Interpret.	Significant pre - post change	





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Clinicians Comments

- No Contraindications identified. Procedure explained with demonstration.
- Medication: none disclosed. Indication: Pre-Employment Medical.
- Coaching required initially to improve technique and effort.
- Nose clip used Satisfactory technique and effort demonstrated.
- Abnormal Spirometry results indicative of mild obstructive patterning as indicative of ratio
- System interpretation was normal as ratio just >70%
- Using the LLN results <LLN = obstruction
- FEV1 Z score not reduced – indication is still to monitor as likely disease pattern will develop
- Percentage change is significant using the old equation and using the new ERS equation it is significant for FEV1 by 15% - exactly the same as older calculation.
- (5.07-4.40/4.51 x100= 14.85%)

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Why is SVC useful?

DYNAMIC COMPRESSION

1. Chronic inflammation → structural changes and narrowing
2. Destruction of alveolar walls ↓ support of small airways and decreases lung elastic recoil
3. Airways unable to remain open during expiration due to loss of elasticity causing the airways to collapse when forced exhalation occurs
4. Reason why it is good practice to perform a slow vc on obstructed patients

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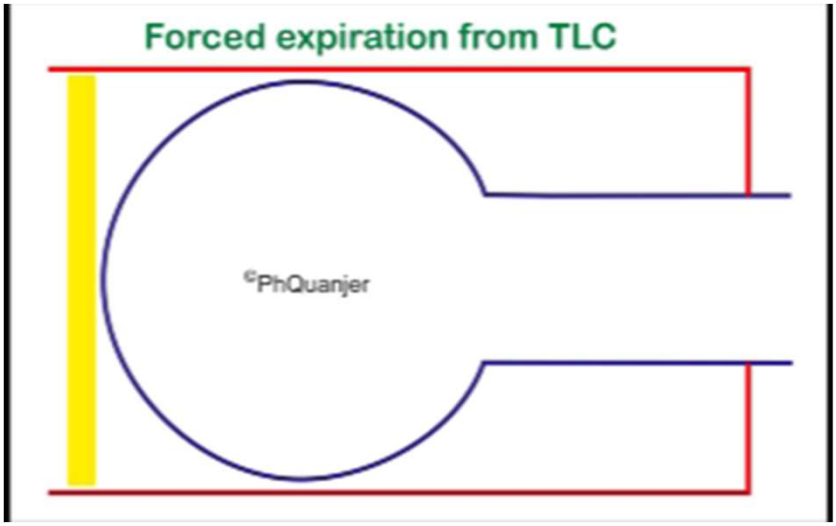
Dynamic Compression



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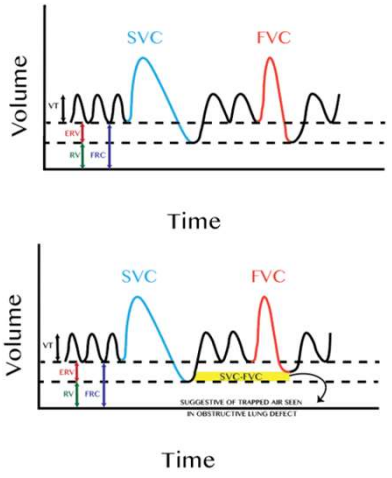
Slow Vital Capacity

- A maximum of 8
- Performed before FVC
- Stable baseline – at least three tidal breaths with end expiratory lung volume within 15% of the VT- should be achievable within 10 breaths
- Breath all the way out to RV and then take a deep breath in to TLC, and then breath normally
- Acceptability= difference between largest and next largest is>150ml or 10% VC whichever is smallest
- Largest value of three acceptable should be selected.



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Restrictive Lung Disease

- Shrunken triangular shape – Normal shape, steeper descent, due to reduced LV
- Observe the sharp point of the peak
- Reduced volume -inability to inflate the thorax, due to either a limitation of:
  - The neuromuscular apparatus
  - The chest wall, or
  - The lung tissue

Examples include:

- Interstitial lung disease such as Asbestosis
- Respiratory muscle weakness
- Thoracic cage deformities

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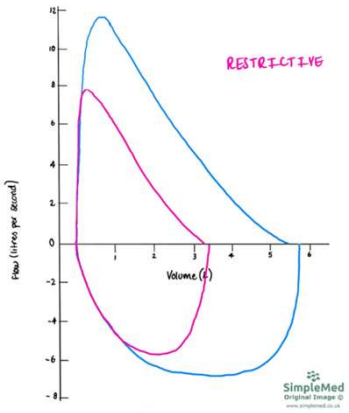
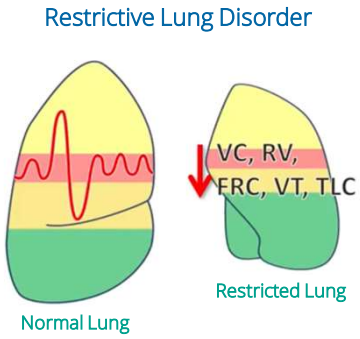
Restrictive Lung Disease





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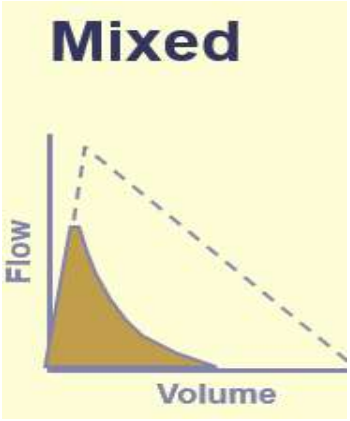
Mixed Lung Disease

- The mixed Obstructive and Restrictive Spirometry curve is characterised by:
  - Airflow obstruction
  - Loss of lung volume
- This defect is relatively uncommon.

  Examples:
  - Sarcoidosis
  - Cystic Fibrosis



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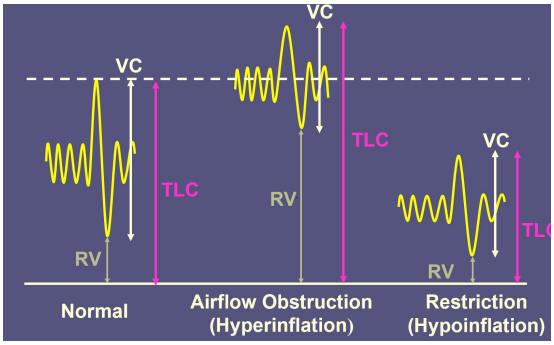
Summary of Lung Diseases

- Pleural Diseases include Pleural diseases include pleural effusion,
- Pleurisy, pneumothorax, hemothorax, and pleural tumors.



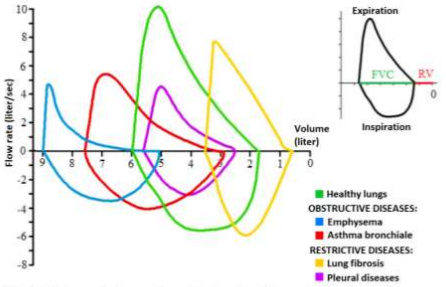


Fig. 2. Flow-Volume loop (output of the spirometry) showing *FVC* manoeuvre for healthy and diseased lungs [3].

