A Focus on Spirometry

CHARLENE MHANGAMI | SENIOR CLINICAL APPLICATION SPECIALIST

Vitalograph®

OBJECTIVE

Update your current knowledge of Spirometry to help you obtain acceptable and repeatable spirometry results.

AGENDA

- Main parameters
- Preparation for the test
- Common test errors
- Case Examples

2019 ATS/ERS SPIROMETRY GUIDELINES

‘Improvements in instrumentation and computational capabilities, together with new research studies and enhanced quality assurance approaches, have led to the need to update the 2005 technical standards for spirometry to take full advantage of current technical capabilities.’

Standardization of Spirometry 2019 Update

An Official American Thoracic Society and European Respiratory Society Technical Statement

Brian L. Graham, Irene Steenbruggen, Martin R. Miller, Igor Z. Barjaktarevic, Brendan G. Cooper, Graham L. Hall, Teal S. Hallstrand, David A. Kaminsky, Kevin McCarthy, Meredith C. McCormack, Cristine E. Oropez, Margaret Rosenfeld, Sanja Stanojevic, Maureen P. Swanney†, and Bruce R. Thompson; on behalf of the American Thoracic Society and the European Respiratory Society

THIS OFFICIAL TECHNICAL STATEMENT WAS APPROVED BY THE AMERICAN THORACIC SOCIETY AND THE EUROPEAN RESPIRATORY SOCIETY SEPTEMBER 2019

Preparing for the test

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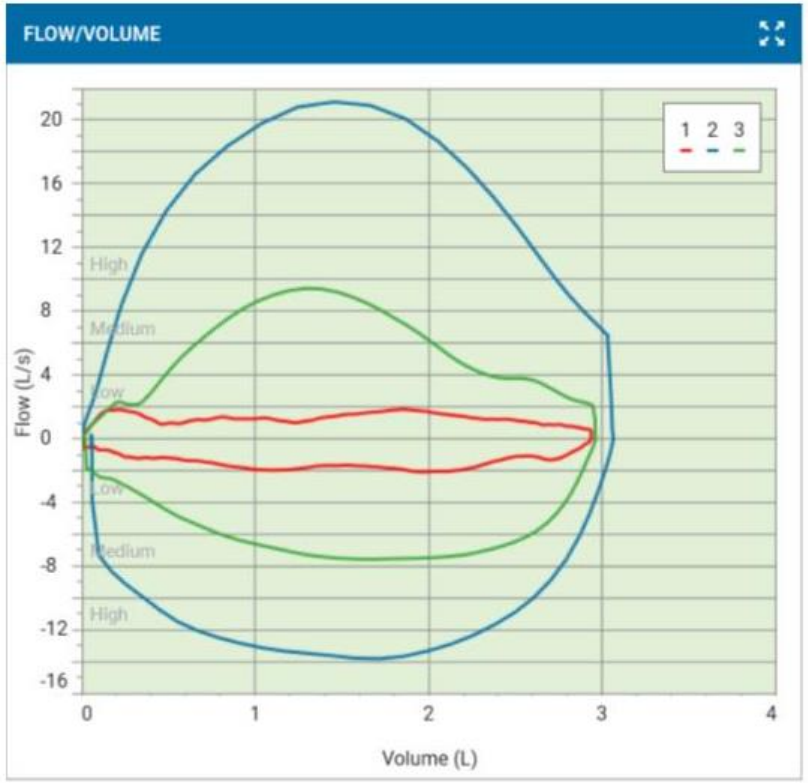
CALIBRATION VERIFICATION

To be performed once a day, before device use.



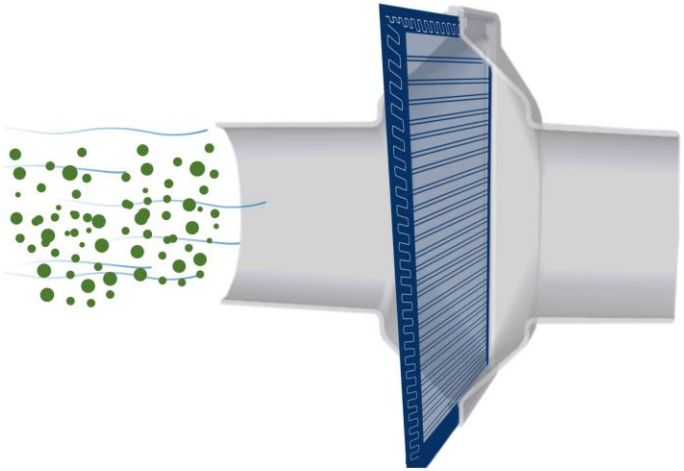
Different flow rates: low, medium, high

3-Litre syringe

Maximum permissible volume error is +/- 3%

INFECTION CONTROL

A bacterial/viral filter that offers protection against 99.99% bacteria and viruses, including COVID19 should be attached to the spirometer before the patient performing the test and disposed of after each patient.



PREPARING THE PATIENT

Avoid wearing restrictive clothing

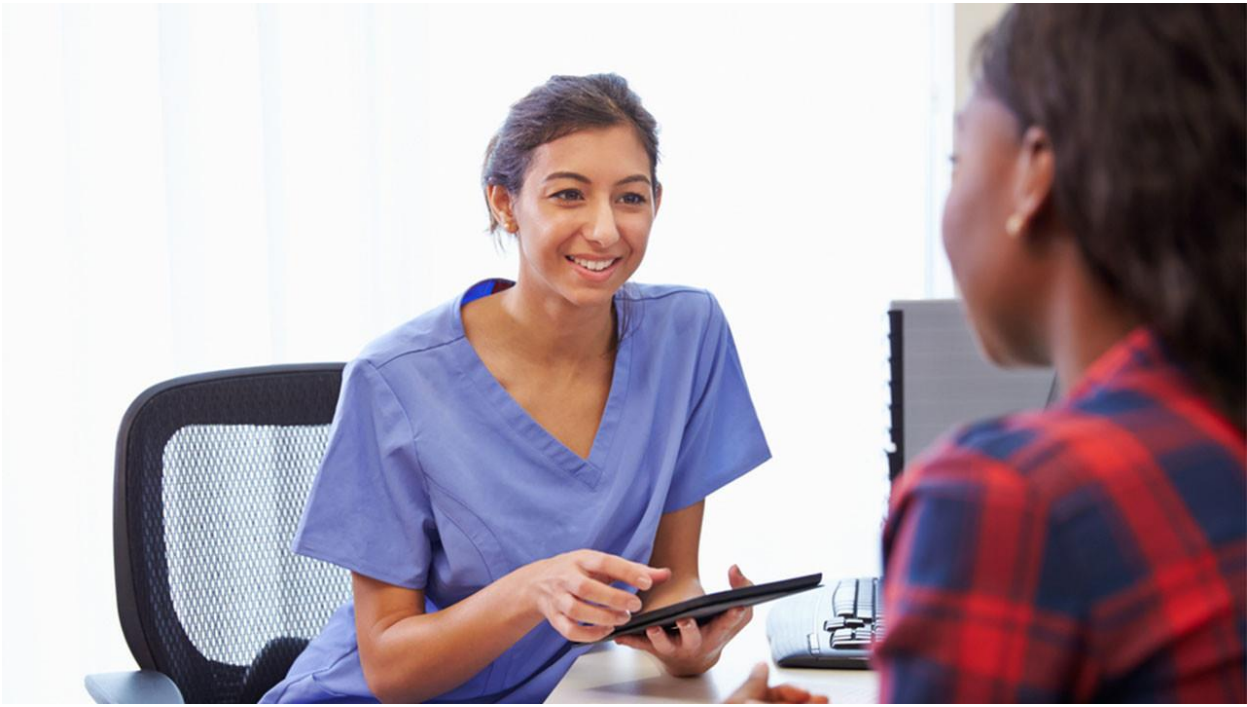
Avoid smoking/vaping 1 hour prior

Avoid consuming alcohol /intoxicants 8-hours prior

Avoid vigorous exercise 1-hour prior

Avoid eating a substantial meal 2 hours prior

PRE-TEST CHECKS



- Confirm patient identification – Name, DOB, ID.
- Height and weight taken without shoes and outdoor clothing.
- Posture (sitting unless supine is requested).
- Ensure a disposable nose clip and bacterial viral filter are available.
- Ask about activities that should be avoided before testing in accordance with 2019 ATS/ERS Spirometry guidelines
- Ask about relative contraindications in accordance with 2019 ATS/ERS Spirometry guidelines

CORRECT PATIENT POSTURE

Head

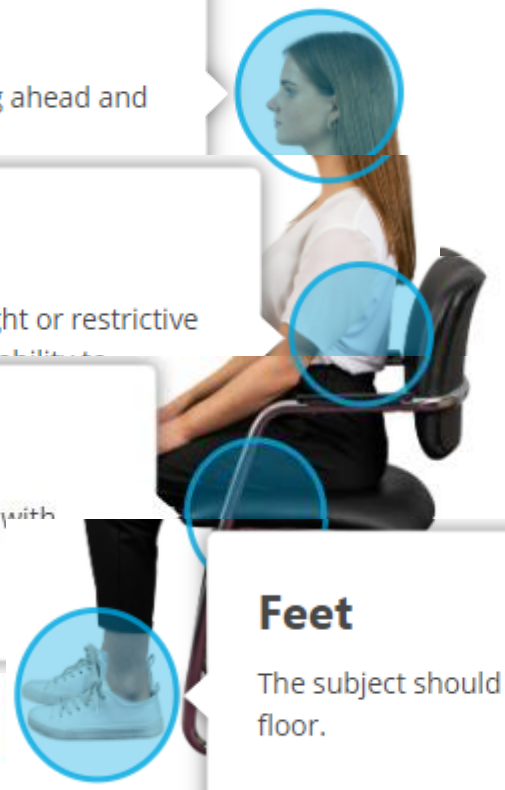
Keep head slightly elevated, looking ahead and chin pointed forward.

Clothing

The subject should not wear tight or restrictive

Seating

The subject should be seated in a chair with arms, and without wheels.



Feet

The subject should place their feet flat on the floor.

Main parameters

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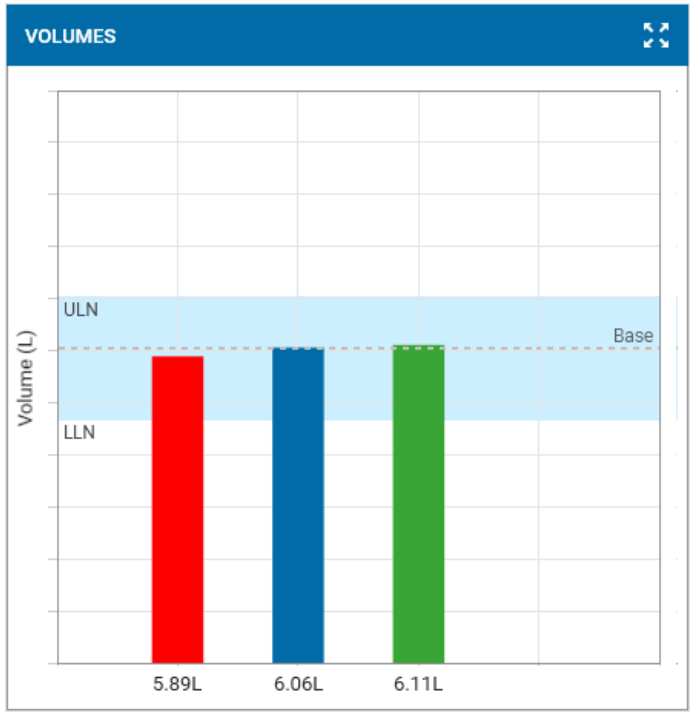
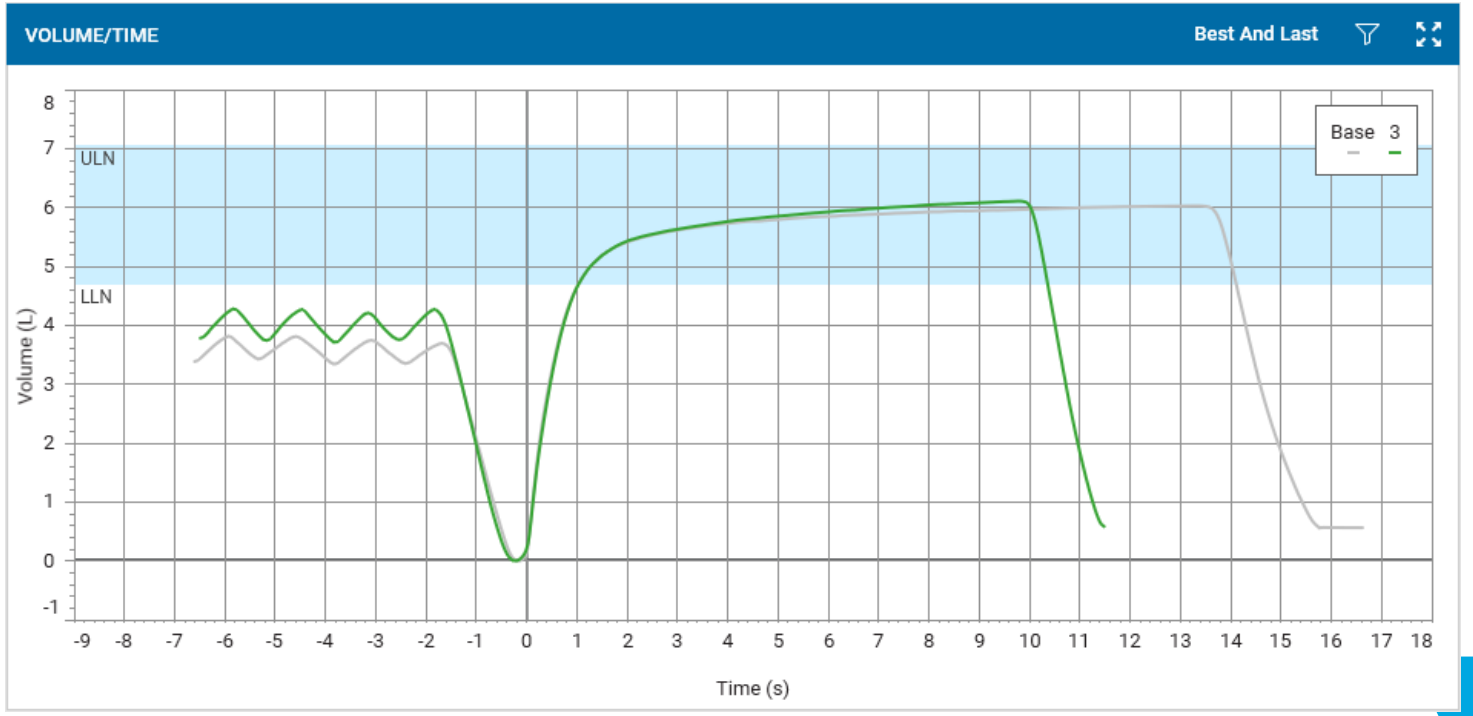
VITAL CAPACITY (VC)

