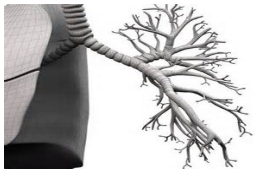

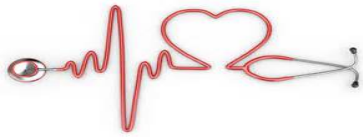

# APLEY MEDICAL LIMITED


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## PULMONARY FUNCTION TEST
## VS
## SPIROMETRY

VS

# SPIROMETRY

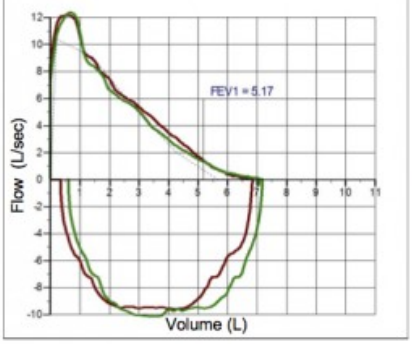
**Morgan Scientific, Inc.**
**Pulmonary Function Testing**
**151 Essex Street Haverhill, MA 01845** **Phone: (978) 521-4440**

**Name: Patrick F. Morgan** **ID: 008** **Test date/time: 4/2/2015 1:20:17 PM**
Height at test: 75 in Weight at test: 224 lb Sex: M Birthdate: 16-Nov-54 Age at test: 60
BMI at test: 28.1 Smoking history (pk-yrs): N/A Ethnic group: W
Physician: Colin B. Chapman, M.D. Estimated Lung Age: N/A Technician: Patrick Morgan
ICD-10: ( ) Referring Physician:
Predicted set: Riley Predicted Set

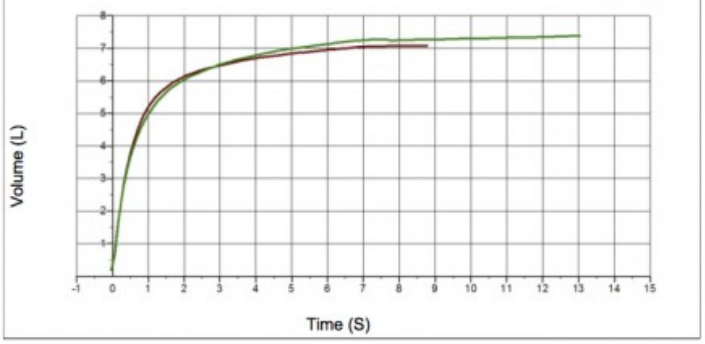
ATS ✔ ✔ Bronchodilator Agent:
Administration Time:

| Expiratory Results: | | Pred | LLN | BEST | %Pred | BEST | % Pred | % Chg | Abs. |
|---|---|---|---|---|---|---|---|---|---|
| StartTime | | ---- | ---- | **13:22** | ---- | **13:31** | ---- | -- | ---- |
| FVC | L | 5.67 | 4.59 | **7.39** | 130 | **7.09** | 125 | -4% | -295 mL |
| FEV.5 | L | 3.29 | 2.16 | **3.78** | 115 | **3.79** | 115 | 0% | 4 mL |
| $FEV_1$ | L | 4.28 | 3.37 | **5.17** | 121 | **5.21** | 122 | 1% | 46 mL |
| $FEV_1$ / FVC | % | 76 | 66 | **70** | 92 | **73** | 96 | 4% | ---- |
| $FEF_{25-75}$ [ISO] | L/s | 3.46 | 1.62 | **3.06** | 88 | **3.54** | 102 | 16% | 476 mL |
| $FEF_{50}$ / $FIF_{50}$ | | ---- | ---- | **0.38** | ---- | **0.51** | ---- | 34% | 126 mL |
| PEFR | L/s | 10.41 | 7.74 | **12.51** | 120 | **12.21** | 117 | -2% | -0.30 L/s |
| FET | sec | ---- | ---- | **13.04** | ---- | **8.79** | ---- | -33% | ---- |
| Back Volume | | ---- | ---- | **0.14** | ---- | **0.10** | ---- | -- | ---- |

**FVC Flow vs. Volume (Best Pre vs Post)**




**FVC Volume vs. Time (Best Pre vs Best Post)**




**Impression:**
FEV1 is within normal range. No obstruction present. No restrictive defect present. Normal RV/TLC ratio; no air trapping present. Diffusing capacity appears normal. No significant response to bronchodilator. Best pre-bronchodilator results of the past 12 months included FVC of 130% and FEV1 of 121% on 11/17/2014. Best post-bronchodilator results of the past 12 months included FVC of 130% and FEV1 of 125% on 11/26/2014.

**Spirometry is a simple test used to help diagnose and monitor certain lung conditions by measuring how much air you can breathe out in one forced breath.**

It's carried out using a device called a spirometer, which is a small machine attached by a cable to a mouthpiece.

Spirometry may be performed by a nurse or doctor at your GP surgery, or it may be carried out during a short visit to a hospital or clinic.

## Why spirometry is carried out

Spirometry can be used to help diagnose a lung condition if you have symptoms of a problem, or your doctor feels you're at an increased risk of developing a particular lung condition.

For example, it may be recommended if you have a persistent cough or breathlessness,

or if you're over 35 and smoke.