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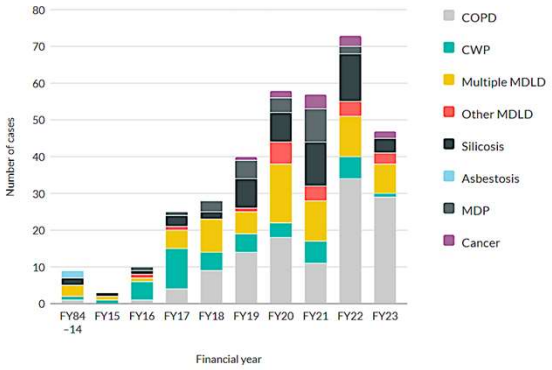
Cases of MDLD Reported to RSHQ

FIGURE 1:

Cases of MDLD reported to RSHQ for all mining since 1984 by financial year (current as at February 28, 2023).



https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-incidents-reports/mine-dust-lung-diseases

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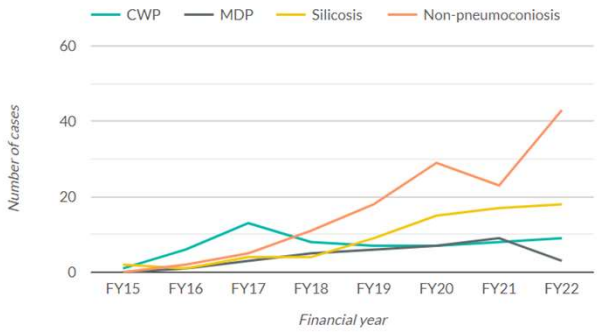
Cases of MDLD Reported to RSHQ

FIGURE 2:

Cases of MDLD reported to RSHQ for all mining industries since 2014-2015 by financial year and disease type (current as at February 28, 2023).



https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-incidents-reports/mine-dust-lung-diseases

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Coal Workers Pneumonoconiosis (CWP)

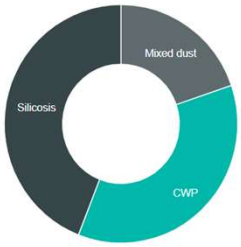
FIGURE 4:

Cases of pneumoconiosis reported to RSHQ for all mining, since 2014-2015 by financial year and disease type (current as at February 28, 2023.

- Prolonged Exposure → 10 years
- Cough, sputum production, SOB
- Early disease may be asymptomatic but still show findings on PFT's and X-ray
- Early detection is key!
- Good quality spirometry is key!

177

pneumoconiosis cases



Mine dust can lead to a range of pathological changes in the lungs. In general terms, the resulting lung changes can be divided into two groups; those which are fibrotic or nodular (example CWP, mixed dust pneumoconiosis and silicosis), and those which are non-nodular (example COPD and lung cancer). Due to being nodular in nature, CWP, mixed dust pneumoconiosis, and silicosis can be graded according to a scale of severity under the ILO classification.

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Silicosis Video

Caeserstone Benchtop

Silicosis Crisis

Feb 2023

60 minutes

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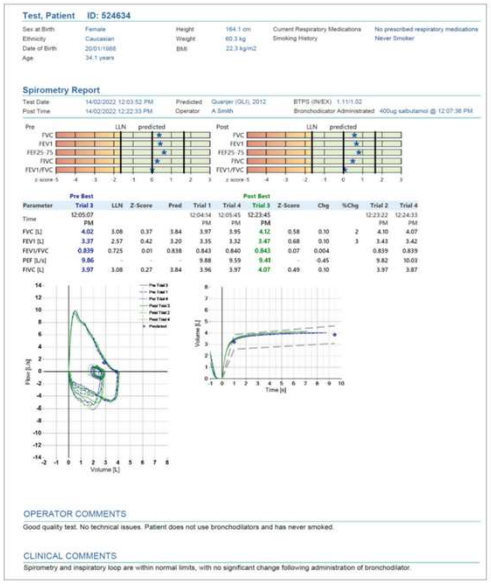
What should a report include?

- Client Demographics
- Test date and time
- Pictogram
- Z scores
- Reference Values
- Operator Comments
- Clinical Comments
- Pre and Post Test Data
- Bronchodilator information
- Comment on manually calculated BD response if software is using old calculation!



Sample report: Pre and post - bronchodilator spirometry report.

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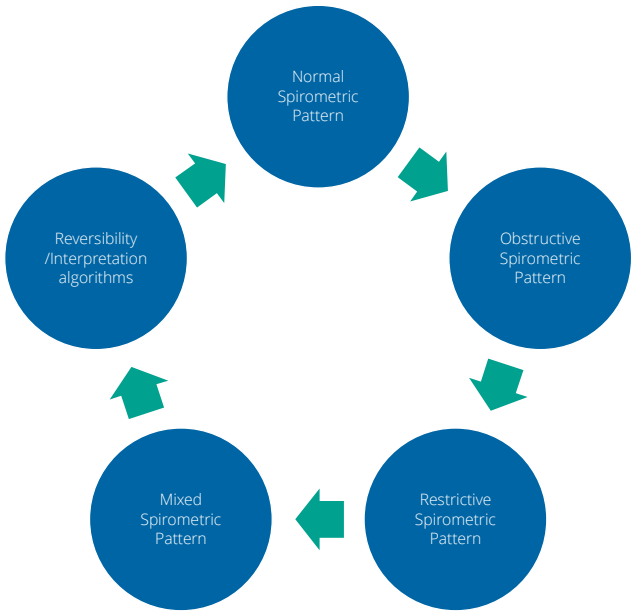
Learning Outcomes



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To maintain your competency in spirometry it is mandated by the TSANZ that you must record 100 spirometry tests in your log book prior to registering for the refresher course, in 12 months time. This is a pre-requisite for the refresher course

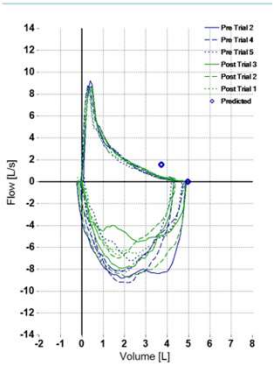
References/ Links

See last page of Learner Workbook

QUIZ

Actvity Case Study 1

- Male
- 73 year old smoker
- Hx of SOB
- Chest infections
- Cough
- x 2 hospital admissions



Sex at Birth	Male	Height	173 cm		Asthma	Yes	
Ethnicity	Caucasian	Weight	98 kg	BMI 32.7	COPD	No	
Smoker	Yes; 10 Cigarette(s) per Day; Years Smoking 15; (7 Pack Years)						

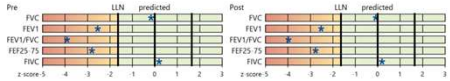
FVL (ex/in) — **Your FEV1 / Predicted: 68%** — **Your Lung Age: 37**

Test Date	31/01/2023 11:38:50 AM	Interpretation	GOLD(2008)/Hardie	BTPS (IN/EX)	1.12/1.02		
Post Time	31/01/2023 11:59:20 AM	Predicted	Quanjer (GLI), 2012				

	Pre							Post					
Parameter	Best	LLN	Z-Score	%Pred	Pred	Trial 2	Trial 4	Trial 5	Best	Z-Score	%Pred	Chg	%Chg	Trial 3	Trial 2	Trial 1
FVC [L]	4.86	3.96	-0.16	98	4.96	4.86	4.76	4.70	4.91	-0.08	99	0.05	1	4.91	4.89	4.85
FEV1 [L]	2.73*	3.20	-2.54	68	4.03	2.75*	2.69*	2.49*	2.76*	-2.52	68	0.01	0	2.76*	2.73*	2.61*
FEV1/FVC	0.566*	0.710	-3.91	-	0.815	0.566*	0.565*	0.529*	0.562*	-3.97	-	-0.004	-1	0.562*	0.558*	0.538*
FEF25-75 [L/s]	1.24*	2.38	-2.80	31	4.02	1.24*	1.11*	1.04*	1.27*	-2.76	32	0.04	3	1.27*	1.14*	1.13*
PEF [L/s]	9.26	-	-	-	-	9.26	8.89	8.80	8.83	-	-	-0.43	-5	8.74	8.83	8.41
FET [s]	15.7	-	-	-	-	15.7	16.0	15.6	15.9	-	-	0.2	1	15.9	16.8	15.2
FIVC [L]	5.08	3.96	0.20	102	4.96	5.08	4.79	4.58	5.08	0.20	102	0.00	0	5.05	5.08	4.75
PIF [L/s]	8.83	-	-	-	-	8.83	8.22	7.23	8.80	-	-	-0.04	0	5.48	8.80	6.72

* Indicates value outside normal range or significant post change.