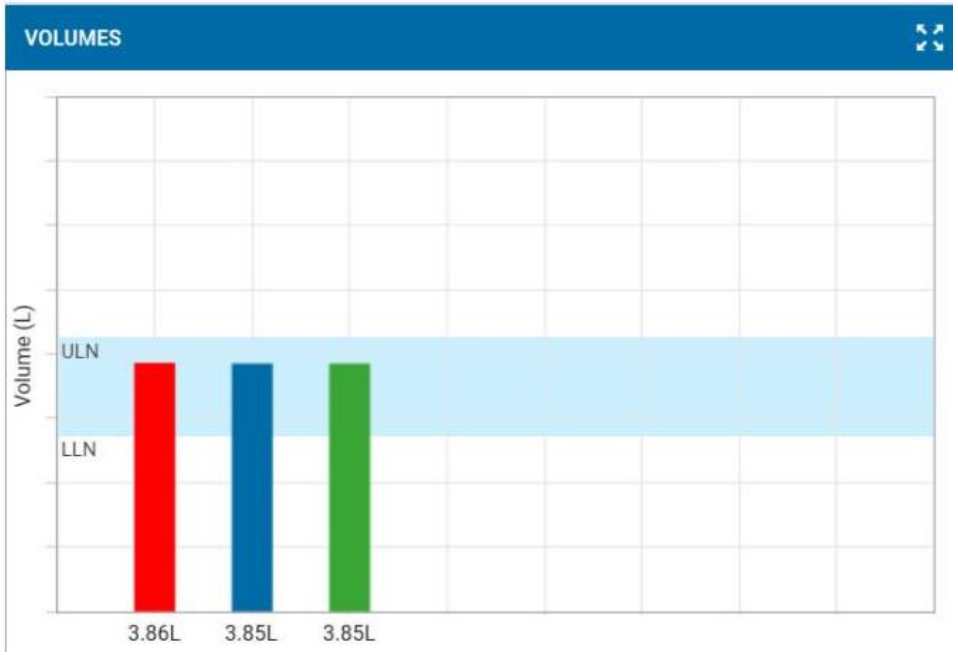
The maximal volume of air that can be expired from the lungs during a relaxed but complete expiration from a position of full inspiration.

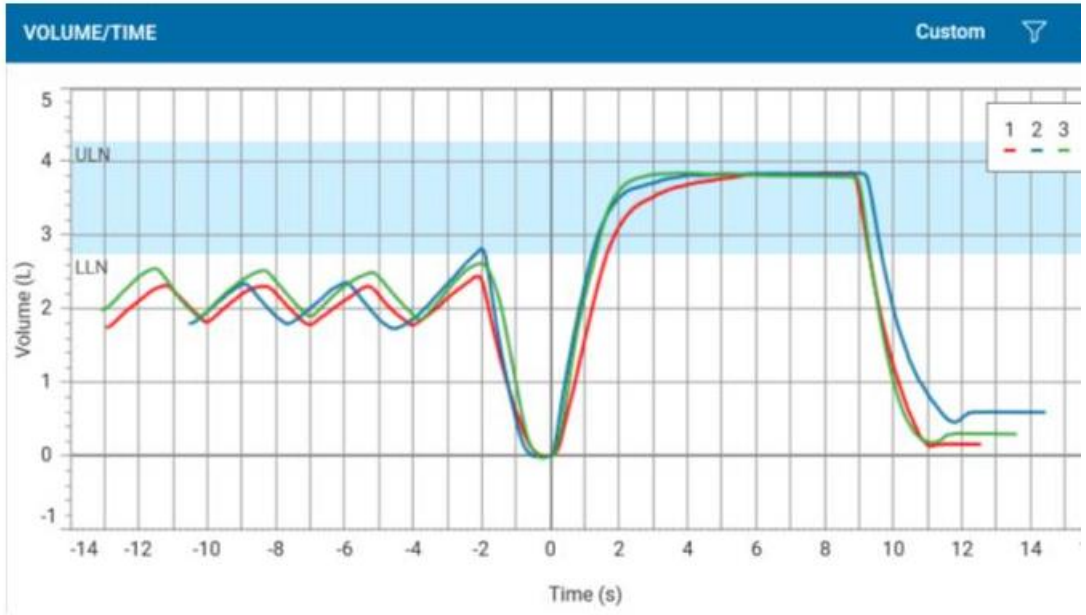




VITAL CAPACITY (VC)

1. Tidal breathing to obtain stable tidal baseline
2. Maximal inhalation
3. Continuous, complete expiration
4. Breathe normally

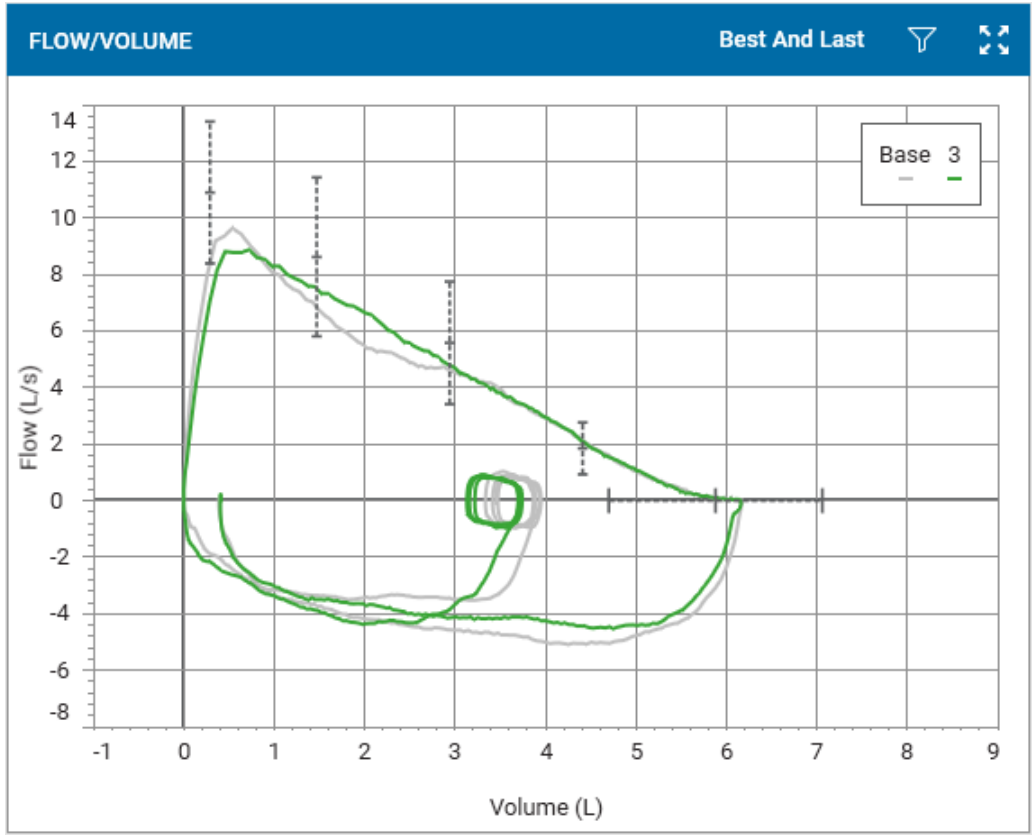


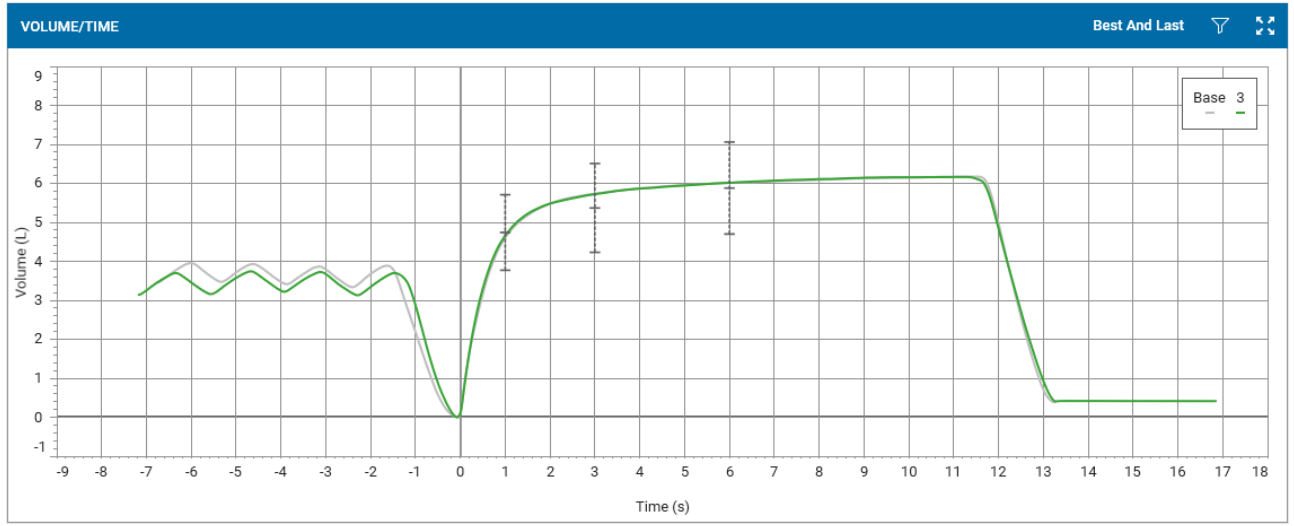


VC measurement

FORCED VITAL CAPACITY (FVC)

The Maximal volume of air that can be expired from the lungs during a forced but complete expiration from a position of full inspiration.





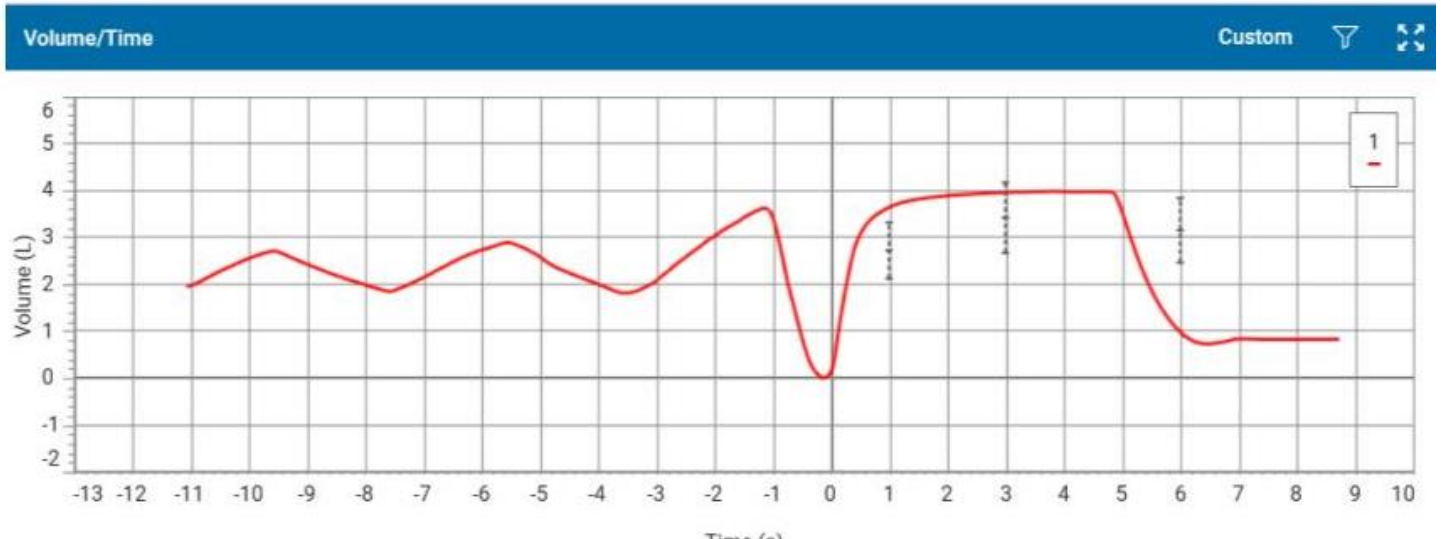
FORCED VITAL CAPACITY (FVC)