Conditions that can be picked up and monitored using spirometry include:

- **asthma** – a long-term condition in which the airways become periodically inflamed (swollen) and narrowed
- **chronic obstructive pulmonary disease (COPD)** – a group of lung conditions where the airways become narrowed

If you've already been diagnosed with one of these conditions, spirometry may be carried out to check the severity of the condition or see how you're responding to treatment.

# FULL PULMONARY FUNCTION TEST

Pulmonary Function testing measures the function of lung capacity and lung and chest wall mechanics to determine whether or not the patient has a lung problem. Pulmonary Function Tests are commonly referred to as "PFTs". When a patient is referred for PFT's, it means that a battery of tests may be carried-out including: simple screening spirometry, static lung volume measurement, diffusing capacity for carbon monoxide, airways resistance, respiratory muscle strength and arterial blood gases.

Pulmonary Function Tests are used for the following reasons:

1. Screening for the presence of obstructive and restrictive diseases

2. Evaluating the patient prior to surgery - this is especially true of patients who:

a. are older than 60-65 years of age

b. are known to have pulmonary disease

c. are obese (as in pathologically obese)

d. have a history of smoking, cough or wheezing

e. will be under anesthesia for a lengthy period of time

f. are undergoing an abdominal or a thoracic operation

1. Evaluating the patient's condition for weaning from a ventilator. If the patient on a ventilator can demonstrate a vital capacity (VC) of 10 - 15 ml/Kg of body weight, it is generally thought that there is enough ventilatory reserve to permit (try) weaning and extubation.

2. Documenting the progression of pulmonary disease - restrictive or obstructive

3. Documenting the effectiveness of therapeutic intervention

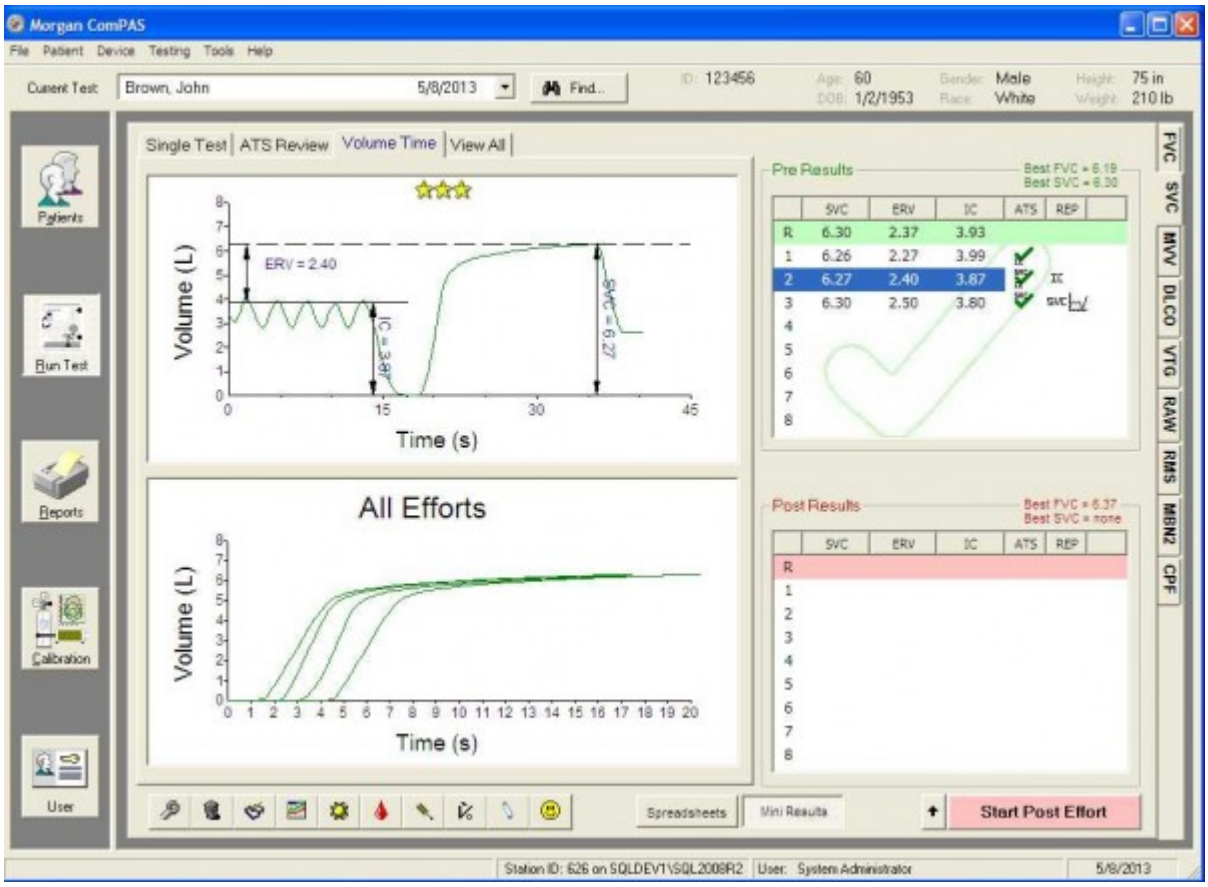
# Static Spirometry (SVC)

Slow Vital Capacity was arguably the first ever recorded lung volume. The full excursion of the maneuver gives a measure of the change in volume of gas in the lungs from complete inspiration to complete expiration or vice versa.

The measurement begins with the subject quietly breathing in a steady-state condition followed by a maximal breath-in and a full breath-out.