Session Quality	Pre	FEV1 - A, FVC - A (FVC Var=0.10L (2.1%); FEV1 Var=0.06L (2.2%))
	Post	FEV1 - A, FVC - A (FVC Var=0.02L (0.5%); FEV1 Var=0.03L (1.2%))
System Interpretation	Pre	Moderate Obstruction
	Post	Moderate Obstruction



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Moderate COPD

with no bronchodilator response

- Concave shape
- Some overlap in FIVC loop but none greater than 5% larger than FVC
- FER ↓
- FEV1 ↓ = Obstruction
- FVC above the LLN (no gas trapping)
- Z score for FER is on the -3.97 line = Moderate
- Z score for FEV1 is -2.52 = moderate
- Smoker
- BD response FVC $\frac{4.91-4.86}{4.96} \times 100 = 1\%$ in FVC
- BD response FEV1 $\frac{2.76-2.75}{4.03} \times 100 = 0.2\%$ in FEV1

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Actvity Case Study 2

- Ex smoker
- no past history or respiratory problems
- 5 years of joint aches and morning stiffness
- recent chest x ray shows diffuse lung infiltrate
- referred for dyspnoea

Last Name:	**DEMO2**	Smoking Hx:	**Quit: 1990**
First Name:		Pack Year:	**20.0**
Site:	**Monash**	Height(cm):	**183.00**
Internal UR:		Weight(kg):	**80.60**
Date of test:	**22/02/2023 15:00**	BMI:	**24.07**
Sex:	**Male**	Physiologist:	**Theresa**
Birth Date:	**04/04/1945 (77)**	Physician:	**Dr M MacDonald**
Ethnicity:	**Caucasian**	Instrument:	**Jaeger MS B1**

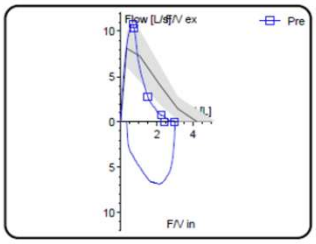
Referred By:

CC:

Clinical Notes:

Respiratory Function Report

Spirometry	LLN	Pre Baseline	Z-Score	%Pred
FEV1 (L)	2.19	2.42	-1.26	77
FVC (L)	3.08	2.97	-1.8	70
VC (L)	3.08	2.97	-1.8	70
FEV1/(F)VC	0.60	0.81	0.86	
FEF25-75% (L/s)	0.88	2.14	-0.07	97
PEF (L/s)	5.06	10.80	1.12	127
FET (s)		---		
FEF50:FIF50 (%)		---		



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Mild Restriction

- Smaller, steeper loop
- FEV1/FVC ratio 81% = ↑
- FVC ↓ = Restriction
- Z score for FVC -1.8 = Mild – But remember it is best to use body plethysmography to correctly diagnose a restrictive defect.
- Ex – Smoker
- TLC performed -64% pred confirming restriction
- Patient found to have fibrosing alveolitis associated with rheumatoid arthritis
- Supranormal flow rates due to increased traction on the airways from the scar tissue causing distension of the airways
- LV reduced because overall size of lungs is restricted by inflammatory and fibrotic scar tissue

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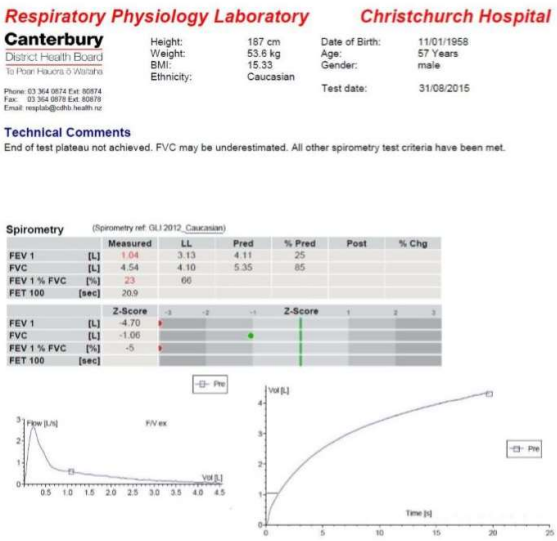
GLI interpretation Activity

Roger (57 years) has just been released from prison. He is coming to see you because he is short of breath walking up and down the local beach; he wonders if he has lost fitness during his time in prison.

Use coal miner's algorithm Pg.32
(coal miners algorithm removed in standards for resource sector workers – June 2021).



Respiratory Physiology Laboratory **Christchurch Hospital**

Canterbury District Health Board
Te Poari Hauora o Waitaha

Phone: 03 364 0674 Ext. 80874
Fax: 03 364 0879 Ext. 80879
Email: resplab@cdhb.health.nz

Height:	187 cm	Date of Birth:	11/01/1958
Weight:	53.6 kg	Age:	57 Years
BMI:	15.33	Gender:	male
Ethnicity:	Caucasian		
		Test date:	31/08/2015

Technical Comments

End of test plateau not achieved. FVC may be underestimated. All other spirometry test criteria have been met.

Spirometry (Spirometry ref: GLI 2012_Caucasian)

		Measured	LL	Pred	% Pred	Post	% Chg
FEV 1	[L]	1.04	3.13	4.11	25		
FVC	[L]	4.54	4.10	5.35	85		
FEV 1 % FVC	[%]	23	66				
FET 100	[sec]	20.9					

		Z-Score	-3 -2 -1 Z-Score 1 2 3
FEV 1	[L]	-4.70	
FVC	[L]	-1.06	
FEV 1 % FVC	[%]	-5	
FET 100	[sec]		

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QUESTION 1:
Equipment and space requirements

- A **dedicated space** to conduct the procedure with appropriate access and egress for a medical response in the event of an emergency is required.
- A **stable chair with arm rests** in which to seat the worker during the test is recommended over performing the test in a standing position.
- **Resuscitation equipment** must be readily accessible.
- A spirometer meeting ATS/ERS requirements
- **Single-use mouthpieces** incorporating bacterial/viral filters are preferred. Single-use one-way mouthpieces may be used. Single use nose clips are recommended.
- **Stadiometer and scales** for determining height and weight. These must be verified to be accurate annually.
- **Bronchodilator** inhaler and single-use spacer for bronchodilator responsiveness assessment (if required).
- **Appropriate system/s** to store raw spirometry data in line with applicable Australian Government requirements on data security and privacy. A printer may be required if hard copies of reports are being produced.
- A **3L calibration syringe** certified as being accurate to ATS/ERS specifications within the past 12 months
- Access to **local atmospheric conditions** (including temperature) as per the spirometer specifications on the day of testing

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QUESTION 2:

How would you ensure that your equipment is functioning properly prior to commencing the test?

- BTPS correction – have correct ambient conditions been entered?
- Biological QC
- Linearity Check

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QUESTION 3:

What other measures are taken prior to commencing spirometry?