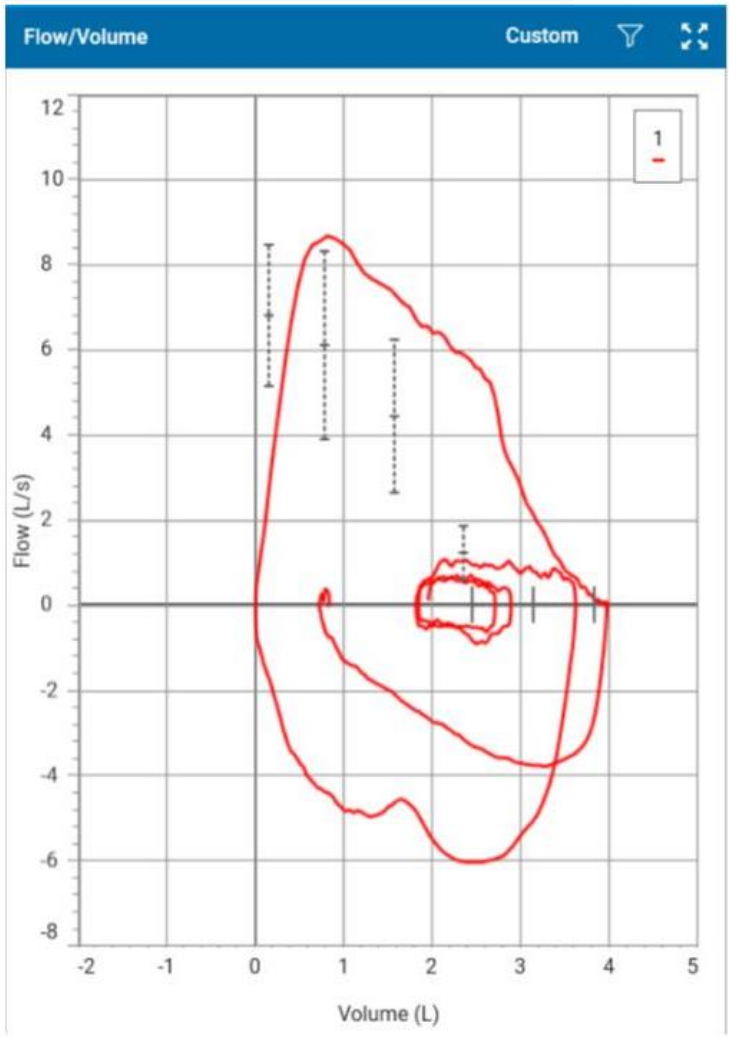
1. Maximal inspiration (A pause of ≤ 2 seconds)

2. A “blast” of expiration

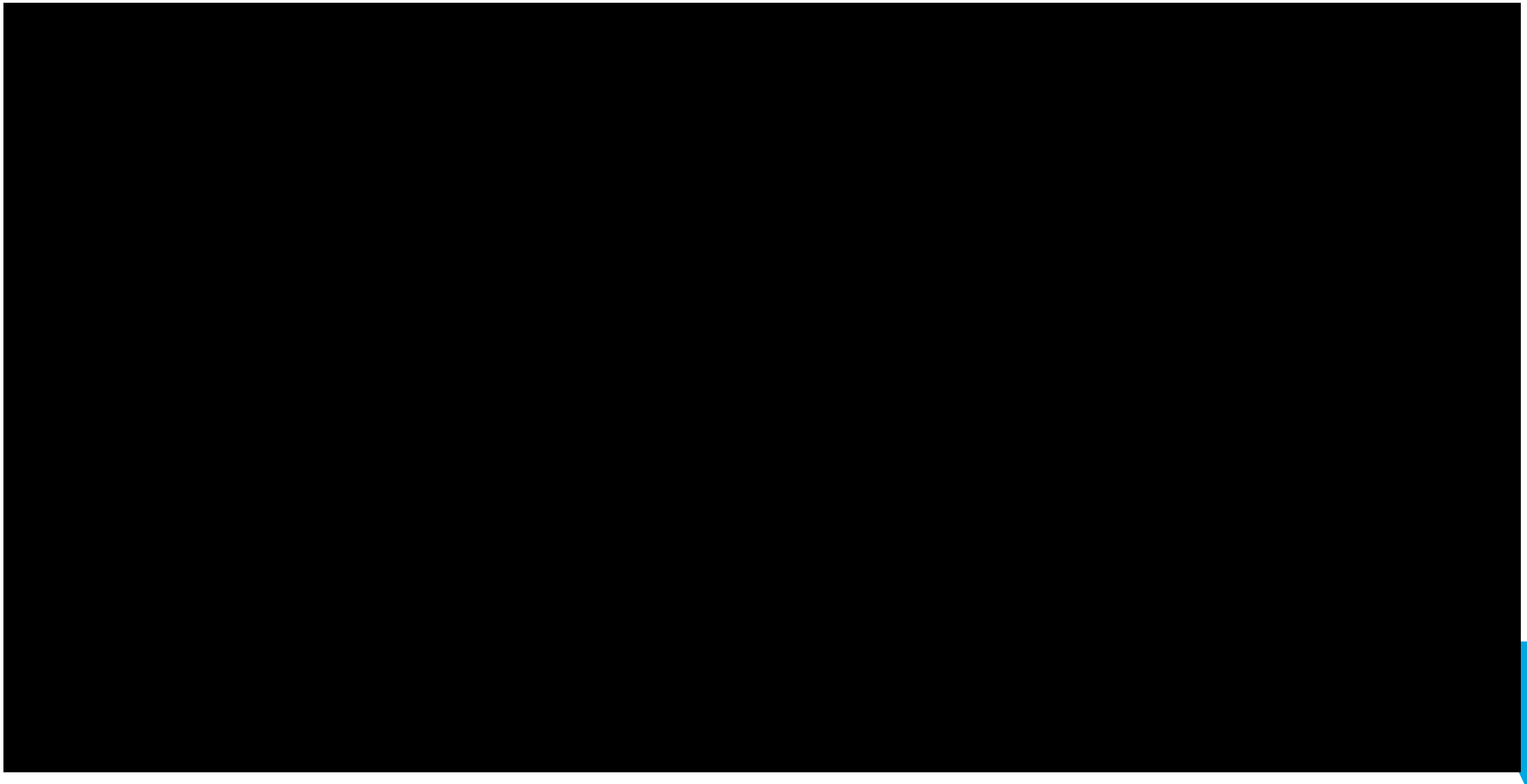
3. Complete expiration

4. Deep inspiration back to total lung capacity.





FVC measurement



MAIN SPIROMETRY PARAMETERS

VC (L) – Vital Capacity

FVC (L) – Forced Vital Capacity

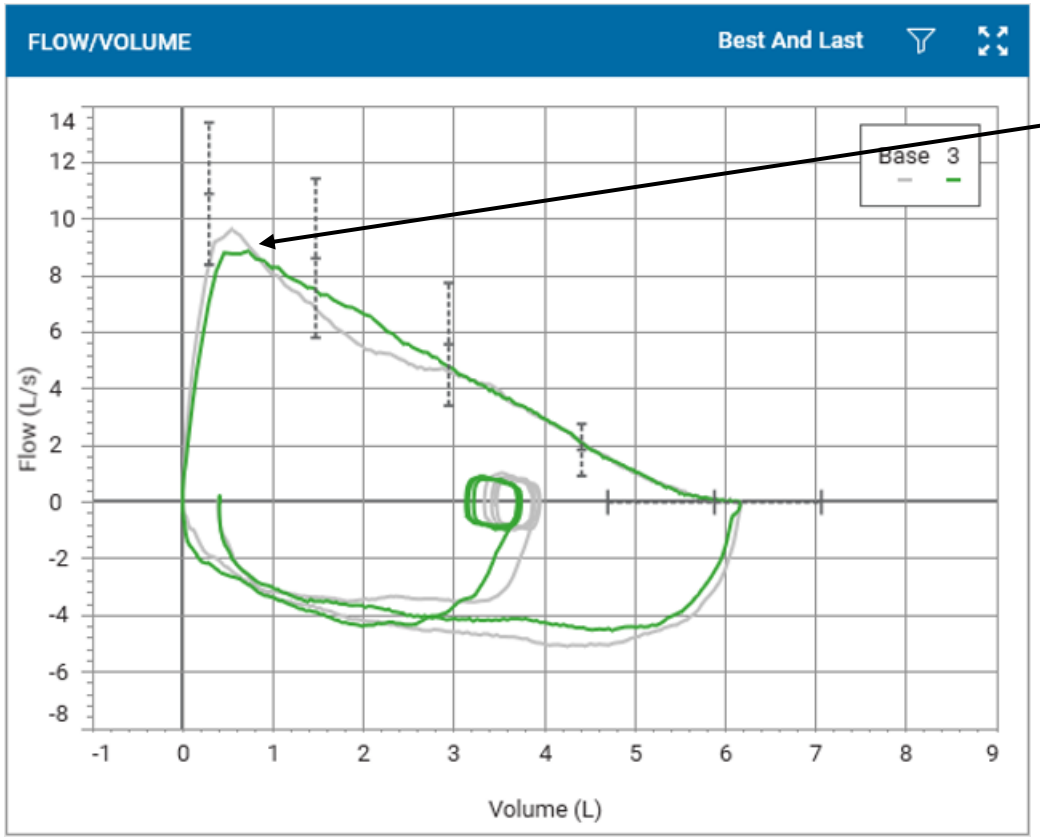
FEV1 (L) – Forced Expiratory Volume in the first second

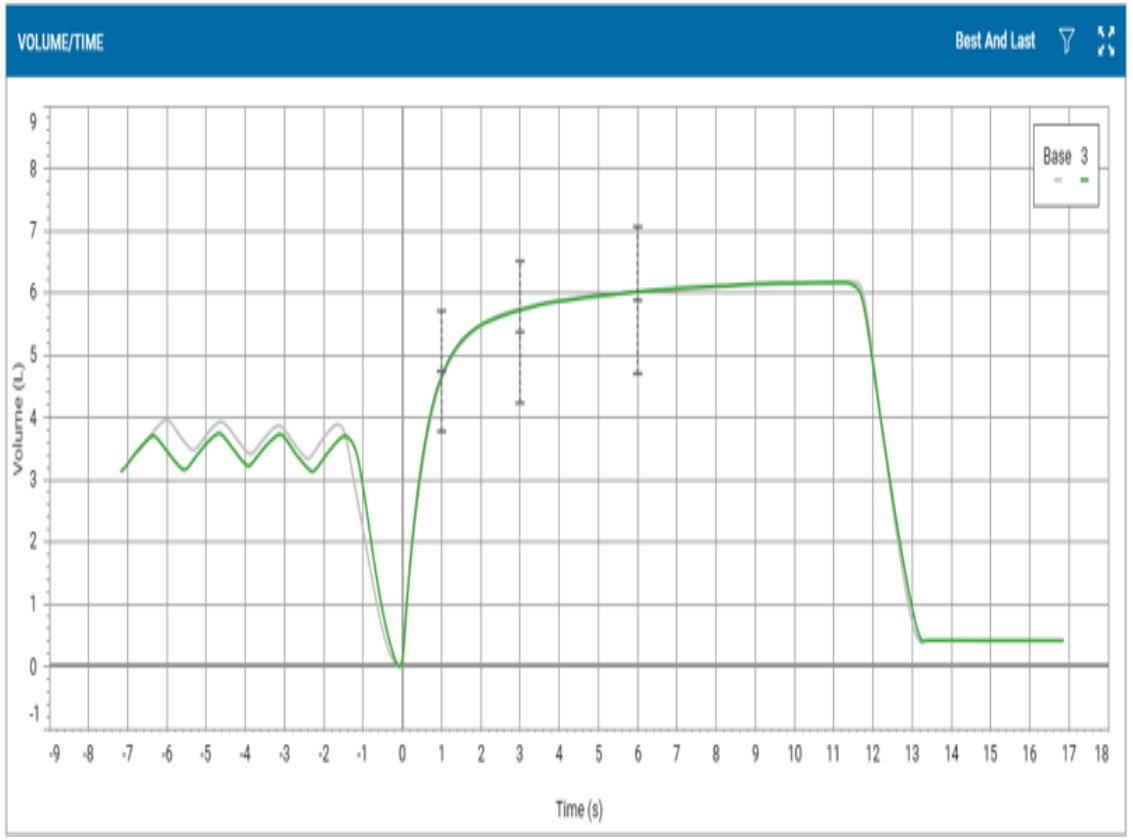
FEV_1/FVC ratio - The ratio of the forced expiratory volume in the first one second to the forced vital capacity