The spirogram of a slow vital capacity maneuver has several key identifying components:

- Slow Vital Capacity (SVC)
- Expiratory Reserve Volume (ERV)
- Inspiratory Capacity (IC). Called a capacity because it is the sum of two lung volumes: IC = IRV+TV



# Dynamic Spirometry (FVC)

Although the most widely utilized pulmonary test, it is commonly the most poorly administered and reported.

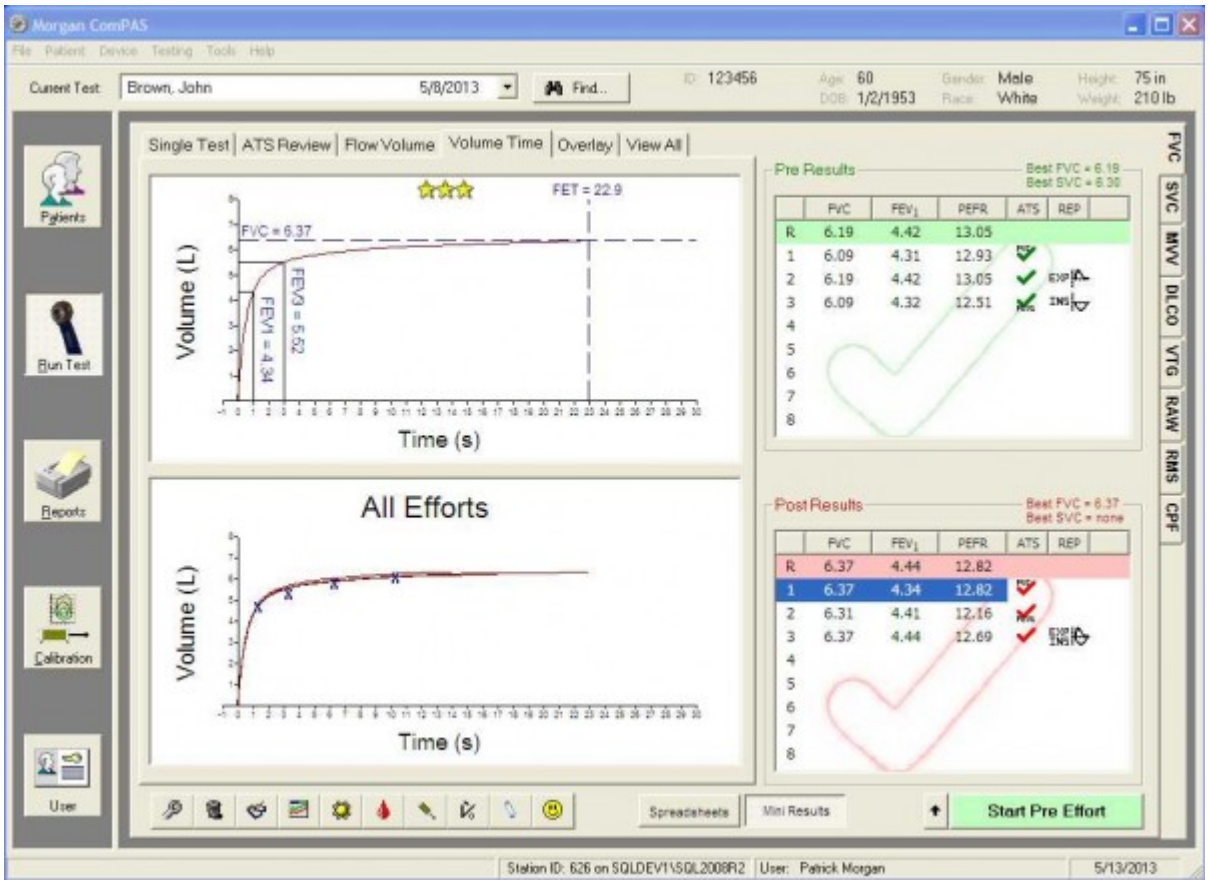
Through clever use of interactive help and clinical monitoring, ComPAS provides excellence in spirometry.

Flow Volume efforts can be completed in any order of breathing with full fidelity of the loop captured and stored.

For reports, data is automatically selected by ATS criteria; however, the user can override both data and loop selection if desired.

The spirogram of a forced vital capacity maneuver has several key identifying components:

- Forced Vital Capacity (FVC)
- Forced Expired Volume in one second (FEV1)
- FEV1/FVC (FEV1/FVC)