- Consent and contraindications
- Take clients height and weight
- Explain and demonstrate test
- Check ethnicity
- Check if bronchodilator medications have been taken
- Ensure patient is in correct testing position

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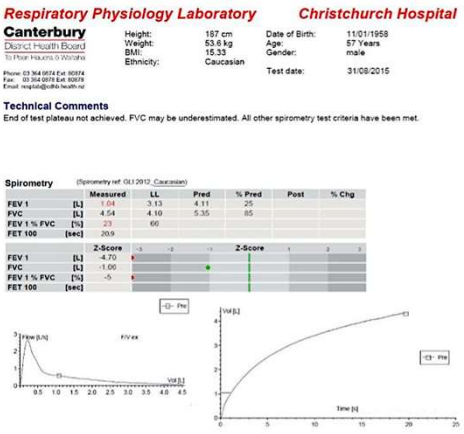
QUESTION 4:

What type of defect is represented in the report

The FEV1/FVC ratio of 1.04 is well below LLN of 3.13. Indicting a OBSTRUCTIVE DEFECT



Respiratory Physiology Laboratory ***Christchurch Hospital***

Canterbury District Health Board

Height:	187 cm	Date of Birth:	11/01/1958
Weight:	53.6 kg	Age:	57 Years
BMI:	15.33	Gender:	male
Ethnicity:	Caucasian	Test date:	31/08/2015

Technical Comments

End of test plateau not achieved. FVC may be underestimated. All other spirometry test criteria have been met.

Spirometry (Spirometry ref: GLI 2012_Caucasian)

		Measured	LL	Pred	% Pred	Post	% Chg
FEV 1	[L]	1.04	3.13	4.11	25		
FVC	[L]	4.54	4.10	5.35	85		
FEV 1 % FVC	[%]	23	66				
FET 100	[sec]	20.9					

		Z-Score	Z-Score
FEV 1	[L]	-4.70	
FVC	[L]	-1.06	
FEV 1 % FVC	[%]	-5	
FET 100	[sec]		

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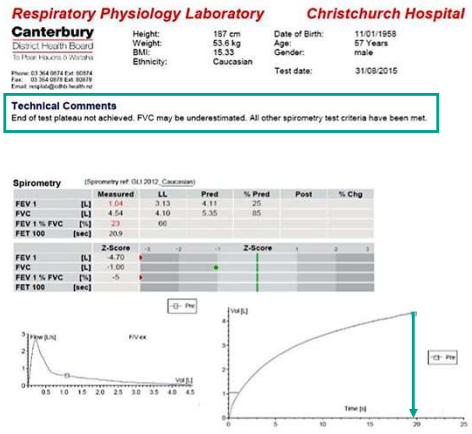
QUESTION 5:

Can you comment on the technical comments made. Will this make any difference to his result?

End of test plateau not met – but after 21 seconds of exhalation this is unlikely to make a clinical difference.



Respiratory Physiology Laboratory **Christchurch Hospital**

Canterbury District Health Board
Te Poari Hauora o Waitaha

Phone: 03 364 0674 Ext: 80674
Fax: 03 364 0676 Ext: 80676
Email: resplab@cdhb.health.nz

Height:	187 cm	Date of Birth:	11/01/1958
Weight:	53.6 kg	Age:	57 Years
BMI:	15.33	Gender:	male
Ethnicity:	Caucasian		
		Test date:	31/08/2015

Technical Comments
End of test plateau not achieved. FVC may be underestimated. All other spirometry test criteria have been met.

Spirometry (Spirometry ref: GLI 2012_Caucasian)

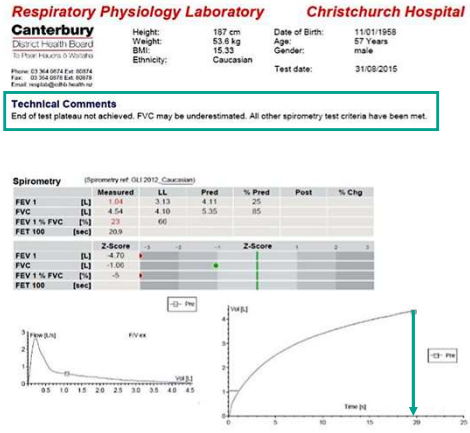
		Measured	LL	Pred	% Pred	Post	% Chg
FEV 1	[L]	1.04	3.13	4.11	25		
FVC	[L]	4.54	4.10	5.35	85		
FEV 1 % FVC	[%]	23	66				
FET 100	[sec]	20.9					

		Z-Score	-3 -2 -1 Z-Score 1 2 3
FEV 1	[L]	-4.70	
FVC	[L]	-1.06	
FEV 1 % FVC	[%]	-5	
FET 100	[sec]		

QUESTION 6:

Can you classify the disease defect using the following guideline?

FEV1/FVC ratio is reduced to 23 which is well below the LLN of 66% Z score of -5.
The FEV1 is 1.04 which is well below LLN of 3.13. Indicting an obstructive defect
Z SCORE OF -4.7 = SEVERE OBSTRUCTION



Respiratory Physiology Laboratory **Christchurch Hospital**

Canterbury District Health Board
Te Poari Hauora o Waitaha

Height:	187 cm	Date of Birth:	11/01/1958
Weight:	53.6 kg	Age:	57 Years
BMI:	15.33	Gender:	male
Ethnicity:	Caucasian	Test date:	31/08/2015

Technical Comments
End of test plateau not achieved. FVC may be underestimated. All other spirometry test criteria have been met.

Spirometry (Spirometry ref: GLI 2012_Caucasian)

		Measured	LL	Pred	% Pred	Post	% Chg
FEV 1	[L]	1.04	3.13	4.11	25		
FVC	[L]	4.54	4.10	5.35	85		
FEV 1 % FVC	[%]	23	66				
FET 100	[sec]	20.9					

		Z-Score	Z-Score
FEV 1	[L]	-4.70	
FVC	[L]	-1.06	
FEV 1 % FVC	[%]	-5	
FET 100	[sec]		

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QUESTION 7:

What other tests would be useful?

Post bronchodilator to determine if asthma or COPD.

Diffusion capacity to determine is damage to gas exchange tissue – especially if smoking is included in history

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Case Study 1

CASE HISTORY
Male
25 years, height 175 cm
Never smoked
No history of respiratory disease, cough in the morning
Normal chest x-ray
Referred for pre-employment lung function tests

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Case Study 1

Last Name: **DEMO6**
First Name:
Site: **Monash**
Internal UR:
Date of test: **09/03/2023 16:00**
Sex: **Male**
Birth Date: **30/03/2012 (10)**
Ethnicity: **Caucasian**

Smoking Hx: **non**
Pack Year:
Height(cm): **151.00**
Weight(kg): **41.20**
BMI: **18.07**
Physiologist: **Melissa**
Physician: **Dr D Mansfield**
Instrument: **Jaeger MS B1**

Monash Health
Lung Function Laboratory

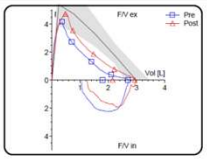
Referred By:

CC:

Clinical Notes: **Asthma**

Respiratory Function Report

Spirometry	LLN	Pre Baseline	Z-Score	%Pred	Post Post BD	Z-Score	%Pred	Chg	%Chg
FEV1 (L)	1.99	1.82	-2.24	75	2.18	-0.95	89	360 mL	15
FVC (L)	2.34	2.79	-0.27	97	2.95	0.22	102	160 mL	6
VC (L)	2.34	2.79	-0.27	97	2.95	0.22	102	160 mL	6
FEV1/(F)VC	0.75	0.65	-2.79		0.74	-1.76			
FEF25-75% (L/s)	1.82	1.06	-3.34	38	1.75	-1.78	64	0.69 L/s	25
PEF (L/s)	2.82	4.18	-0.82	76	4.72	-0.49	85	0.54 L/s	10
FET (s)		---			---				
FEF50:FIF50 (%)		---			---				



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Case Study 1: Interpretation

Interpretation: Obstructive ventilatory function

The concave shape of the loop indicates obstruction

Ratio is <LLN
FEV1 is <LLN
FEV1 Z score is -2.24= Mild classification

FEV1 % Change after BD is 15 % and is therefore significant.
Likely Asthma

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Case Study 2:
PART A

CASE HISTORY
Male
Caucasian
Non smoker
No significant history of respiratory disease other than occasional URTI and productive cough in morning
Attended GP for unrelated reason

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Case Study 2:
PART A

Last Name:	**DEMOS**	Smoking Hx:	**Never**
First Name:		Pack Year:	
Site:	**Monash**	Height(cm):	**145.70**
Internal UR:		Weight(kg):	**41.70**
Date of test:	**27/02/2023 11:45**	BMI:	**19.64**
Sex:	**Male**	Physiologist:	**Jess**
Birth Date:	**21/12/2012 (10)**	Physician:	**Dr M MacDonald**
Ethnicity:	**Caucasian**	Instrument:	**Jaeger MS B1**

Monash Health
Lung Function Laboratory

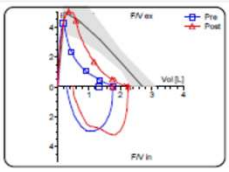
Referred By:

CC:

Clinical Notes:

Respiratory Function Report

Spirometry	LLN	Pre Baseline	Z-Score	%Pred	Post Post BD	Z-Score	%Pred	Chg	%Chg
FEV1 (L)	1.81	1.31	-3.59	59	1.73	-1.95	78	420 mL	19
FVC (L)	2.11	1.78	-2.76	68	2.31	-0.98	89	530 mL	20
VC (L)	2.11	1.78	-2.76	68	2.31	-0.98	89	530 mL	20
FEV1/(F)VC	0.75	0.74	-1.84		0.75	-1.67			
FEF25-75% (L/s)	1.66	0.96	-3.33	38	1.40	-2.22	56	0.44 L/s	17
PEF (L/s)	2.28	4.25	-0.45	85	5.01	0.01	100	0.76 L/s	15
FET (s)		---			---				
FEF50:FIF50 (%)		---			---				



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Case Study 2:
PART A
Interpretation

<Ratio below LLN
<FEV1 below LLN with a z score of -3.59 = Moderate
<FVC below LLN with z score of – 2.76 = Moderate
Indicating moderate obstruction with a reduced FVC
Is this gas trapping or true mixed picture?

This test is showing results using the new calculation
FVC BDR = 20%
FEV1 BDR = 19%
Significant response to BD is greater than 10%
FVC is above the LLN after BD and this therefore indicates gas trapping.
Moderate mixed pattern improving to a mild obstruction after significant response to BD, and release of gas trapping

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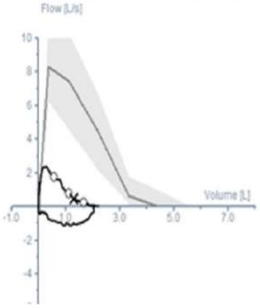
Case Study 2:
PART B

Q FEV1 A19		Pred	Pred LL	Best	%(Best/Pred)				
FEV1	L	3.33	2.39	1.3	39	1.19	1.3	1.25	1.19
FVC	L	4.44	3.28	2.22	50	2.07	2.22	2.09	2.01
FEV1%F	%	75.42	61.84	58.53	78	58.88	58.53	59.58	59.43
PEF	L/s	8.29	6.3	3.07	37	2.93	2.41	2.95	3.07
MMEF	L/s	2.46	1.05	0.61	25	0.51	0.61	0.48	0.4
Vbe%FV	%			1.63		1.48	1.63	2.47	2.31
VBEex	L			0.04		0.03	0.04	0.05	0.05
FVC IN	L			2.05		1.16	2.05	1.48	1.68



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Case Study 2:
PART B
Interpretation

<Ratio below LLN
<FEV1 below LLN
<FVC below LLN
No Z scores given
Indicating mixed pattern
Is this gas trapping or true mixed picture?

Mixed Pattern
Could have performed post BD to see if the reduced FVC is due to gas trapping (like in part a)
Lung volumes need to be completed to identify true restriction

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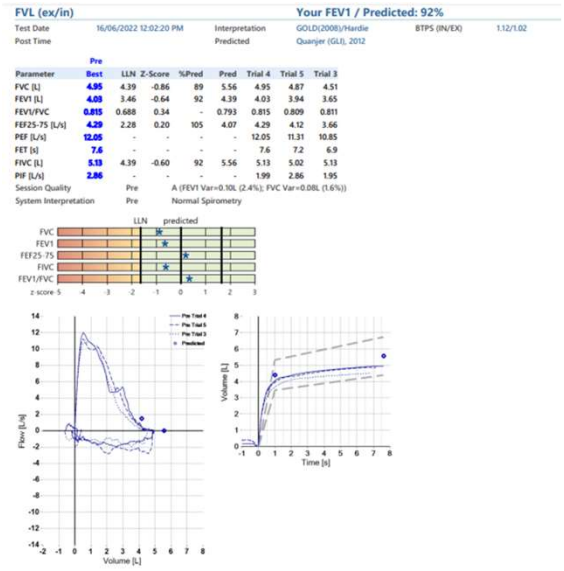
QUESTION 1:

Is this test acceptable?
What errors can you see?



FVL (ex/in) — Your FEV1 / Predicted: 92%

Test Date 16/06/2022 12:02:20 PM | Interpretation GOLD(2008)/Hardie | BTPS (IN/EX) 1.12/1.02
Post Time | Predicted Quanjer (GLI), 2012

Parameter	Pre Best	LLN	Z-Score	%Pred	Pred	Trial 4	Trial 5	Trial 3
FVC [L]	4.95	4.39	-0.86	89	5.56	4.95	4.87	4.51
FEV1 [L]	4.03	3.46	-0.64	92	4.39	4.03	3.94	3.65
FEV1/FVC	0.815	0.688	0.34	-	0.793	0.815	0.809	0.811
FEF25-75 [L/s]	4.29	2.28	0.20	105	4.07	4.29	4.12	3.66
PEF [L/s]	12.05	-	-	-	-	12.05	11.31	10.85
FET [s]	7.6	-	-	-	-	7.6	7.2	6.9
FIVC [L]	5.13	4.39	-0.60	92	5.56	5.13	5.02	5.13
PIF [L/s]	2.86	-	-	-	-	1.99	2.86	1.95
Session Quality		Pre	A (FEV1 Var=0.10L (2.4%); FVC Var=0.08L (1.6%))					
System Interpretation		Pre	Normal Spirometry					

Answer

Trial 4 - Interruption to flow

Trial 5 -Some inconsistency in flow

Trial 3 – Submaximal inspiration – values reduced

Not A Grade spirometry

More trials required

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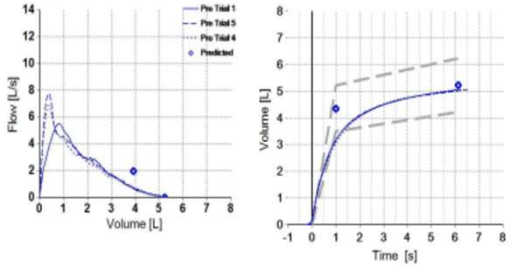
QUESTION 2:

Is this test acceptable?
What errors can you see?