PEF (L/s) – Peak expiratory flow

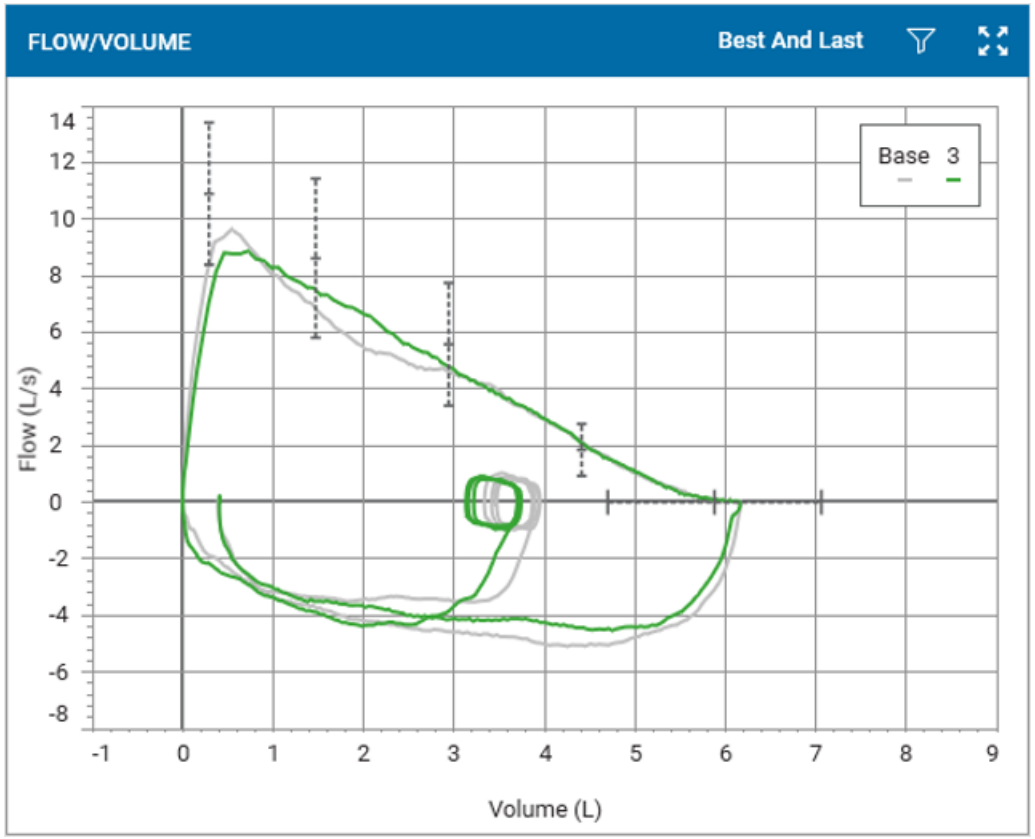
FEF_{25}, FEF_{50}, FEF_{75} =Flow rate at 25%, 50% and 75% **of FVC**

MAIN SPIROMETRY PARAMETERS

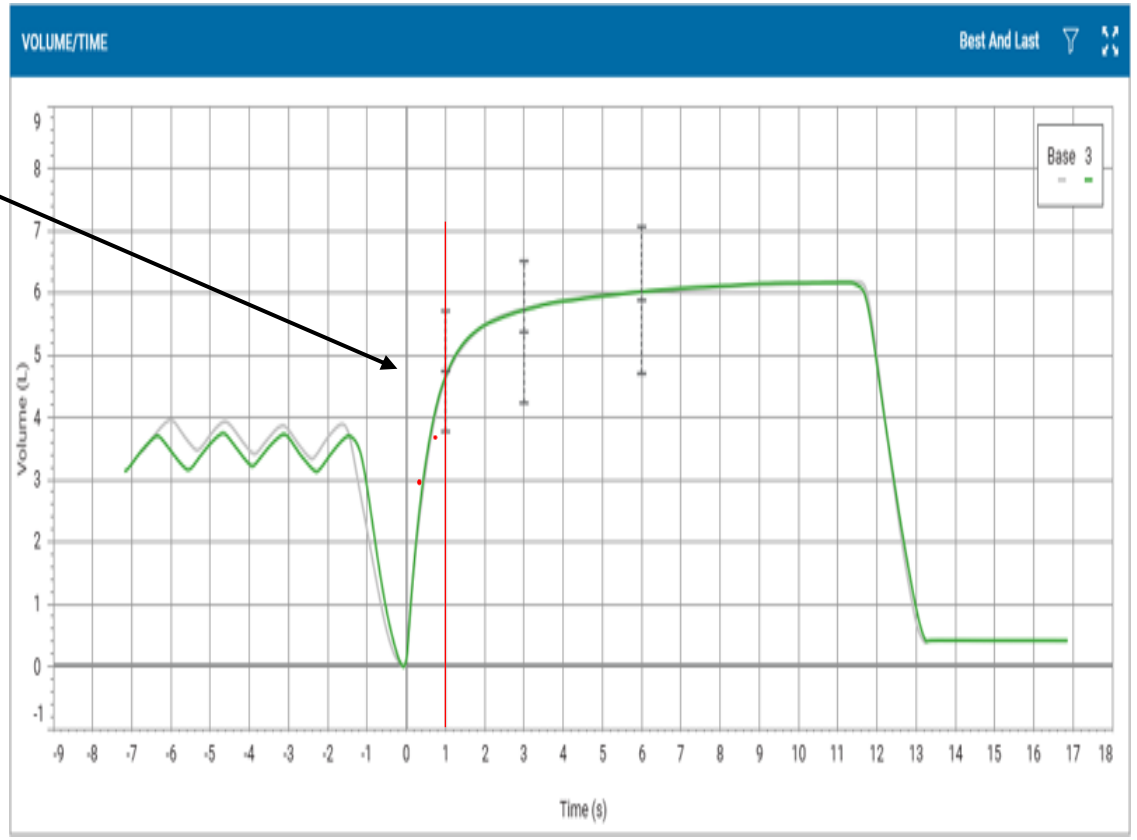




MAIN SPIROMETRY PARAMETERS



FEV1



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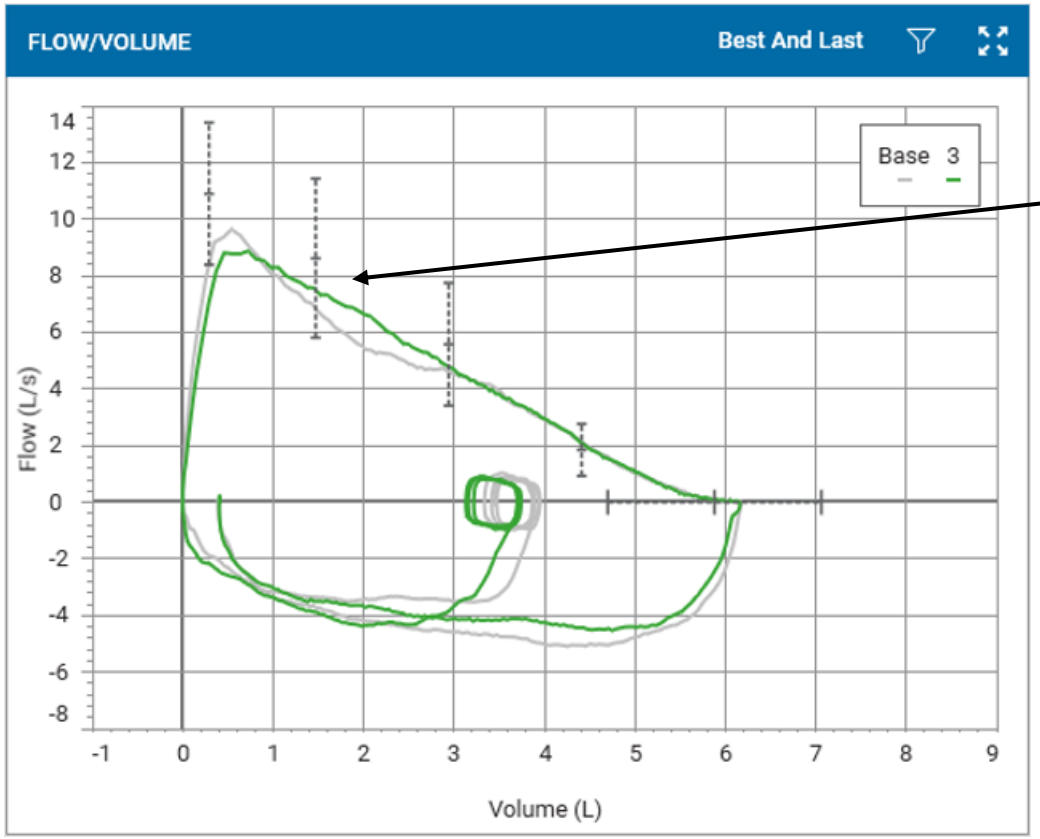
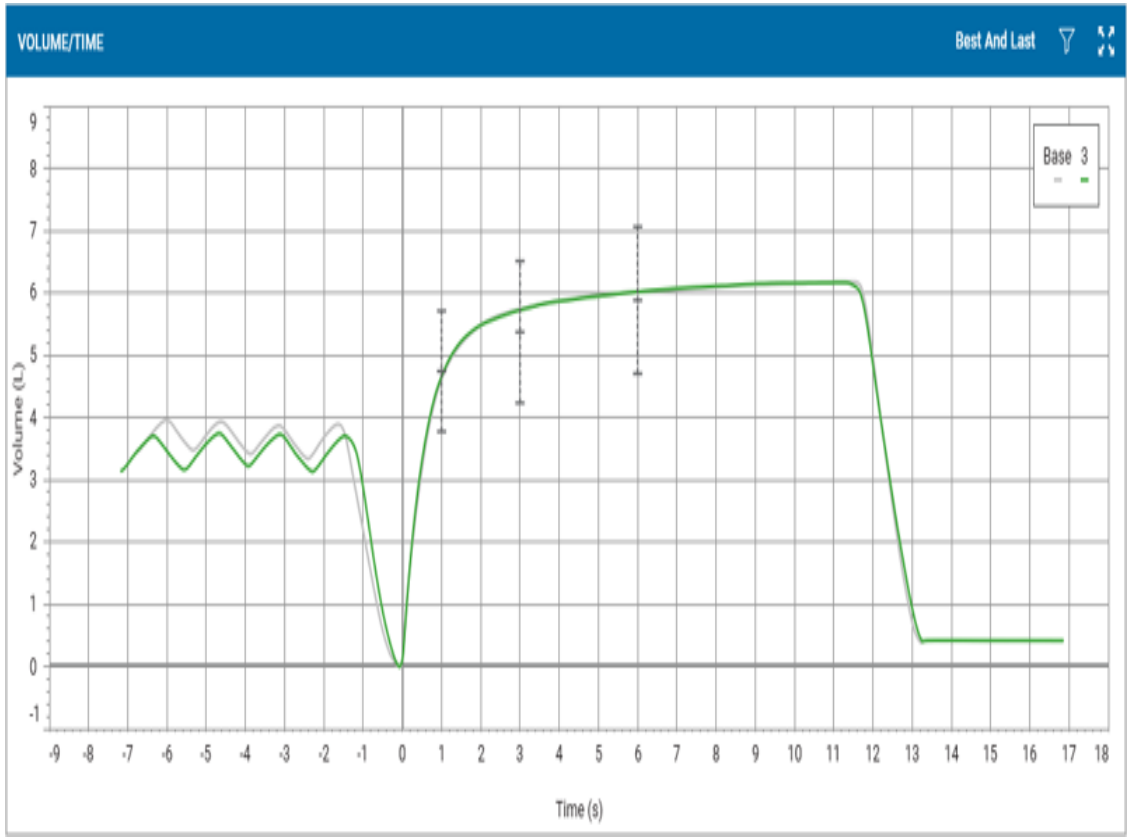
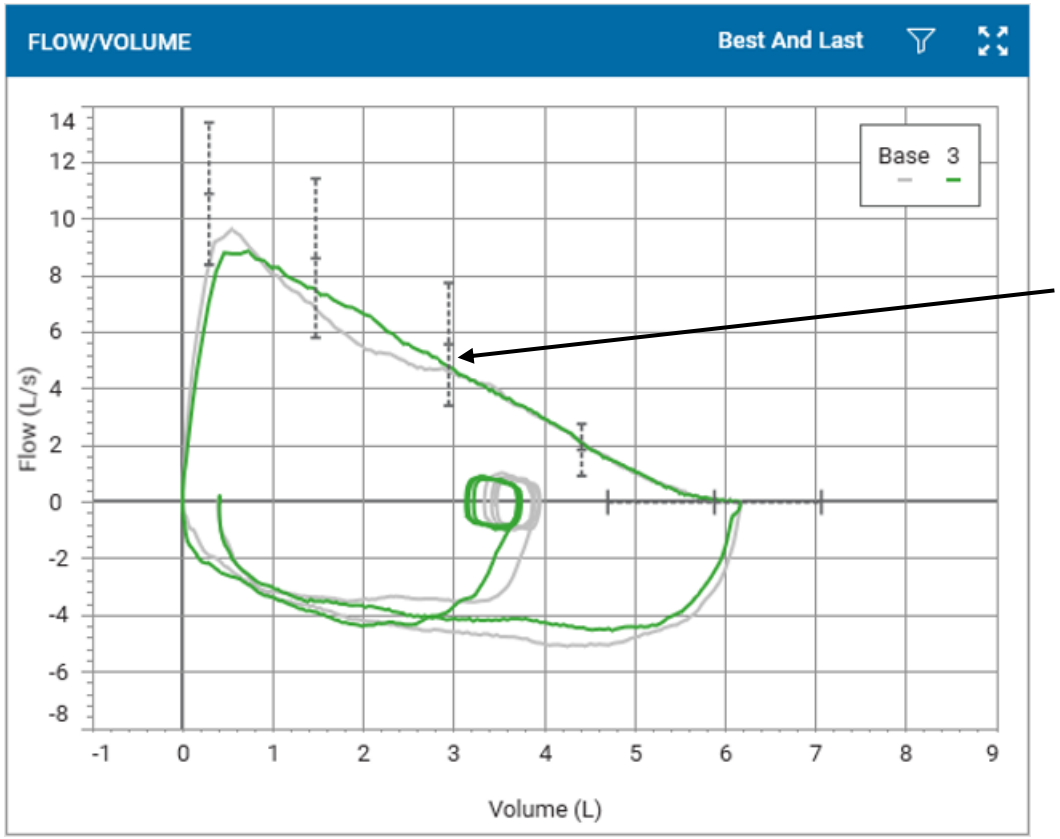