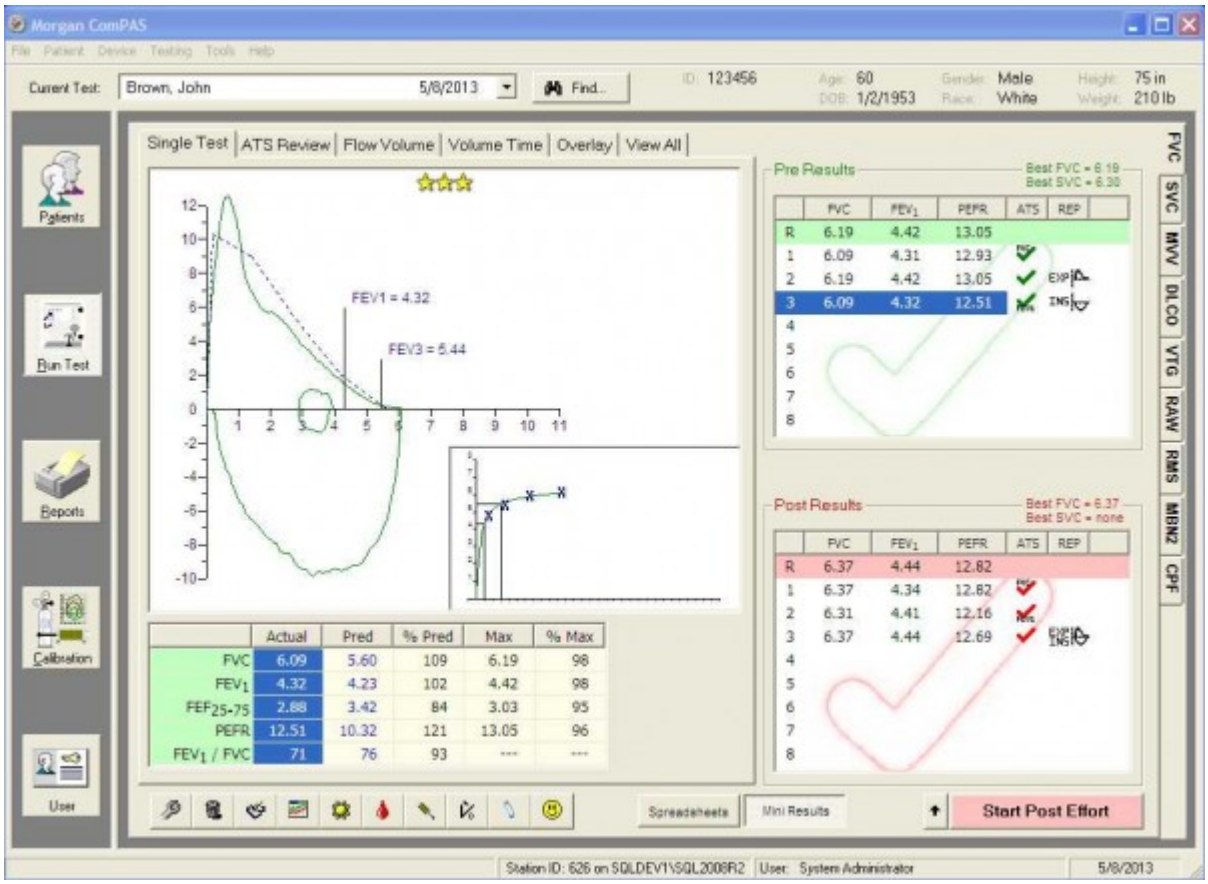


# Flow Volume Loops

The forced volume excursion when plotted against flow rate reveals perhaps the most recognizable shape in pulmonary function testing. There are many measurements that can be taken from this single dynamic effort:

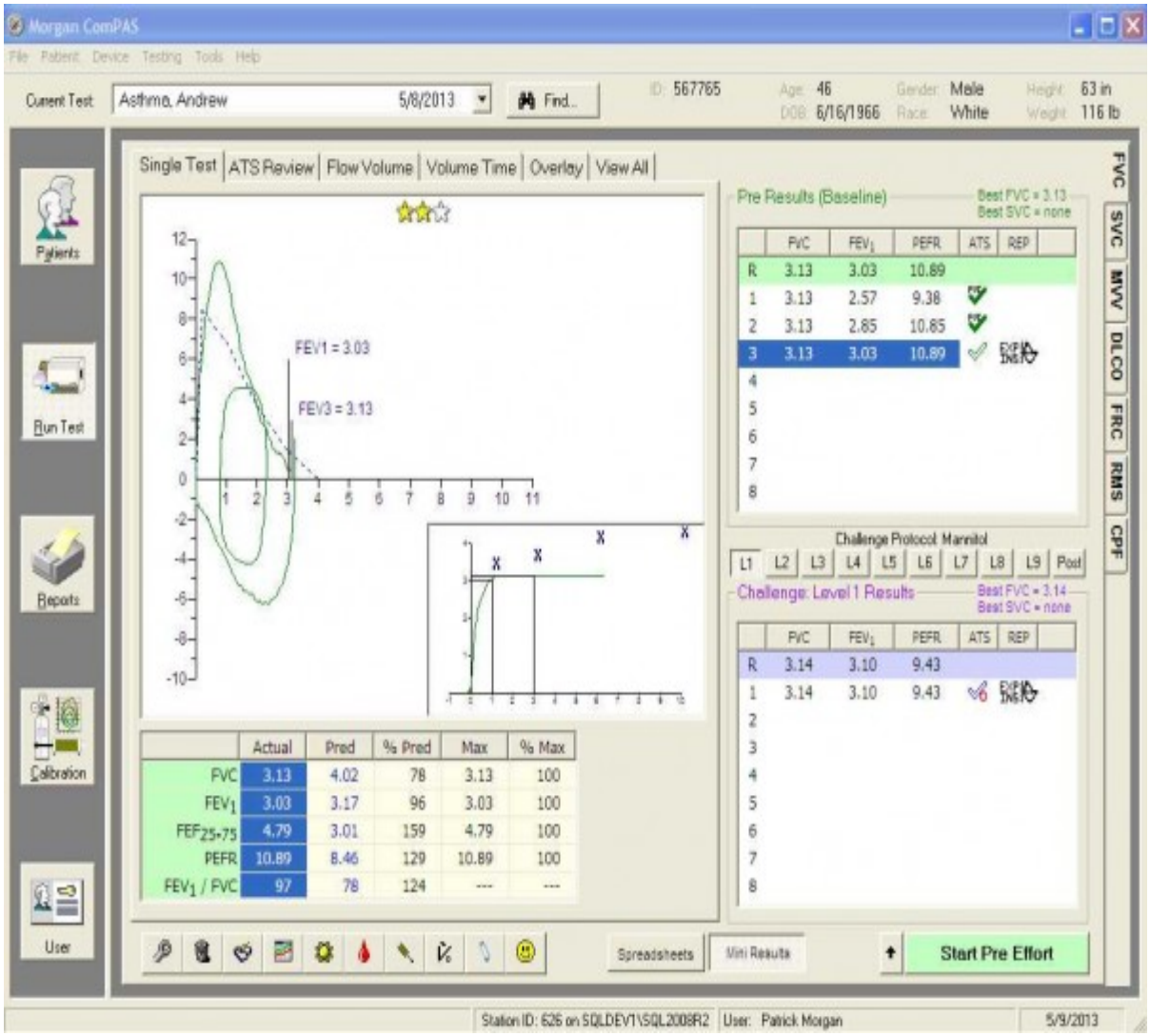
Identifying Measurements on the Flow Volume Loop