Parameter	Pred	LLN	Best	Trial 1	Trial 5	Trial 4	%Pred
Time				2:41:37 PM	2:43:39 PM	2:43:22 PM	
FVC [L]	5.22	4.22	5.07	5.05	5.06	5.07	97
FEV1 [L]	4.36	3.49	3.16*	3.16*	3.15*	3.03*	73
FEV1/FVC [%]	83.8	72.5	62.4*	62.6*	62.2*	59.8*	74
FEF25-75 [L/s]	4.56	2.88	1.91*	1.91*	1.91*	1.78*	42
PEF [L/s]	-	-	7.81	5.51	7.81	6.88	-
FET [s]	-	-	6.1	6.1	6.5	6.4	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	A (FEV1 Var=0.01L (0.4%); FVC Var=0.01L (0.1%))
System Interpretation	Pre	Moderate Obstruction



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Answer

Trial 4 - Good trial

Trial 5 - Good trial

Trial 3 – Slow Start

Best trial selected as trial 1 even though the PEF is the worst

More trials required

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QUESTION 3:

What disease pattern does this test show?
Classify the Severity?

Last Name:	DEMO2	Smoking Hx:	Quit: 1990
First Name:		Pack Year:	20.0
Site:	Monash	Height(cm):	183.00
Internal UR:		Weight(kg):	80.60
Date of test:	22/02/2023 15:00	BMI:	24.07
Sex:	Male	Physiologist:	Theresa
Birth Date:	04/04/1945 (77)	Physician:	Dr M MacDonald
Ethnicity:	Caucasian	Instrument:	Jaeger MS B1

Monash Health
Lung Function Laboratory

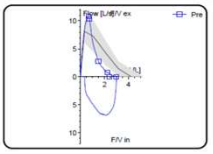
Referred By:

CC:

Clinical Notes:

Respiratory Function Report

Spirometry	LLN	Pre Baseline	Z-Score	%Pred
FEV1 (L)	2.19	2.42	-1.26	77
FVC (L)	3.08	2.97	-1.8	70
VC (L)	3.08	2.97	-1.8	70
FEV1/(F)VC	0.60	0.81	0.86	
FEF25-75% (L/s)	0.88	2.14	-0.07	97
PEF (L/s)	5.06	10.80	1.12	127
FET (s)		---		
FEF50:FIF50 (%)		---		



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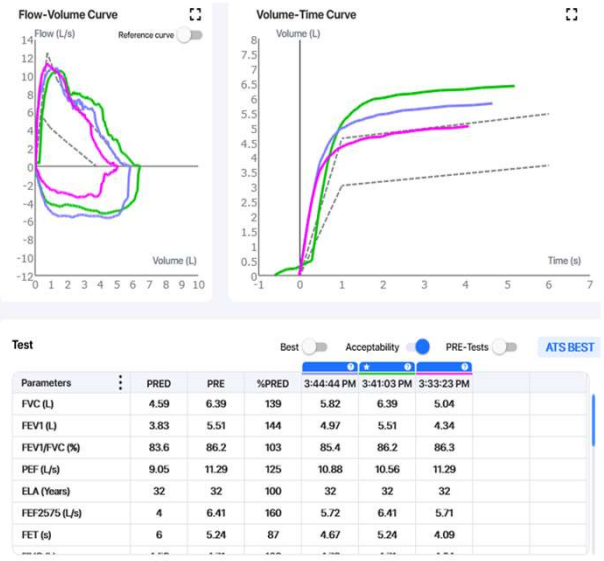
Answer

FVC and VC	
FEV1/FVC ratio	
Classic restrictive pattern, note how the loop drops off quickly as restrictive cases can empty quickly. Flow is not limited, only volume	
Lung volumes are more accurate at classifying severity in restriction	
Further investigation with lung volumes and chest x ray is warranted	

QUESTION 4:

Is this test acceptable?
What errors can you see?



Test

Best | Acceptability | PRE-Tests | ATS BEST

Parameters	PRED	PRE	%PRED	3:44:44 PM	3:41:03 PM	3:33:23 PM
FVC (L)	4.59	6.39	139	5.82	6.39	5.04
FEV1 (L)	3.83	5.51	144	4.97	5.51	4.34
FEV1/FVC (%)	83.6	86.2	103	85.4	86.2	86.3
PEF (L/s)	9.05	11.29	125	10.88	10.56	11.29
ELA (Years)	32	32	100	32	32	32
FEF2575 (L/s)	4	6.41	160	5.72	6.41	5.71
FET (s)	6	5.24	87	4.67	5.24	4.09

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Answer

Green trial could have a hesitation at the start

Purple and pink trials appear to have a submaximal inhalation, and that is why you are getting variable values, especially for the pink trial - Encourage more on the breath in

ATS standards where not met.
FEV1 variability – 540 ml - Not met due to submaximal inspiration
FVC variability – 570ml – Not met due to submaximal inspiration

1 acceptable trial. Repeatability criteria not mt due to submaximal inspiration. ATS standards not met and therefore test should be interrupted with care

However, the one acceptable trial appears to show normal spirometry.

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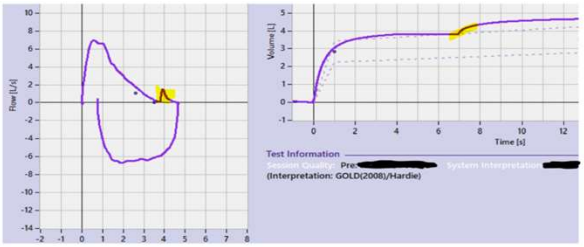
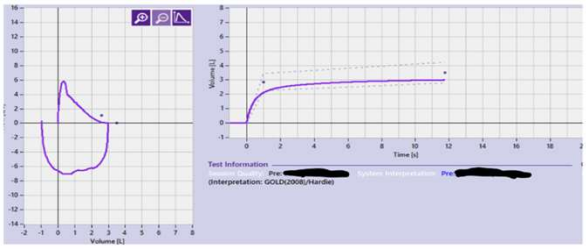
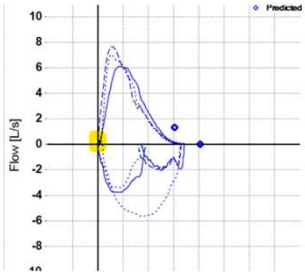
What errors do you see?







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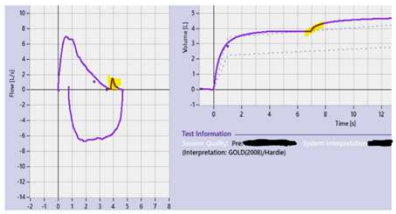
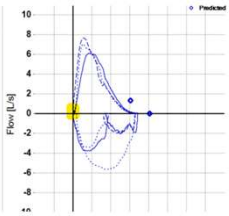
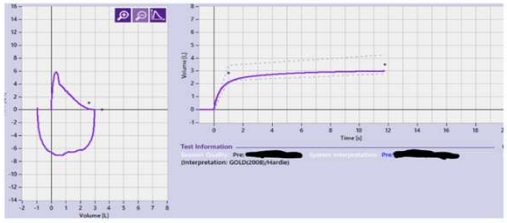
What errors do you see?