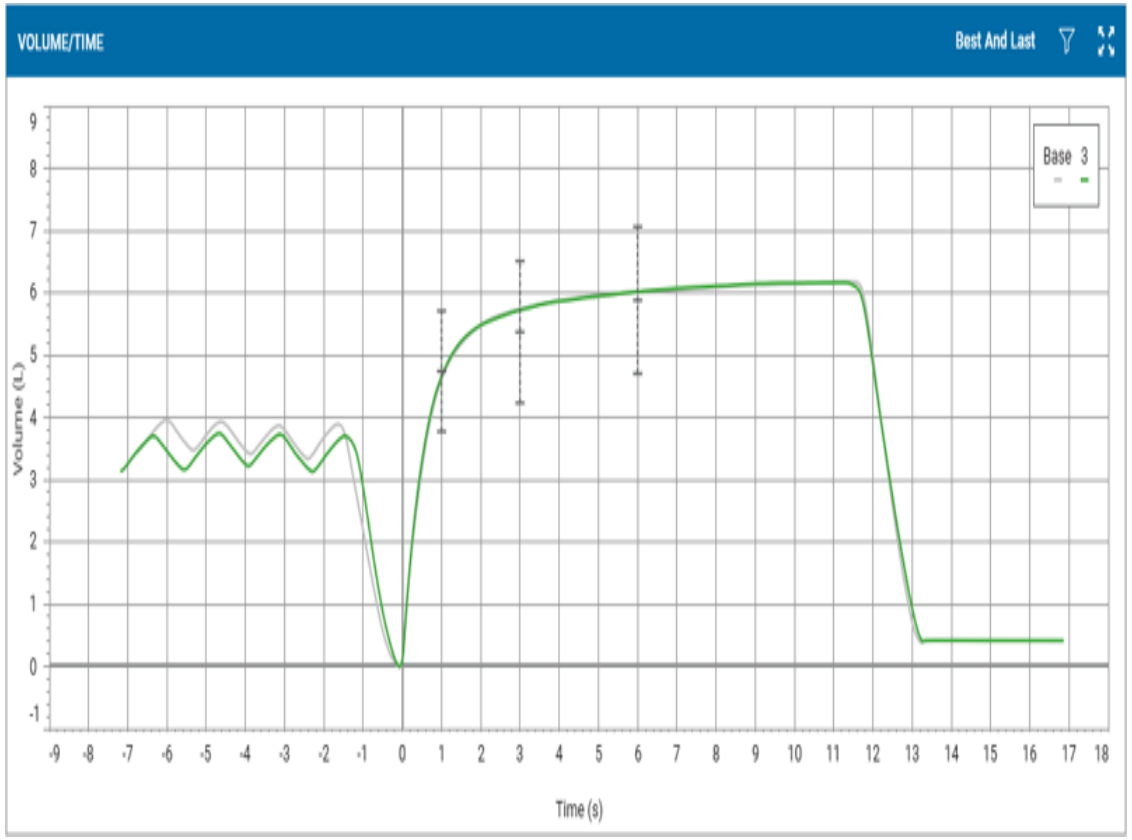
FEF_{25}



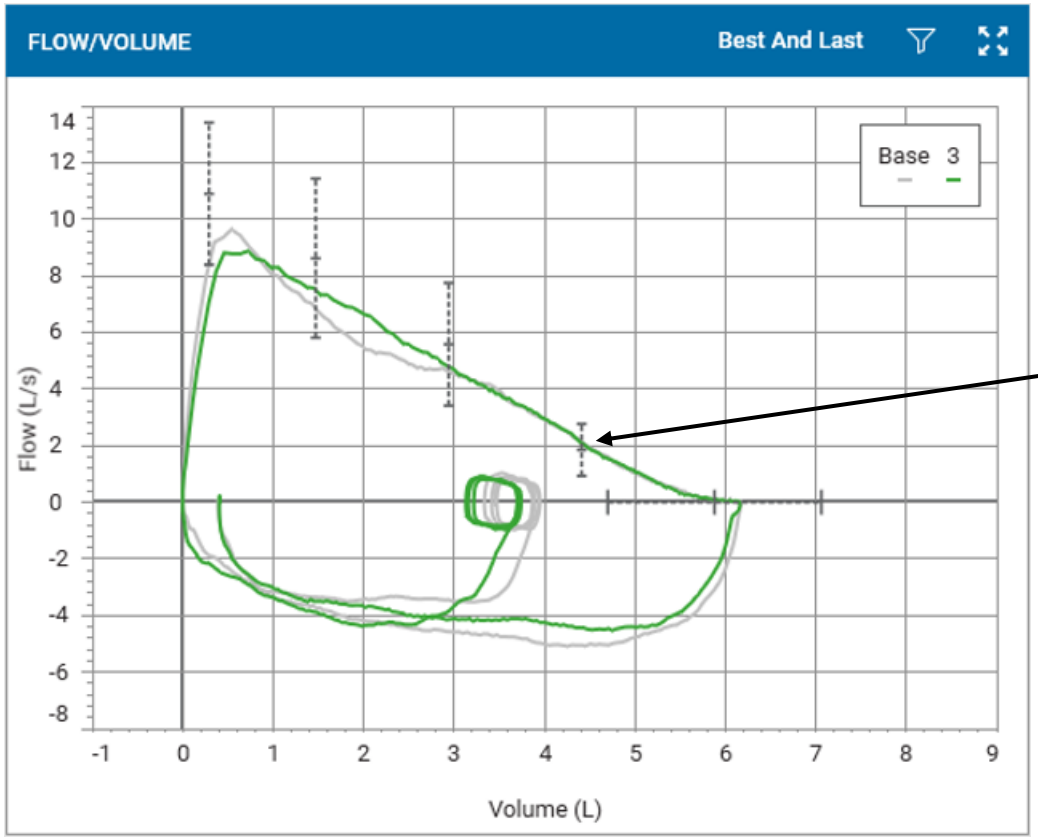
MAIN SPIROMETRY PARAMETERS



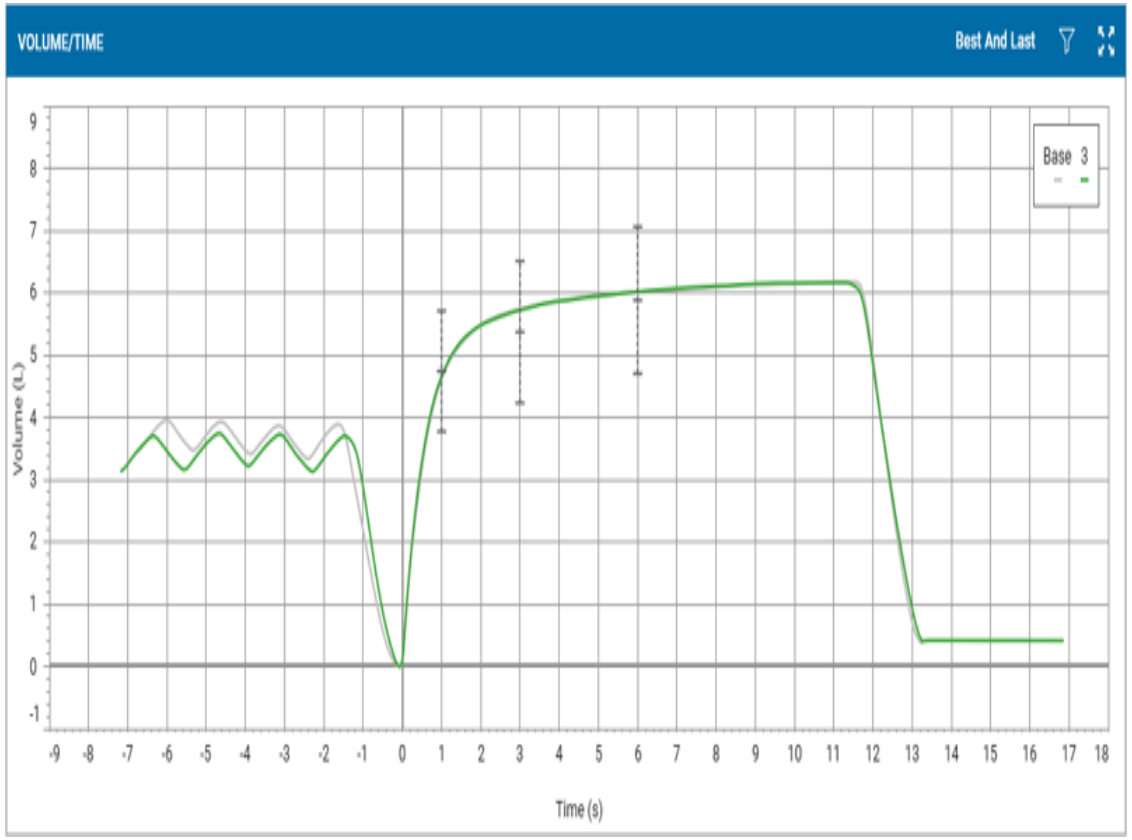
FEF_{50}



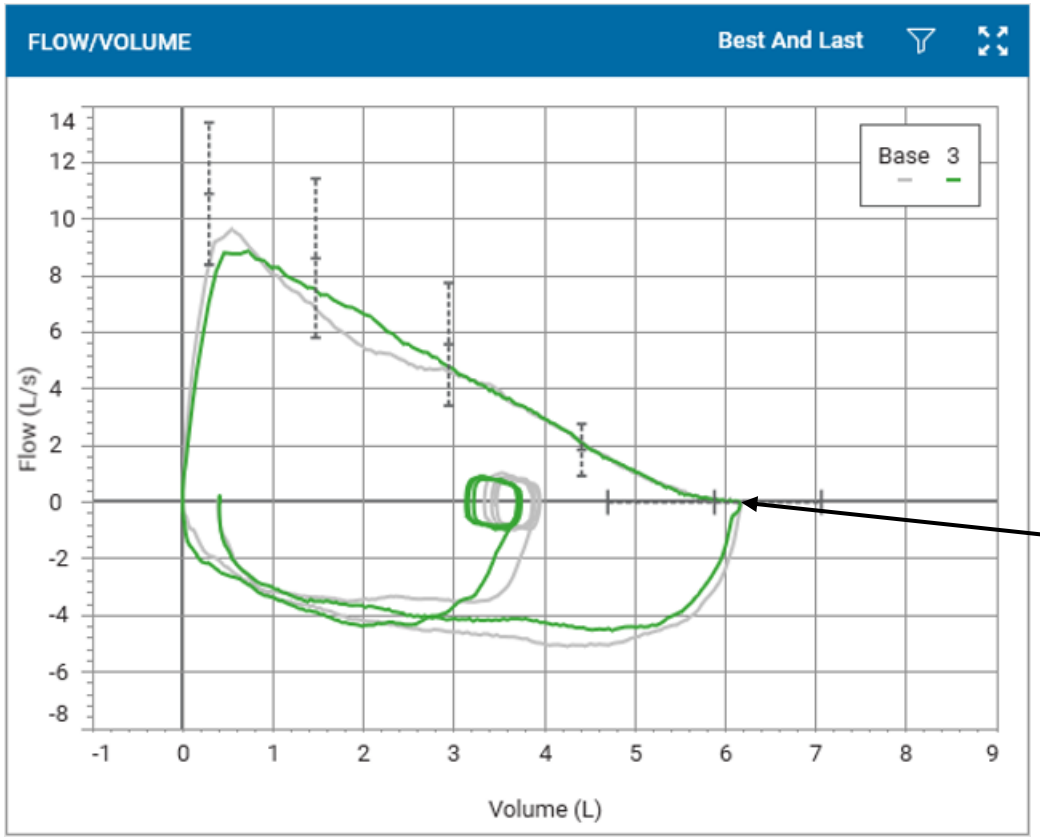
MAIN SPIROMETRY PARAMETERS



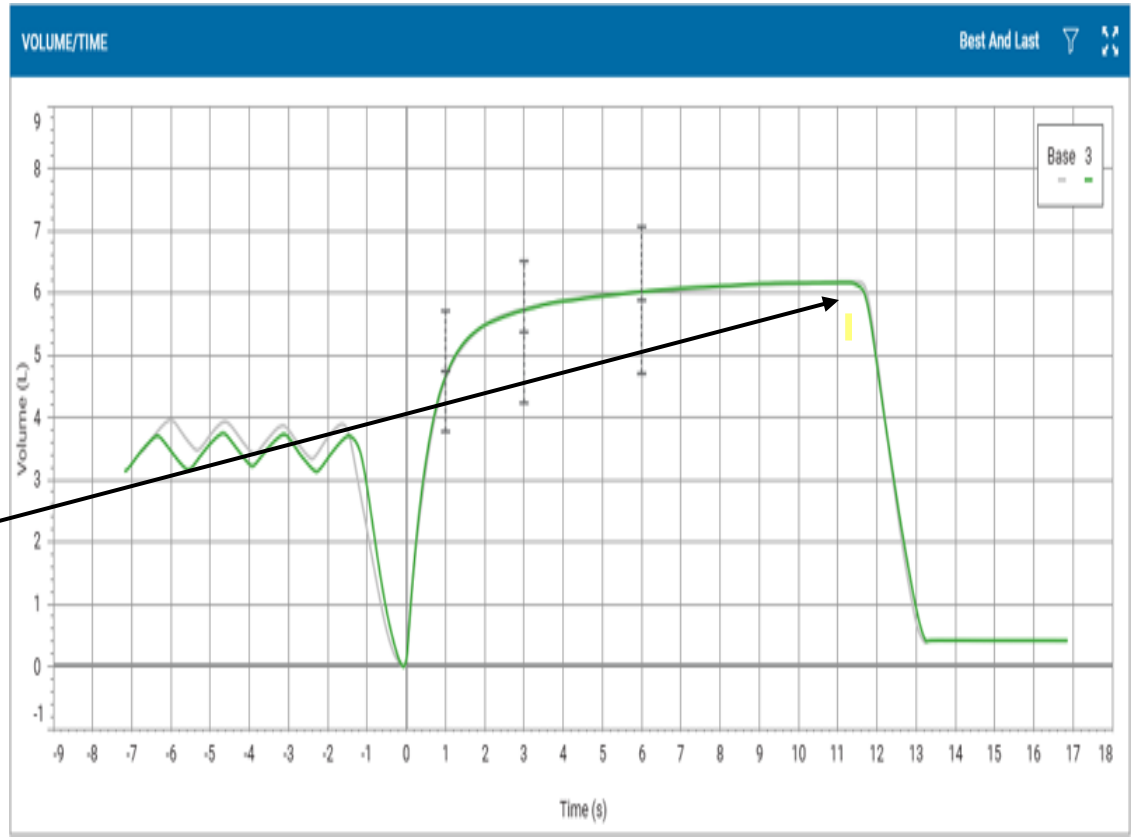
FEF_{75}



MAIN SPIROMETRY PARAMETERS



FVC



Common errors

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REPEATABILITY & QUALITY ASSURANCE