- Peak Expiratory Flow Rate (PEFR)
- Forced Expiratory Volume after 0.5 seconds (FEV0.5)
- Forced Expiratory Volume after 1 second (FEV1)
- Forced Expiratory Volume after 3 seconds (FEV3)
- Forced Expiratory Volume after 6 seconds (FEV6)
- Forced Vital Capacity (FVC)
- Forced Expiratory Flow at 25% of FVC (FEF25)
- Forced Expiratory Flow at 50% of FVC (FEF50)
- Forced Expiratory Flow at 75% of FVC (FEF75)
- Forced Expiratory Flow 25– 75%  of FVC (FEF25-75)
- Forced Expiratory Flow at 25% of FVC iso-volume (FEF25_iso)
- Forced Expiratory Flow at 50% of FVC iso-volume (FEF50_iso)
- Forced Expiratory Flow at 75% of FVC iso-volume (FEF75_iso)
- Forced Expiratory Flow 25– 75%  of FVC iso-volume (FEF25-75_iso)
- Forced Inspiratory Flow at 25% of FVC (FIF25)
- Peak Inspiratory Flow Rate (PIFR)
- Forced Inspiratory Flow at 50% of FVC (FIF50)
- Forced Inspiratory Flow at 75% of FVC (FIF75)
- And many more…



# Bronchial Challenge

Bronchial challenge testing is highly versatile and performed with ease in ComPAS. The challenge options support  methacholine, Aridol, Exercise and Cold Air. The challenge protocols can be easily designed to suit any range of procedures and from the protocol the test is calmly sequenced through each level with clear and straightforward displays. Never before has provocation testing been so beautifully designed and easy to accomplish!



# Maximum Voluntary Ventilation

The volume of gas that can be breathed in 15 seconds when a person breathes as deeply and quickly as possible. The result is extrapolated from 15 seconds to show what could be achieved over one minute. At the best of times, the MVV can be a difficult test to assess in terms of patient effort and compliance. To help determine effort, each time an MVV is performed in ComPAS, the data are compared to the subject's FEV1 x 35 and FEV1 x 40.

# Single Breath Diffusion

Since the pioneering days when the test was first developed in England, testing of Single Breath Diffusion (DLCO) has been part of our heritage. Our excellence for DLCO testing and reproducibility comes from a studied application of measurement technique and hardware design guided by watchful software. Automated procedures for system preparation coupled with precision analysis make DLCO a test that is easy to perform and highly reproducible.

In many ways, DLCO is a general measure of the complete 'efficiency' of the lungs because it is influenced by three key components: The surface area of the lung with contact to diffusing alveoli (VA – Alveolar Volume), the thickness of the alveolar-capillary membrane (Dm - Membrane Diffusion) and the volume of blood available in the capillary bed of the lung (Vc – Capillary Blood Volume).

In this test we use a special gas mixture containing 0.300% CO, 10.0% Helium, 21,0% O2 and balance N2.

The CO is used to trace the diffusion in place of O2 because it is a one-way transfer across the alveolar-capillary membrane for combination with Hb. The helium in the mixture is used to obtain a measure of the alveolar volume.

The challenge of Single Breath Diffusion testing is to obtain a representative sample of gas from an area of the lungs where diffusion is taking place. In the "traditional" method for measuring DLCO the patient first breathes all the way out to residual volume and is then connected to the test gas. They breathe all the way in to TLC and are then instructed to hold their breath for approximately 10 seconds. After having held their breath for ten seconds, the first amount of gas that leaves the lips when breathing out, has been resident in the physiological dead-space (mouth, trachea and two main bronchi) and must therefore be discarded before collecting a valid gas sample.

Measurements from DLCO testing:

- Single Breath Diffusing Capacity (DLCO)
- Alveolar Volume (VA)
- Diffusion per unit area of Lung Volume (DL/VA)