Extra breath – will increase the FVC



Slow start – will affect the FEV1



Submaximal Inspiration – will underestimate all values

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Criteria not met

An **acceptable** manoeuvre must be achieved at least three times and is acceptable only if it **achieves all** of the following acceptability criteria[2]:

- 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, FIVC must not be >=0.10L or >5% of FVC, whichever is greater.

A testing session is deemed to be **repeatable** if the following is achieved[2]:

- ≥ 2 acceptable FVC values are within 0.15L of each other; and
- ≥ 2 acceptable FEV_1 values are within 0.15L of each other.

Operators are encouraged to obtain at least three acceptable and repeatable efforts where possible to maximise the confidence in the final result.

Operators must work to achieve a minimum quality grade of B or higher for FEV_1 and FVC (see below). Spirometry efforts of lower quality must be noted.

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- 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.
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KINNECT | TRAINING

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- 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.
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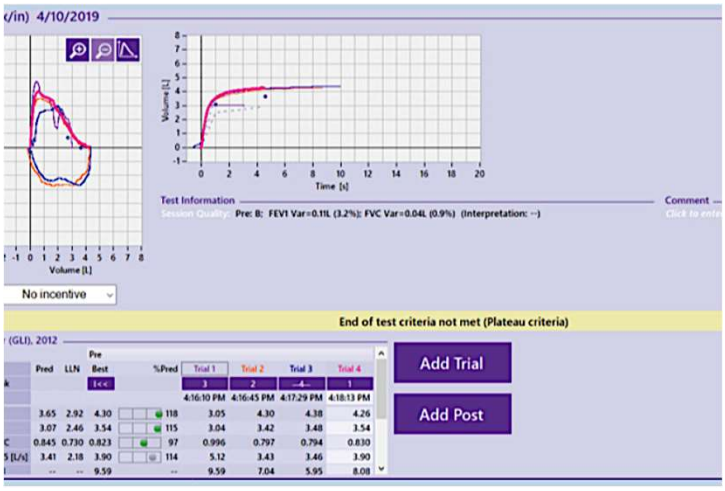
Post Course Submission

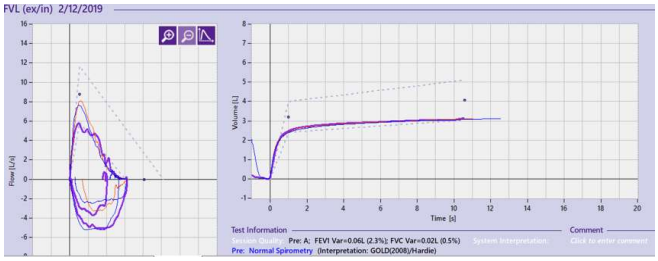
- 10 spirometry tests
- De-identified
- Best three loops to be shown
- Data for best three test
- 1 month to submit unless extension requested
- KinnectTrainingResources

Is this test acceptable and reproducible?



PCS Example 1

Test quality A, but FEV1 taken from loop with submaximal expiration



	Pre						
	Pred	LLN	Best		%Pred	Trial 1	Trial 2	Trial 3
Trial Rank			I<<			1	2	3
Time						7:39:55 AM	7:42:58 AM	7:44:37 AM
FVC [L]	4.06	3.03	3.13		77	3.13	3.12	3.10
FEV1 [L]	3.19	2.39	2.48		78	2.48	2.42	2.39
FEV1/FVC	0.800	0.722	0.791		99	0.791	0.777	0.771
FEF25-75 [L/s]	3.21	2.12	2.52		79	2.52	2.09	2.02
PEF [L/s]	8.75	5.85	8.09		92	5.82	8.09	7.65

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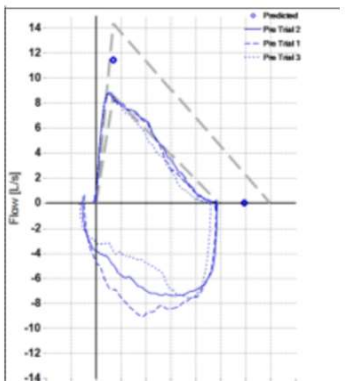
Has this patient true restriction?



Patient Information

Name	[redacted]
ID	#0054
Age	23 (30/09/1997)
Height	183 cm
Weight	153 kg BMI 45.7
Gender	Male
Ethnicity	Caucasian
Smoker	No

Test Information

Test Type	
Test Date	
Post Time	
Interpretation	
Predicted	
Value Selection	
BTPS (IN/EX)	

Test Result

Your FEV1 / Predicted: 80%

Parameter	Pred	LLN	Pre Best	Trial 2	Trial 1	Trial 3	%Pred
FVC [L]	5.93	4.90	4.87*	4.87*	4.85*	4.60*	82
FEV1 [L]	4.99	4.19	3.97*	3.97*	3.89*	3.65*	80
FEV1/FVC	0.848	0.770	0.816	0.816	0.803	0.793	96
FEF25-75% [L/s]	5.00	4.82	4.15*	4.15*	3.76*	3.47*	83
PEF [L/s]	11.49	8.59	8.87	8.87	8.77	8.83	77
FET [s]	-	-	7.9	7.9	8.6	11.0	-
FIVC [L]	5.93	4.90	5.38	5.38	5.28	5.24	91
PIF [L/s]	-	-	9.02	7.40	9.02	7.57	-
Session Quality			Pre	A (FEV1 Var=0.08L (2.0%); FVC Var=0.02L (0.3%))			
System Interpretation			Pre	Restriction probable; further examination recommended			

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Is this patient restricted?

Gender	Male	Height	165.5 cm	COPD	--
Ethnicity	Asian	Weight	62 kg	BMI 22.6	
Smoker	No				

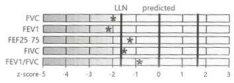
FVL (ex/in) — **Your FEV1 / Predicted: 72%**

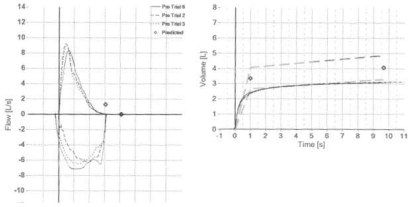
Test Date	17/11/2021 1:28:21 PM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time		Predicted	Quanjer (GLI), 2012 * 1.00	BTPS (IN/EX)	1.11/1.02

Parameter	Pred	LLN	Pre Best	Trial 6	Trial 2	Trial 3	%Pred	Z-Score
FVC [L]	4.06	3.27	3.11*	3.05*	3.11*	3.07*	77	-1.97
FEV1 [L]	3.35	2.64	2.41*	2.41*	2.34*	2.33*	72	-2.18
FEV1/FVC	0.824	0.727	0.776	0.790	0.751	0.758	94	-0.82
FEF25-75 [L/s]	3.44	1.99	2.33	2.33	1.74*	1.79*	68	-1.25
PEF [L/s]	-	-	9.26	8.31	9.26	9.02	-	-
FET [s]	-	-	9.6	9.6	11.0	10.3	-	-
FIVC [L]	4.06	3.27	3.34	3.27*	3.10*	3.34	82	-1.51
PIF [L/s]	-	-	7.17	7.17	6.27	6.49	-	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	A (FEV1 Var=0.08L (3.1%); FVC Var=0.04L (1.4%))
System Interpretation	Pre	Restriction probable; further examination recommended





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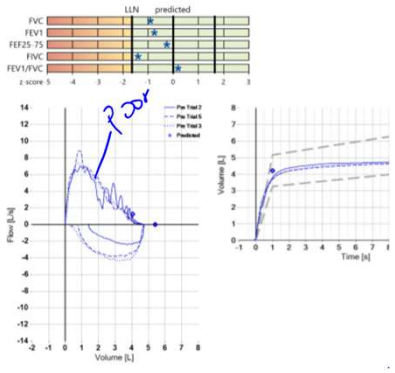
Poor PEF – Spirometer selects wrong FEV1!