Minimum of 3 technically acceptable blows:

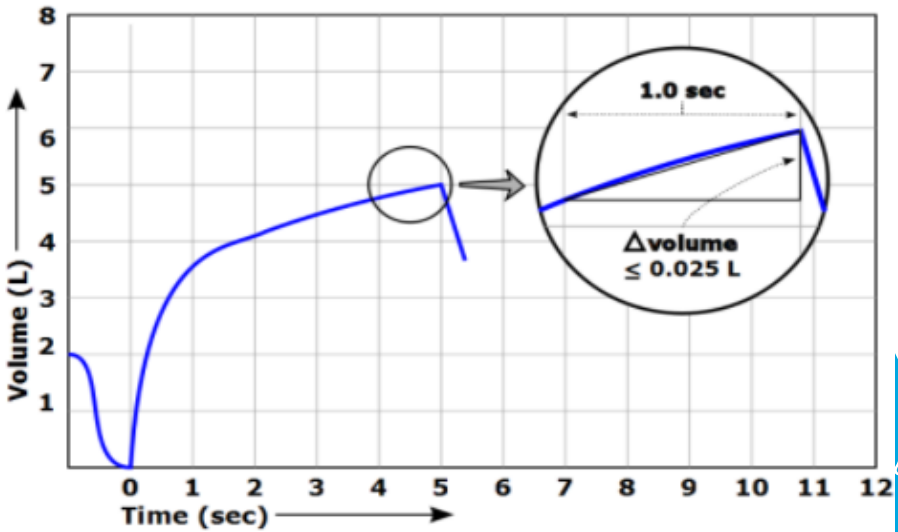
- No evidence of an obstructed mouthpiece or spirometer.
- No slow start or hesitation (BEV <5% of FVC or 0.100 L, whichever is greater).
- No cough during the first second of expiration
- No glottic closure in the first second of expiration or after the first second
- Achieved one of the **EOFE** criteria
- No evidence of a leak
- **Maximum effort**

Repeatability criteria:
- 2 useable **FVC** and **FEV1** values within **150ml** or 5 % whichever is greater.

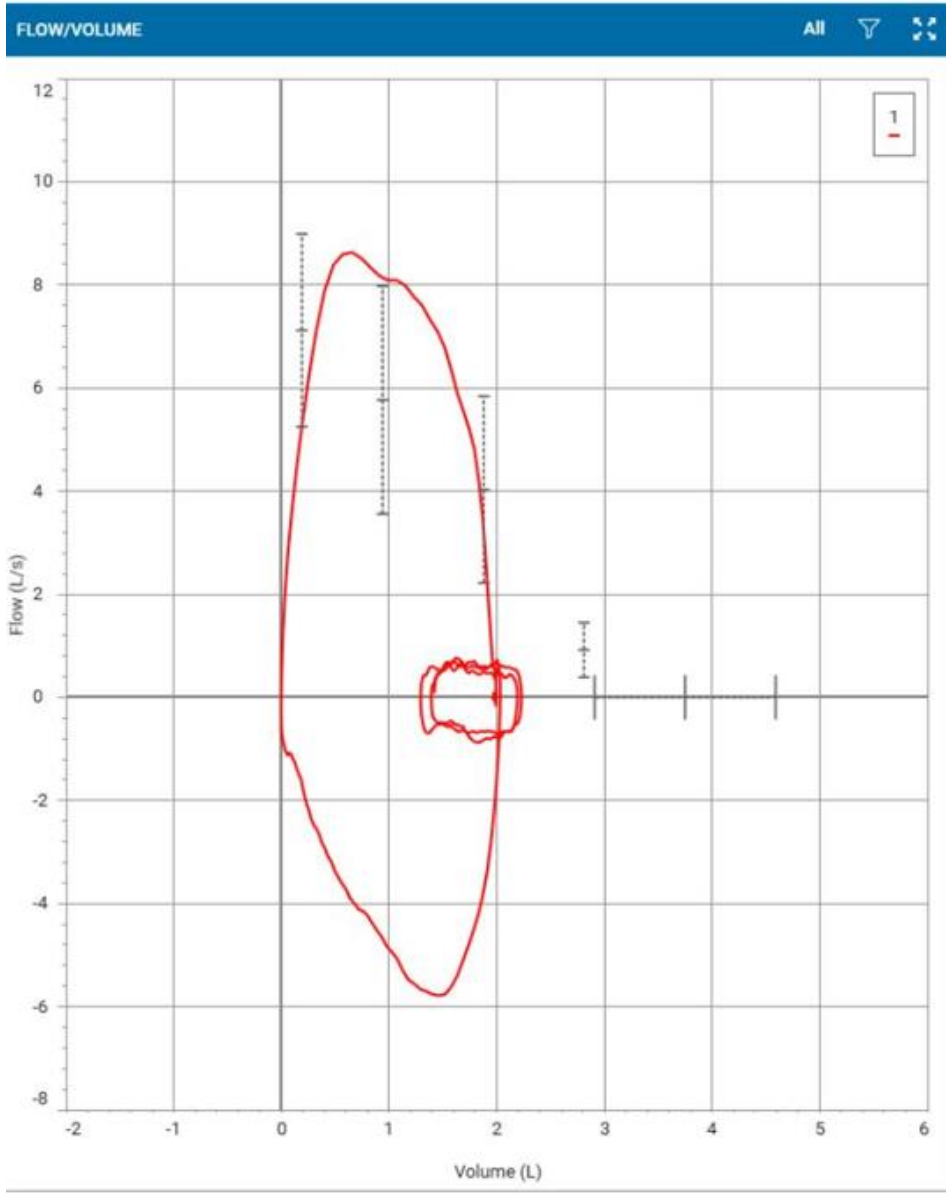
END OF FORCED EXPIRATION (EOFE)

Important to recognise whether **true FVC** has been achieved

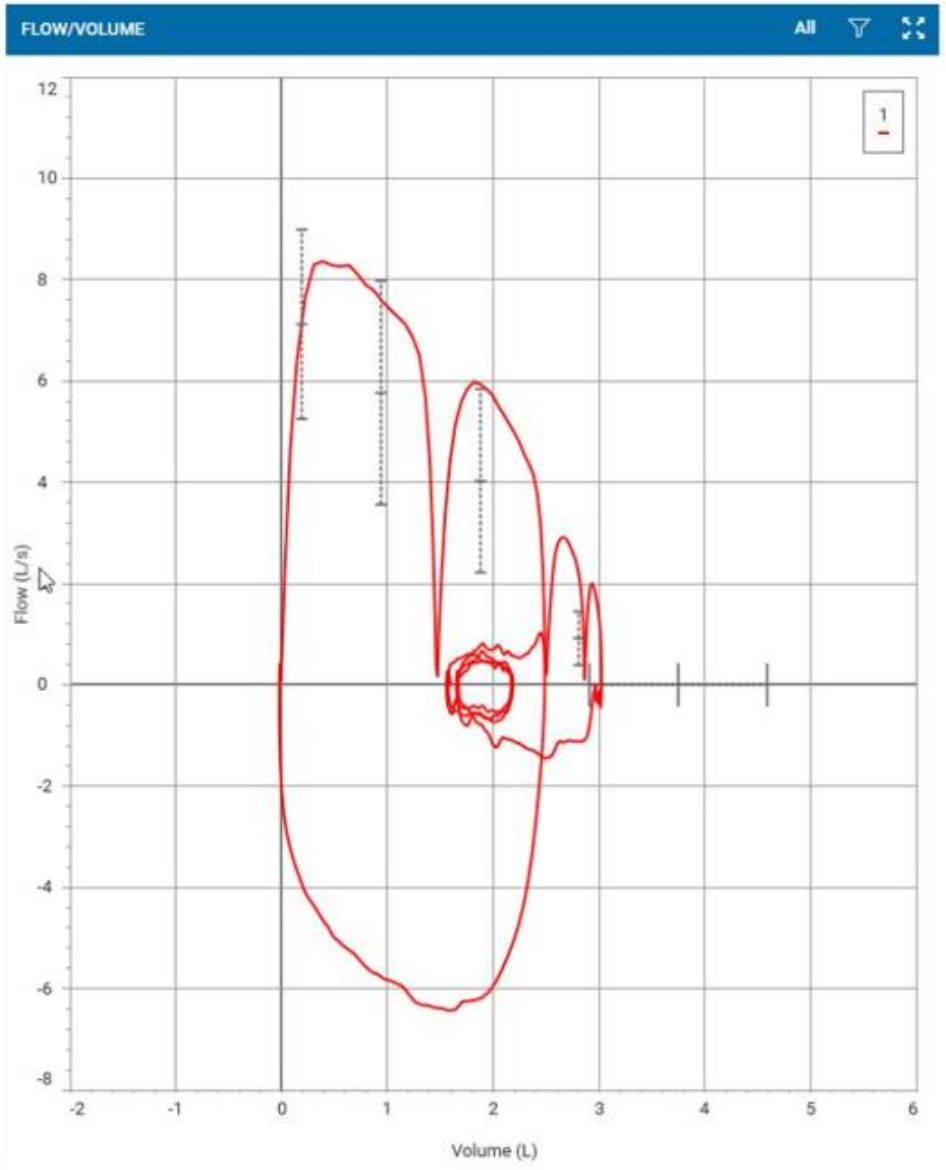
- Less than 0.025 L change in volume for 1 second “a plateau”
- Forced expiratory time of 15 seconds