# Nitrogen Recovery (TLC)

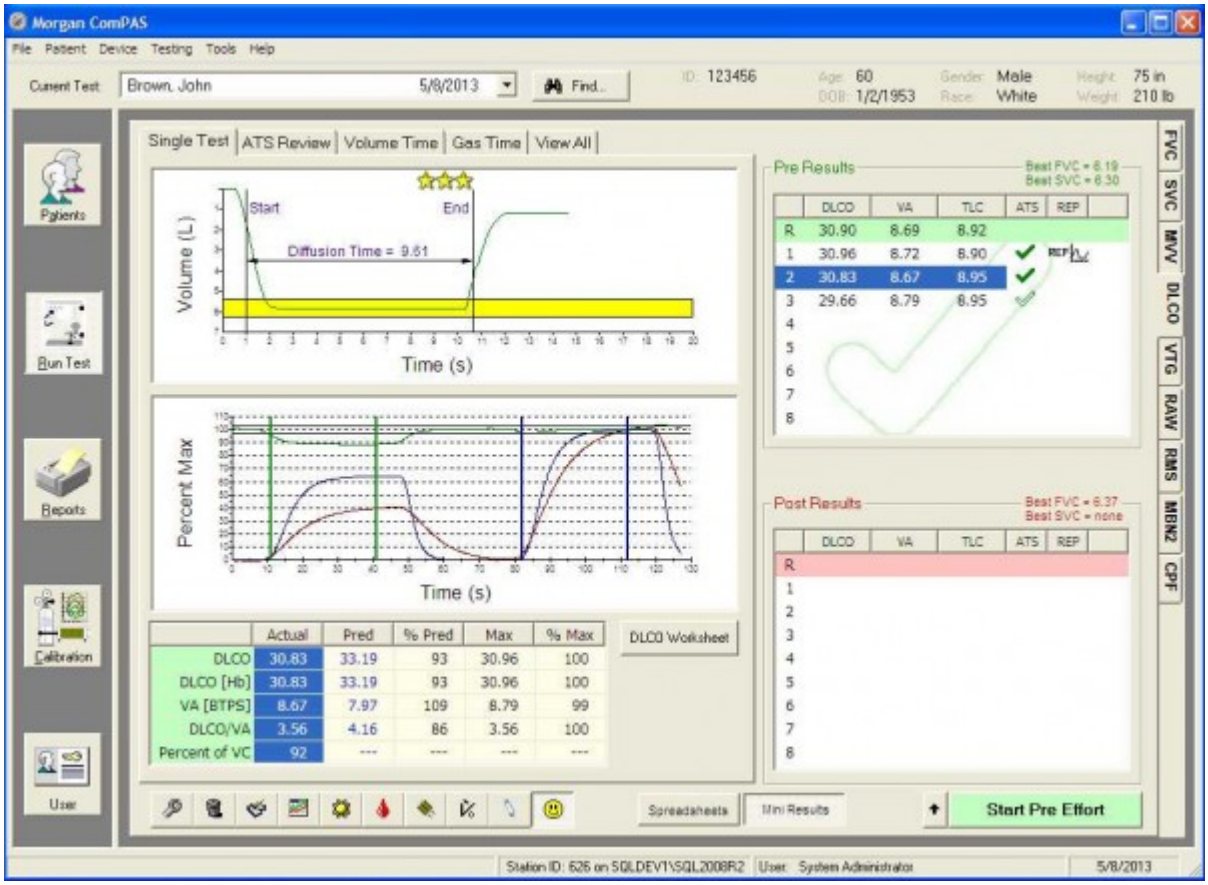
Total Lung Capacity (TLC) can be measured during the performance of any Single Breath Diffusion (DLCO) study.

This is an excellent screening method for identifying patients requiring further lung volume study.

All Medisoft instruments are equipped with the necessary oxygen sensor to enable the technique.

Identifying Measurements from DLCO efforts:

- TLC (TLC)
- Lung subdivisions using data from SVC

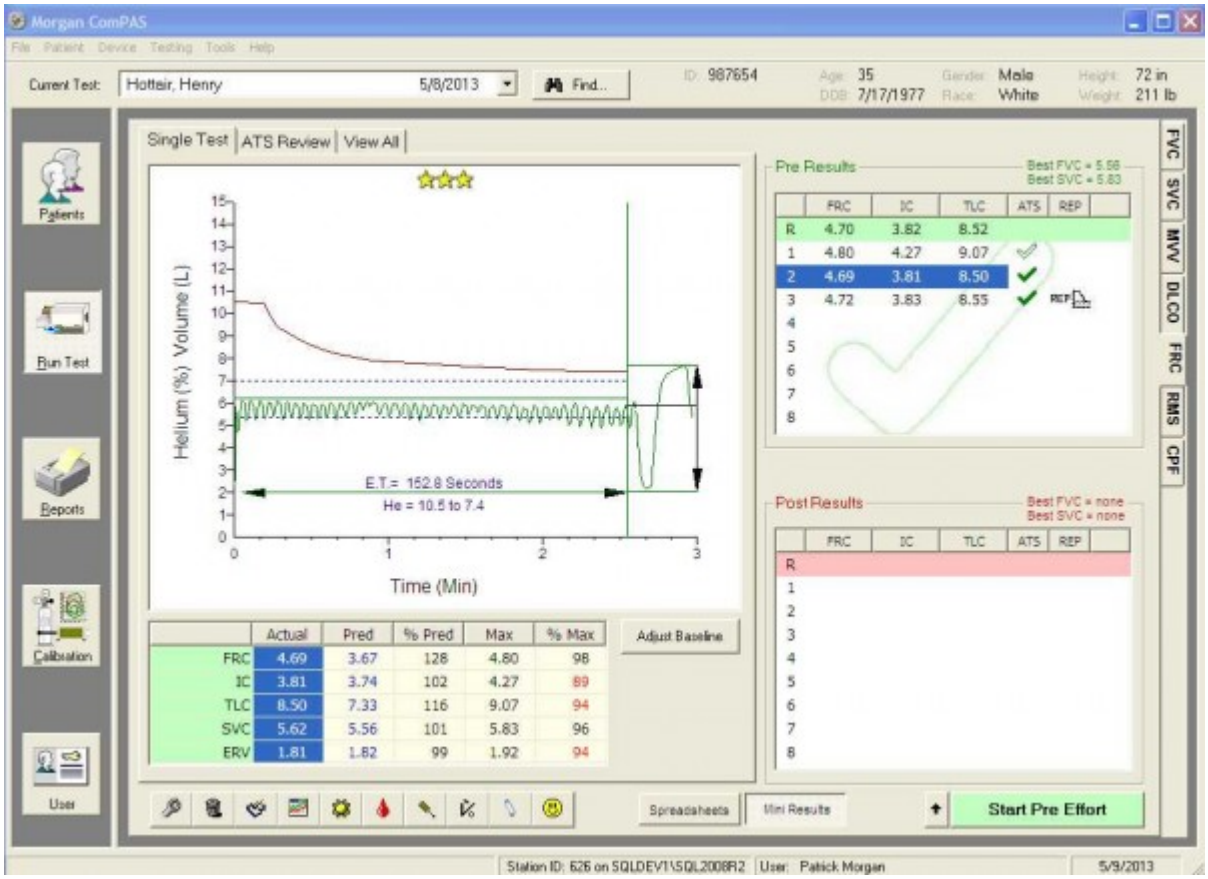


# Helium Dilution (FRC)

Functional Residual Capacity (FRC) is measured with careful maintenance of oxygen levels suitable for all patients, including those requiring supplemental oxygen. The maneuver is carried-out in quiet comfort for the patient with prompts for stability and options for repeated static spirometry at the test conclusion.

Identifying Measurements from FRC efforts:

- Functional Residual Capacity (FRC)
- Inspiratory Capacity (IC)
- Expiratory Reserve Volume (ERV)
- Total Lung Capacity (TLC)
- Vital Capacity (VC)
- Residual Volume (RV)
- Ratio (RV/TLC)
- Equilibration Time (ET)

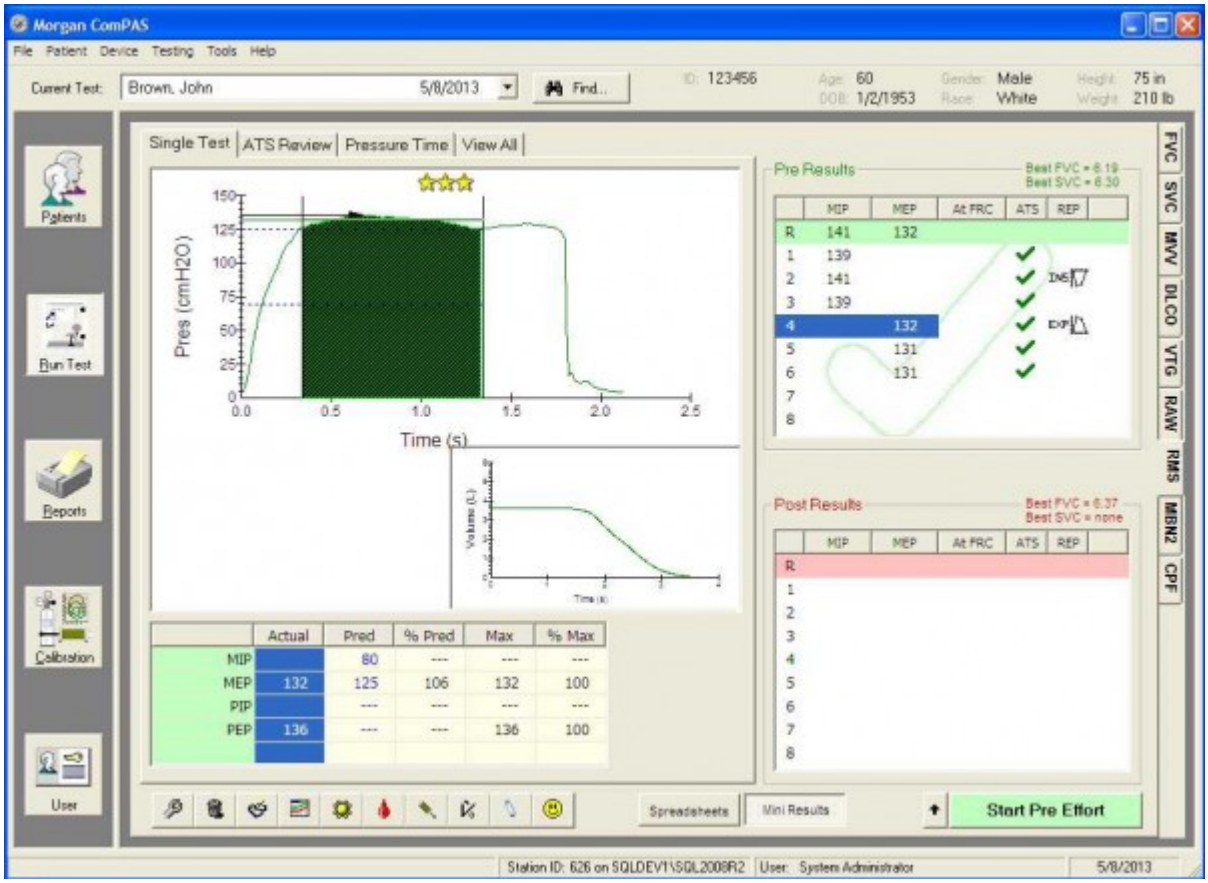


# Respiratory Muscle Strength

Maximum Inspiratory and Expiratory Pressures (MIP and MEP) can be measured from TLC or RV respectively or from FRC. The lung volume at which the pressures are measured is captured by the spirometry tracing simultaneous to the test maneuver.