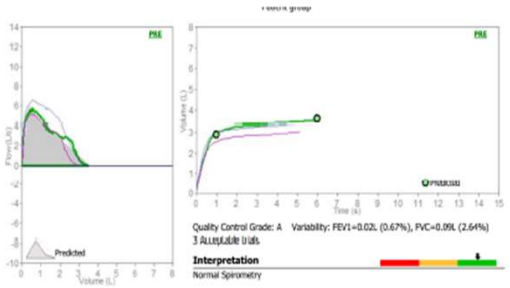
Parameter	Pred	LLN	Best	Trial 4	Trial 5	Trial 3	%Pred
FVC [L]	5.40	4.20	4.75	4.75	4.72	4.66	88
FEV1 [L]	4.21	3.26	3.78	3.78	3.68	3.69	90
FEV1/FVC	0.782	0.671	0.796	0.796	0.779	0.791	102
FEF25-75 [L/s]	3.67	1.94	3.41	3.41	3.15	3.45	93
PEF [L/s]	-	-	8.90	7.00	8.90	7.46	-
FET [s]	-	-	10.2	10.2	12.6	9.1	-
FIVC [L]	5.40	4.20	4.38	3.31*	3.95*	4.38	81
PIF [L/s]	-	-	4.38	2.41	3.84	4.38	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	A (FEV1 Var=0.09L (2.4%); FVC Var=0.02L (0.4%))
System Interpretation	Pre	Normal Spirometry



Thoughts?



Visit date 29/01/2020

Patient code	39198	Age	43
Surname	[redacted]	Gender	Female
Name		Height, cm	162
Date of birth	28/02/1976	Weight, kg	61
Ethnic group	Caucasian	BMI	23.24
Smoke	No smoker	Pack-Year	
Patient group			

PRE Trial date 29/01/2020 1:29:56 PM

Parameters		LLN	Pred	Best	%Pred	Z-score	PRE # 1	PRE # 2	PRE # 3	POST	%Pred	%Chg
FEV1	L	2.29	2.90	3.01*	104	0.32	2.61	2.99	3.01	*		
FVC	L	2.83	3.57	3.50*	98	-0.16	3.01	3.50	3.41	*		
FEV1/FVC	%	70.5	81.5	86.0*	106	0.78	86.7	85.4	88.3	*		
PEF	L/s	3.46	6.11	6.65*	109	0.34	5.17	5.81	6.65	*		
EVA	Years		43	43	100		55	43	43			
FEF25/75	L/s	1.77	2.99	3.31	111	0.37	3.40	3.31	4.30			
FET	s		6.00	6.06	101		5.12	6.06	5.06			
FIVC	L	2.83	3.57									
FEV1/VC	%	70.5	81.5									

*Best values from all loops - BTPS 1.097 24 °C (75.2 °F) - Predicted GLI Caucasian

Conclusion / Medical report

5 ACCEPTABLE TRIALS COMPLETE. UNABLE TO REACH 6 SECOND MINIMUM EXAHLE. ADMIN WORKER.

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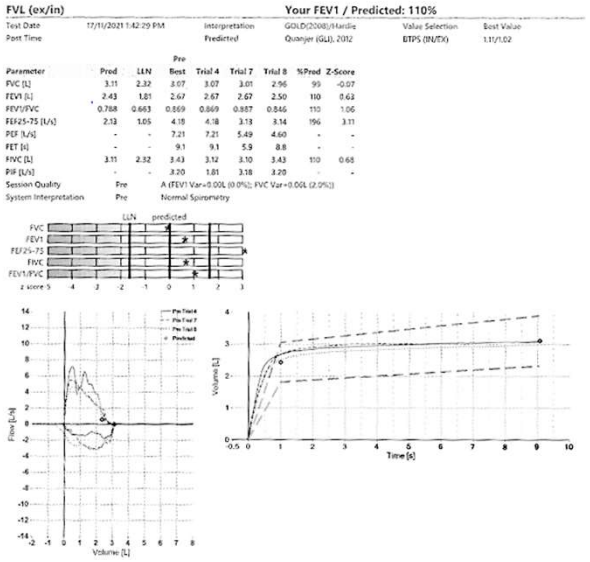
Don’t trust your spirometer –is this A grade?



FVL (ex/in) — Your FEV1 / Predicted: 110%

Test Date	17/11/2021 1:42:29 PM		Interpretation	GOLD(2008)/Hardie		Value Selection	Best Value	
Post Time			Predicted	Quanjer (GLI), 2012		BTPS (IN/EX)	1.11/1.02	
Parameter	Pred	LLN	Pre Best	Trial 4	Trial 7	Trial 8	%Pred	Z-Score
FVC [L]	3.11	2.32	3.07	3.07	3.01	2.96	99	-0.07
FEV1 [L]	2.43	1.81	2.67	2.67	2.67	2.50	110	0.62
FEV1/FVC	0.768	0.663	0.869	0.869	0.887	0.846	113	1.06
FEF25-75 [L/s]	2.13	1.05	4.18	4.18	3.73	3.14	196	3.11
PEF [L/s]	-	-	7.21	7.21	5.49	4.60	-	-
FET [s]	-	-	9.1	9.1	5.9	8.8	-	-
FIVC [L]	3.11	2.32	3.43	3.12	3.10	3.43	110	0.65
PIF [L/s]	-	-	3.20	1.81	3.18	3.20	-	-
Session Quality	Pre		A (FEV1 Var=0.00L (0.0%); FVC Var=0.00L (2.0%))					
System Interpretation	Pre		Normal Spirometry					

Test Issues

- Predicted equation should be GLI not Gore Crockett
- B grade more trials could have been attempted. Trial 3 does not meet FIVC acceptability criteria
- Session quality should be graded separately as per ATS standards 2019
- Interpretation is mild obstruction as ratio is <LLN. However note this is more than likely due to the very large VC. The FEV1 is above LLN and 90% predicted is lung function normal in spite of the ratio being <LLN

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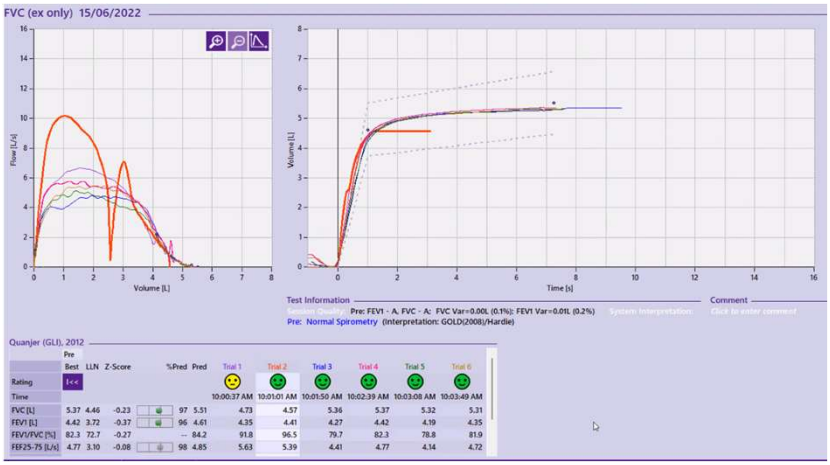
A grade spirometry???



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Feedback

Please evaluate this session to help us improve.

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Congratulations!

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