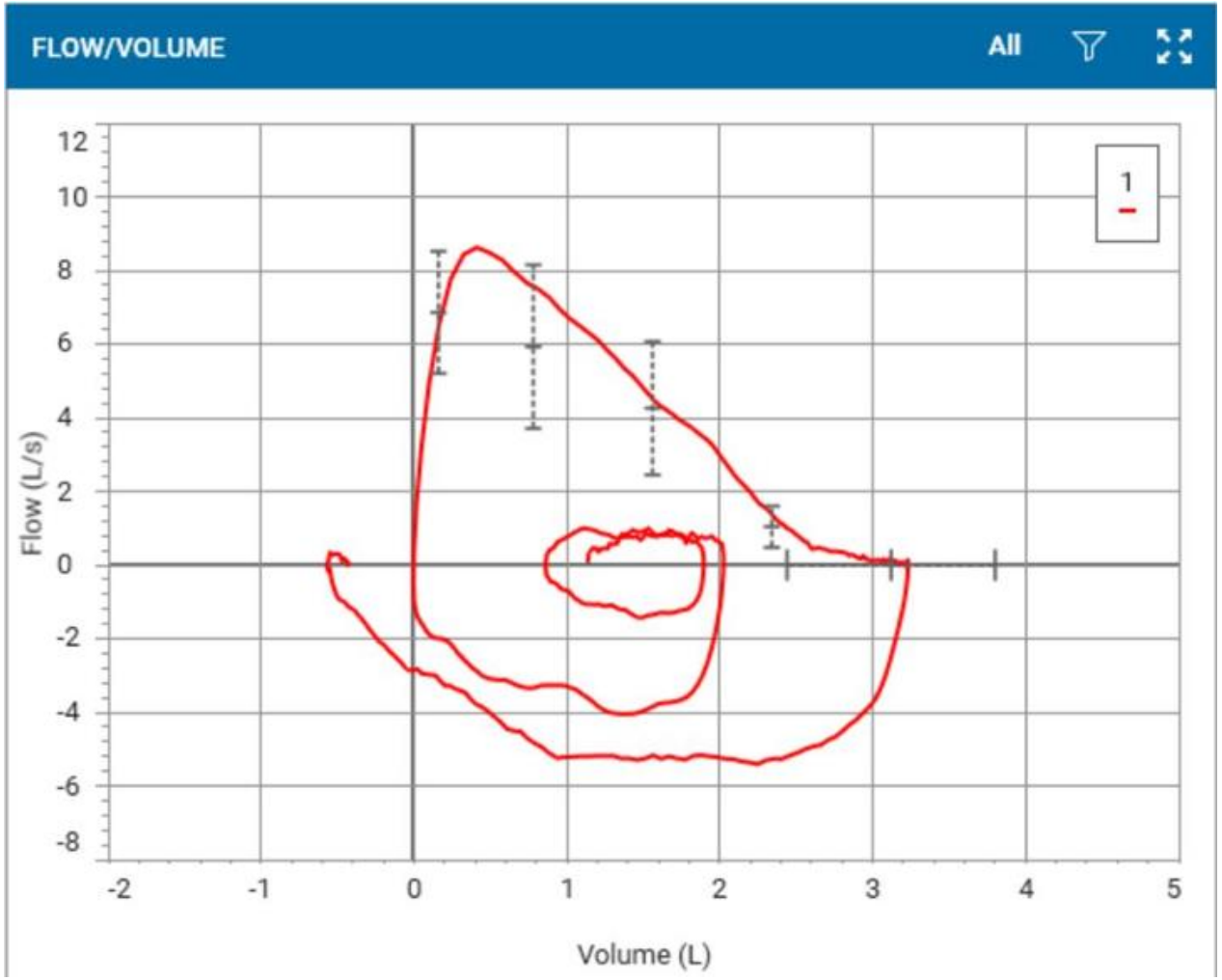
EARLY TERMINATION



COUGH



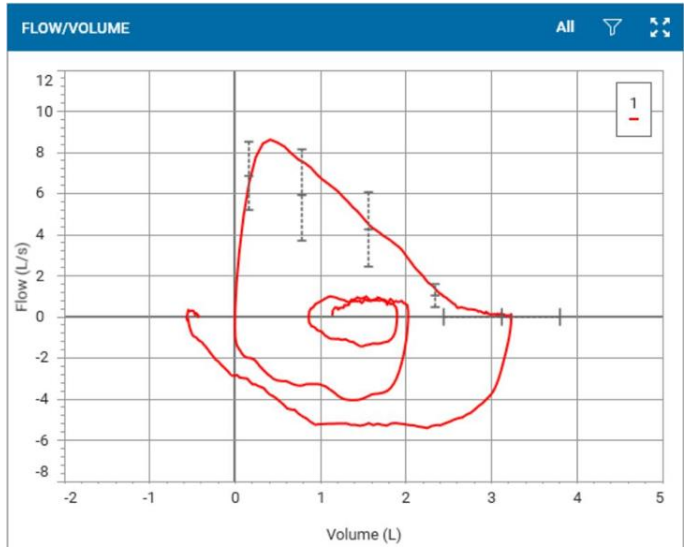
INITIAL SUBOPTIMAL INHALATION



REPEATABILITY & QUALITY ASSURANCE

FIVC- FVC

Comparing FIVC with FVC verifies that the start of the FVC manoeuvre was from full inhalation.



FIVC – FVC must <0.100L or 5% of FVC

If **FIVC – FVC** >0.100 or 5% of FVC the effort is unacceptable

✔ FIVC-FVC

✘ FIVC-FVC

If the FIVC is greater than FVC then the patient did not start maneuver at TLC.

Case examples

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INTERPRETATION

- Predicted normal values – age, height, gender, ethnicity.

- Global lung initiative (GLI) 2012 Spirometry reference equations are the recommended most up to date **multi-ethnic** and wide **age range**.

- GLI 2022 - The GLI global (2022) reference equations provide a single benchmark to standardize an individual's lung function measurements against **sex**, **standing height**, and **age.**

GLI

Global Lung Function Initiative

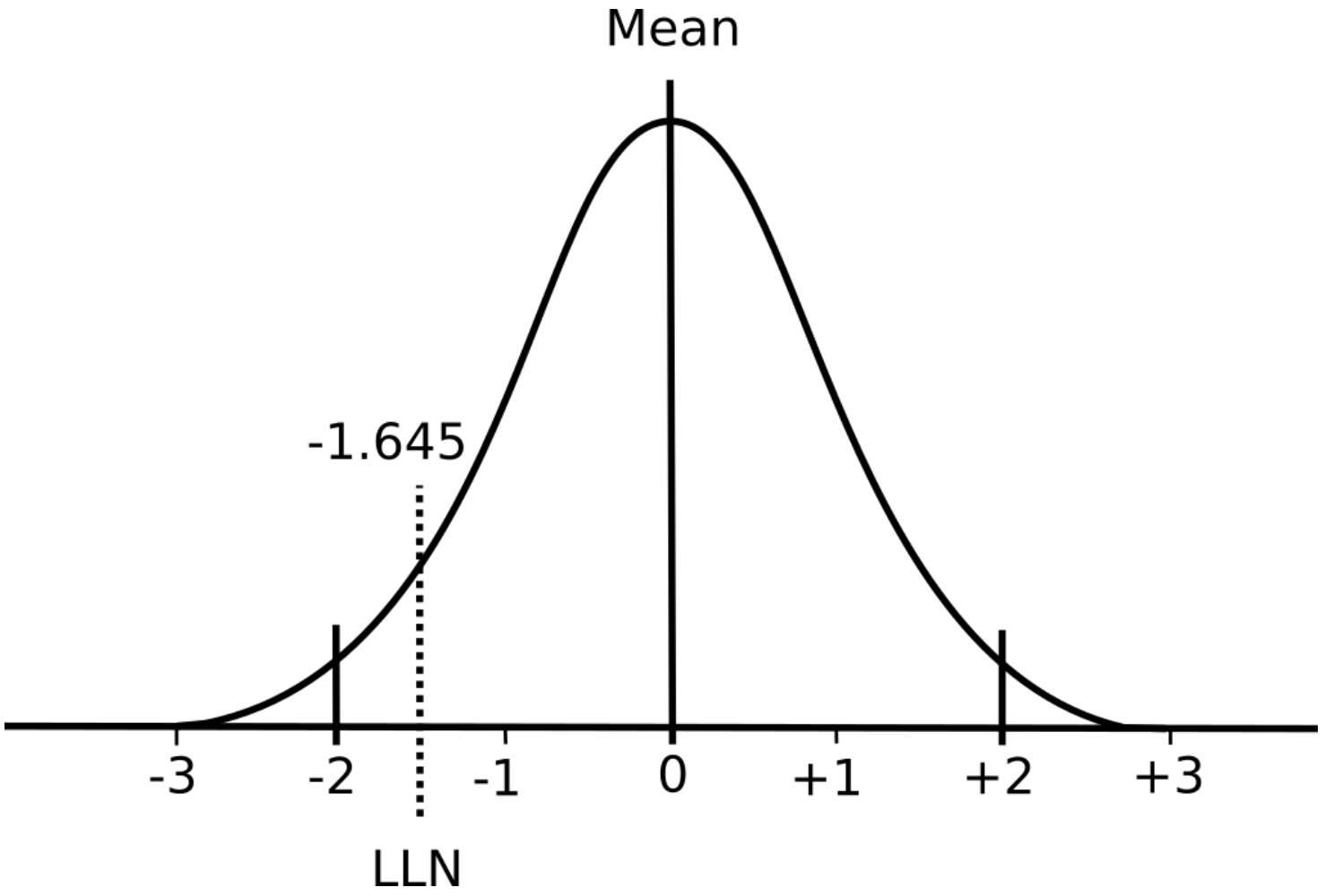
ERS/ATS technical standard on interpretive strategies for routine lung function tests

Sanja Stanojevic, David A. Kaminsky, Martin Miller, Bruce Thompson, Andrea Aliverti, Igor Barjaktarevic, Brendan G. Cooper, Bruce Culver, Eric Derom, Graham L. Hall, Teal S. Hallstrand, Joerg D. Leuppi, Neil MacIntyre, Meredith McCormack, Margaret Rosenfeld, Erik R. Swenson

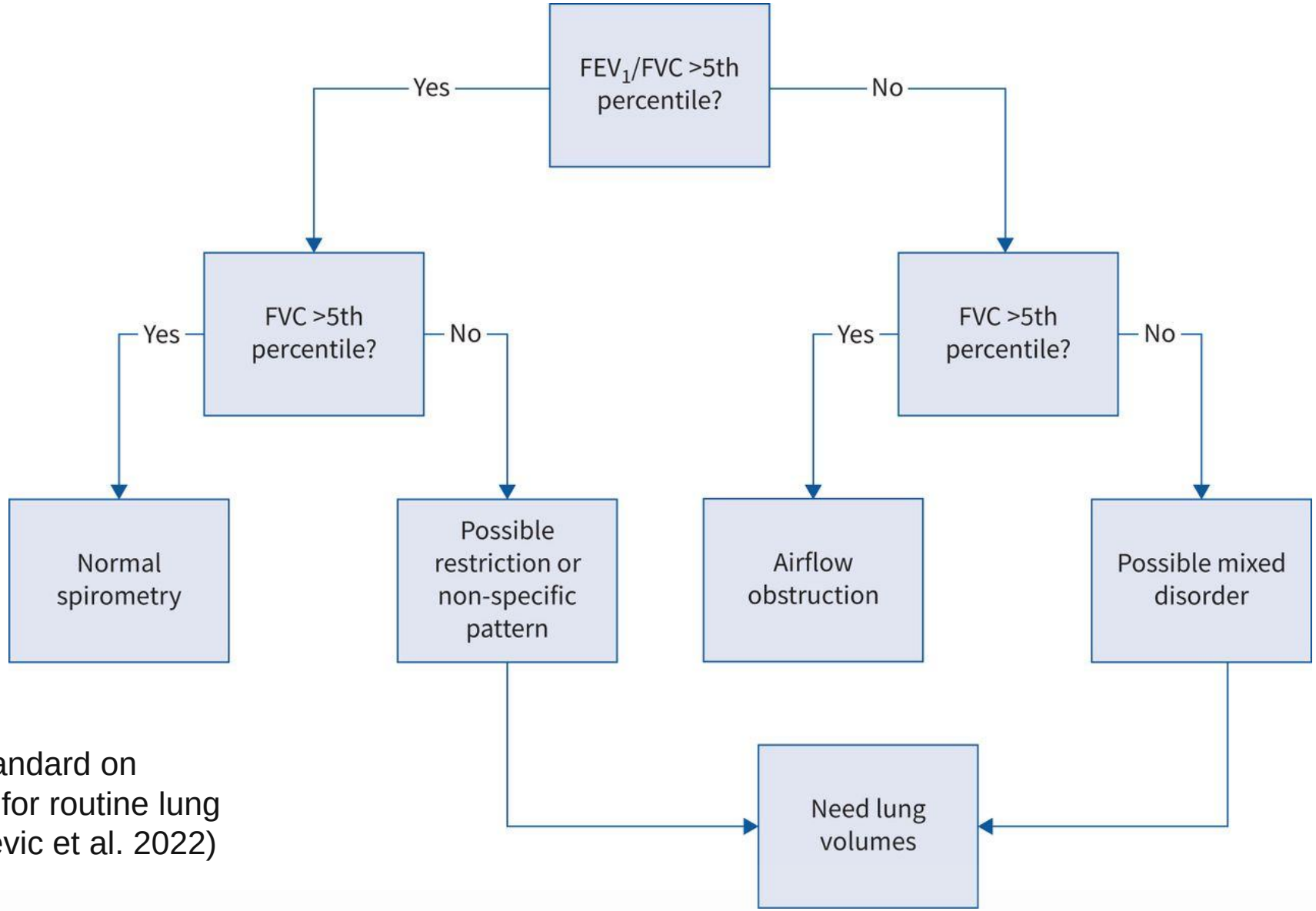
Please cite this article as: Stanojevic S, Kaminsky DA, Miller M, *et al*. ERS/ATS technical standard on interpretive strategies for routine lung function tests. *Eur Respir J* 2021; in press (https://doi.org/10.1183/13993003.01499-2021).

INTERPRETATION

Recommendation to use Z-score or LLN for interpretation – a Z-score value of (S.R) -1.645



Systematic approach to interpretation

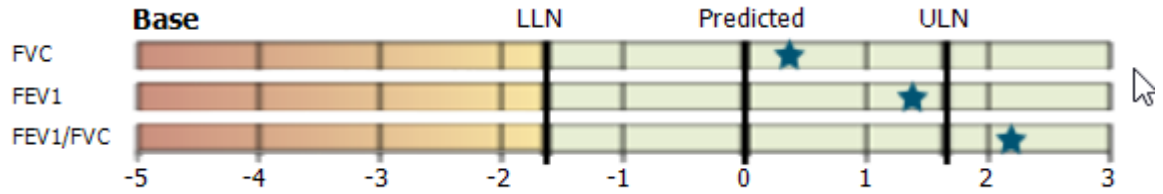


ERS/ATS technical standard on interpretive strategies for routine lung function tests (Stanojevic et al. 2022)

NORMAL RESULTS

Measured values are compared with predicted values derived from predictive reference equations.