Identifying Measurements from RMS efforts:

- Maximum Inspired Pressure (MIP)
- Maximum Expired Pressure (MEP)
- Peak Inspired pressure (PIP)
- Peak expired Pressure (PEP)

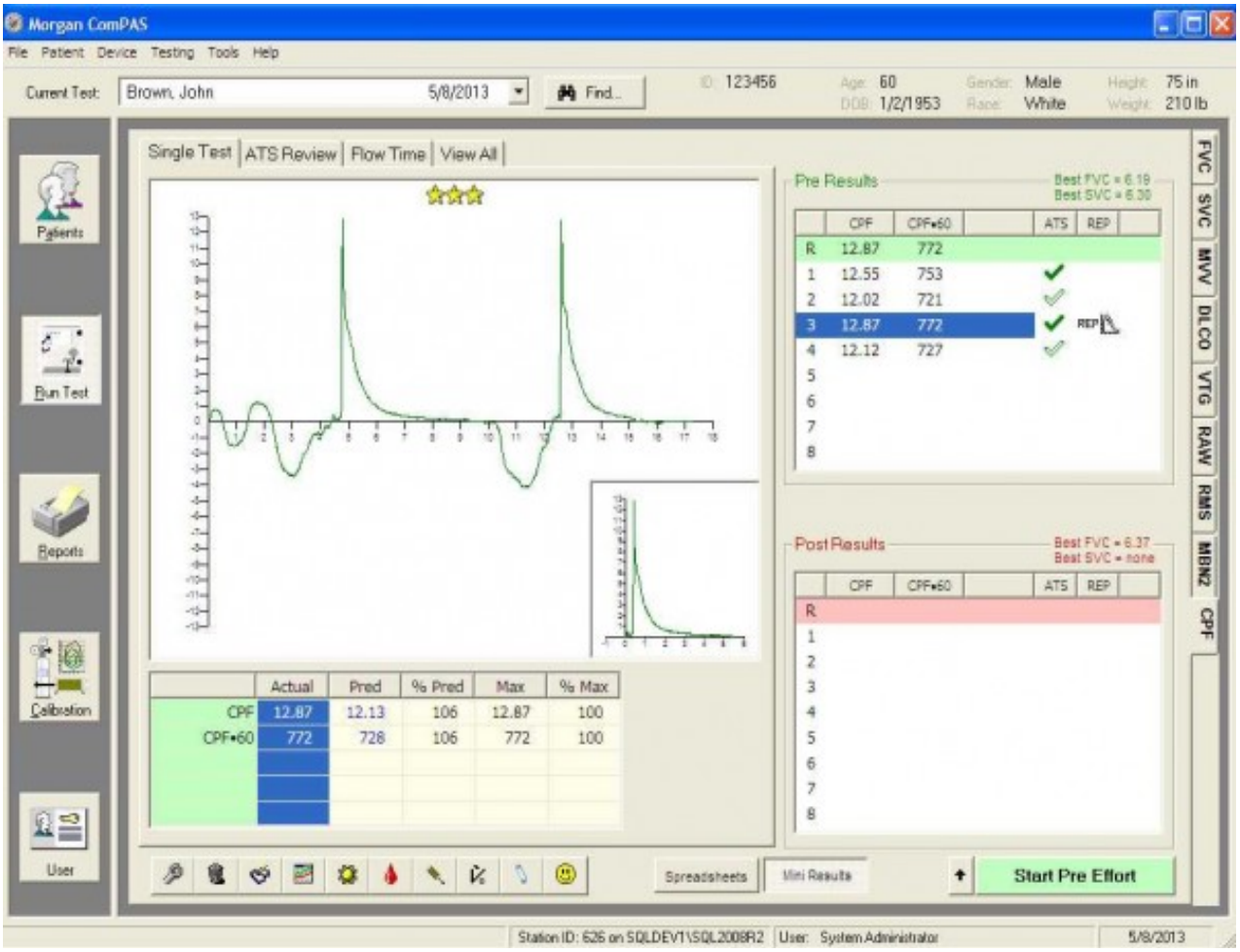


# Cough Peak Flow

In some cases of neuromuscular disease, both adults and children exhibit a weak cough; measurement of Cough Peak Flow (CPF) is useful to monitor expiratory muscle weakness and bulbar involvement. The CPF is the velocity of air being expelled from the lungs after a cough maneuver usually from maximum inspiration. This measurement can be expressed and reported in ComPAS in L/min or L/sec.

Identifying Measurements from CPF efforts:

- Cough Peak Flow (CPF)



# Six Minute Walk

The Six-Minute Walk Test (6MW) is used to assess the sub-maximal level of an individual's functional capacity. The test evaluates integrated responses to moderate exercise including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation and muscle metabolism. It measures the distance an individual is able to walk over a total of six minutes on a hard, flat surface. The goal is for the individual to walk as far as possible in six minutes without jogging or running.

Test data stored on the Nonin WristOx can be directly downloaded into ComPAS via Bluetooth. The smart report can be set to provide a stand-alone 6MWT report or integrate the data into a full PFT report format.

Identifying Measurements from 6MW efforts:

- Six Minute Walk (6MW)