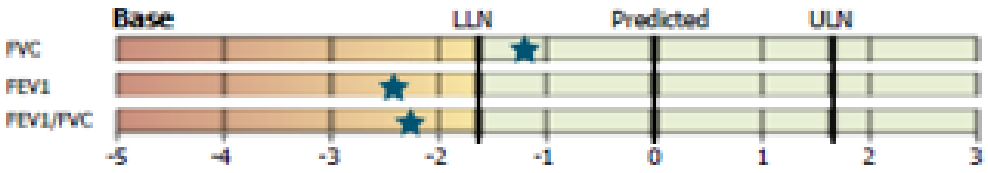
- FEV1/FVC ratio **greater than** 0.70 or z-score **greater than** -1.645 and LLN
- FVC **greater than** 80%predicted or z-score **greater than** -1.645 and LLN
- FEV1 **greater than** 80%predicted or z-score **greater than** -1.645and LLN

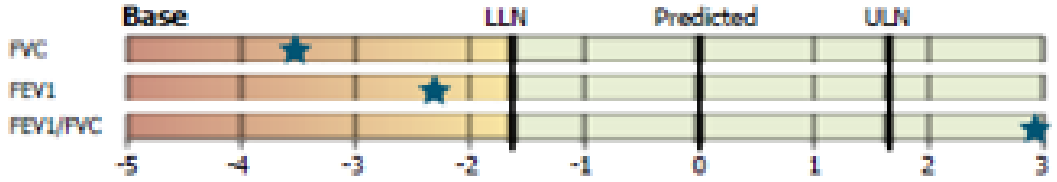


ABNORMAL RESULTS

Measured values are compared with predicted values derived from predictive reference equations.

- FEV1/FVC ratio **less than** 0.70 or z-score **less than** -1.645 and LLN
- FVC **less than** than 80%predicted or z-score **less than -**1.645 and LLN
- FVC **less than** than 80%predicted or z-score **less than** -1.645 and LLN





OBSTRUCTIVE DEFECT

- Reduced FEV1/FVC ratio
- Mildly reduced FEV1
- Normal FVC

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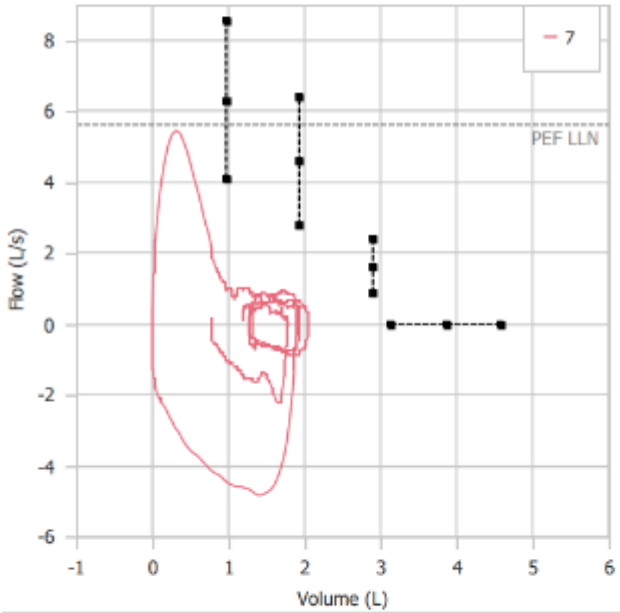
Spirometry report

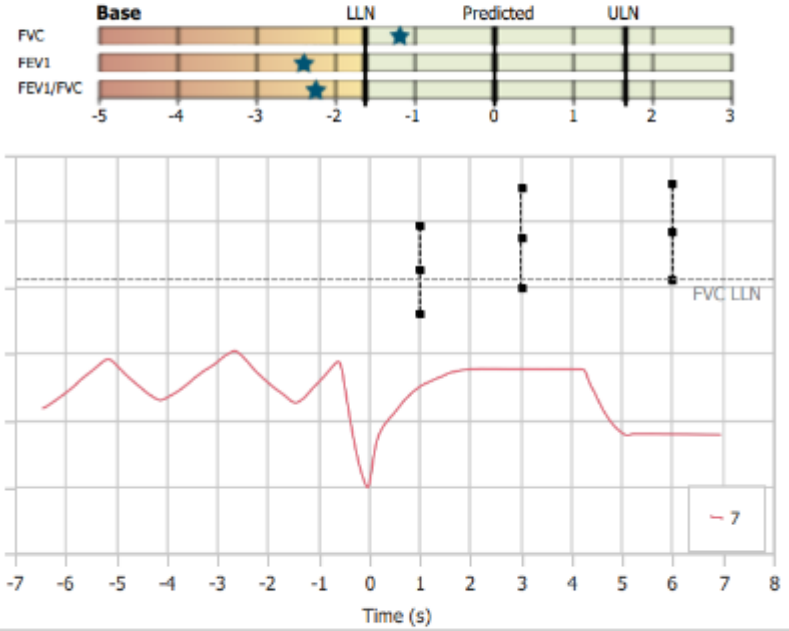
ADD

clinic 1 Base FVC
Subject
111
Melissa Smith

GROUP: -	**SITE: Vitalograph**	**PERFORMED: 01/11/2024 11:08:45 CharleneM (Administrator)**

Alternate ID	-	**Height**	170.0cm; 66.9in	**Device Name**	Pneumotrac Model-6800
Sex at Birth	Female	**BMI**	23.9	**Device Serial**	PV11282
Age	30.51	**Smoking**	Non Smoker	**Calibration**	01/11/2024 10:34:00
Date of Birth	29/04/1994	**Predicted Set**	GLI Other or Mixed Origin	**Temperature**	22.3°C; 72.1°F
Population	Other or Mixed Origin	**Correction Factor**	100 %		
Weight	69.0kg; 152.1lb	**Posture**	-		





Values at BTPS	Base				
Parameter	**Best**	**LLN**	**Z-Score**	**Pred**	**%Pred**
FVC (L)	**3.32**	3.13	-1.21	3.86	86.01%
FEV1 (L)	**2.31**	2.63	-2.42	3.28	70.43%
FEV1/FVC	**0.70**	0.75	-2.27	0.85	-
PEF (L/s)	**5.45**	5.59	-1.76	7.46	73.06%

RESTRICTIVE DEFECT

- Normal FEV1/FVC ratio
- Reduced FEV1
- Reduced FVC

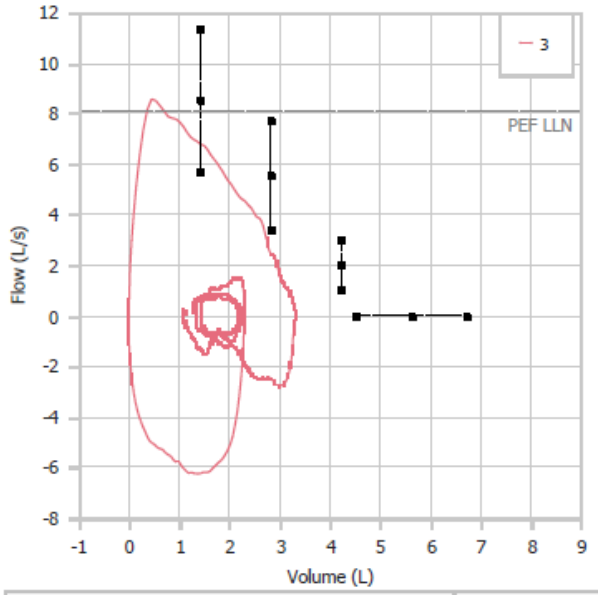
Vitalograph®

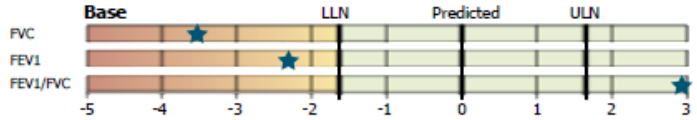
Spirometry report

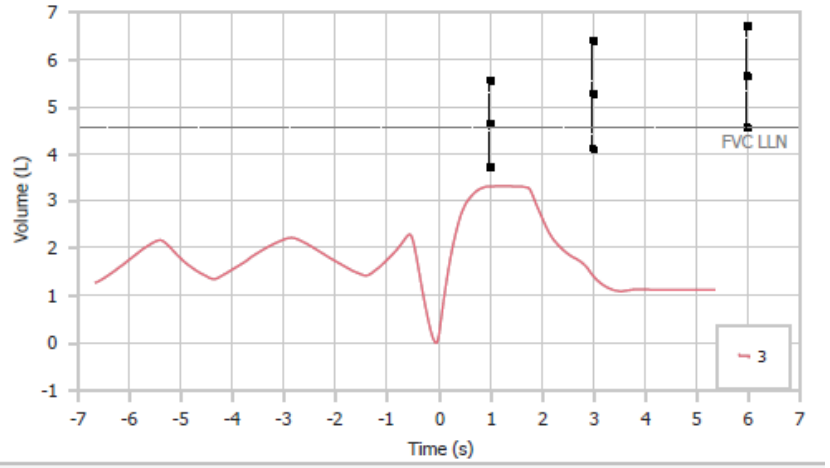
clinic 1 Base FVC
Subject
061123
Gary Jones

GROUP: -
SITE: Vitalograph
PERFORMED: 06/11/2024 11:38:40
CharleneM (Administrator)

Alternate ID	-	**Height**	180.0cm; 70.9in	**Device Name**	Pneumotrac Model-6800
Sex at Birth	Male	**BMI**	21.6	**Device Serial**	PV11282
Age	29.30	**Smoking**	-	**Calibration**	06/11/2024 11:30:00
Date of Birth	18/07/1995	**Predicted Set**	GLI Caucasian	**Temperature**	21.6°C; 70.9°F
Population	Caucasian	**Correction Factor**	100 %		
Weight	70.0kg; 154.3lb	**Posture**	-		







Values at BTPS	Base				
Parameter	**Best**	**LLN**	**Z-Score**	**Pred**	**%Pred**
FVC (L)	**3.31**	4.54	-3.52	5.63	58.79%
FEV1 (L)	**3.31**	3.70	-2.32	4.63	71.49%
FEV1/FVC	**1.00**	0.72	3.33	0.83	-
PEF (L/s)	**8.57**	8.07	-1.30	10.44	82.09%

Thank You, Questions?

CHARLENE MHANGAMI | SENIOR CLINICAL APPLICATION SPECIALIST

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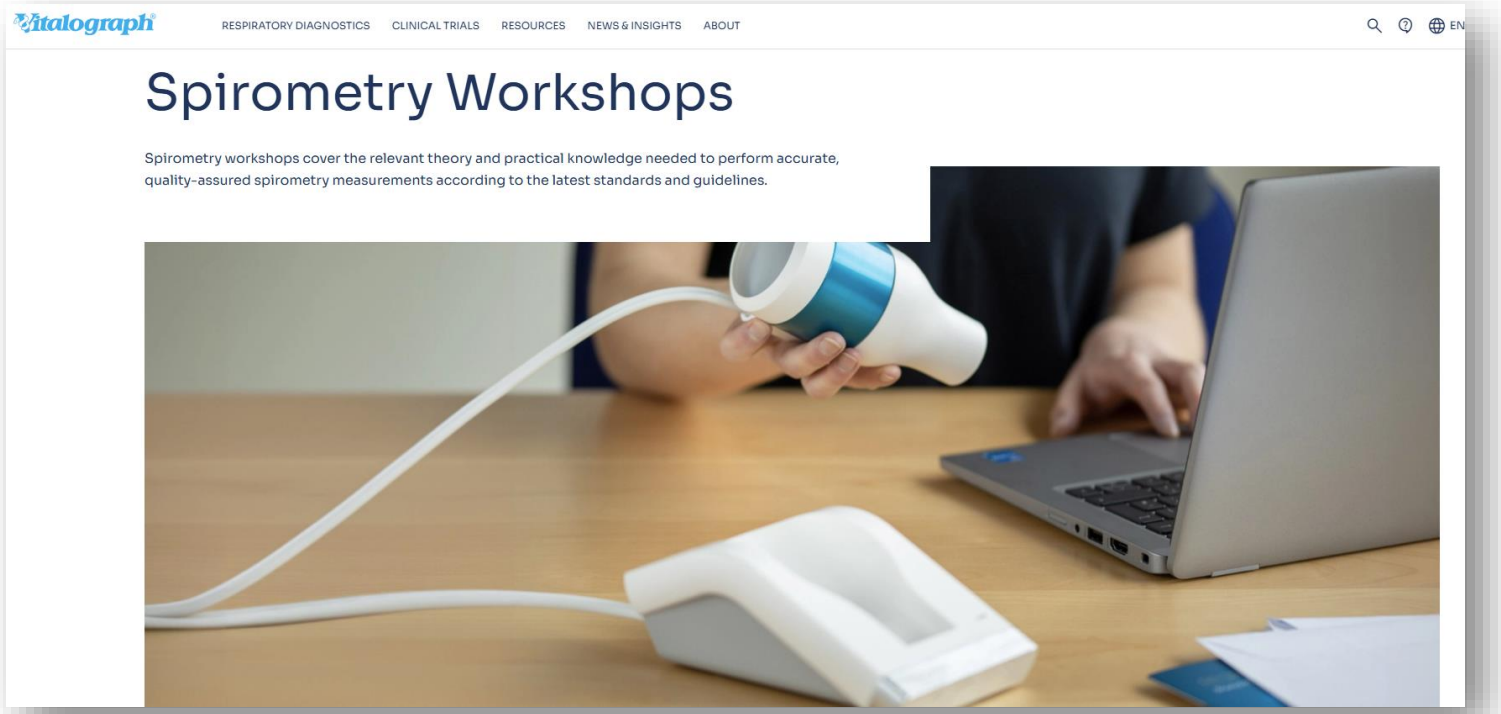

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