

# Pulmonary Function Tests

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# Learning outcomes

## Be able to:

- Be able to relate the concepts of FVC, FEV1 and FVC/FEV1 ratio to obstructive and restrictive disease.
- Understand reported spirometry results in relation to disease
- Be able to explain changes in peak flow in relation to changes in respiratory disease status

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# Pulmonary Function Tests

- Pulmonary function tests provide objective data on a patient's lung function.
- Used to
  - Measure underlying lung function
  - Changes in lung function secondary to treatment or exacerbations
  - Monitor changes in progressive lung disease such as COPD
  - Monitor lung function during use of drugs toxic to the lungs
- Most common pulmonary function tests used include
  - Lung volumes
  - Spirometry
  - Lung flow volume loops
  - Peak expiratory flow

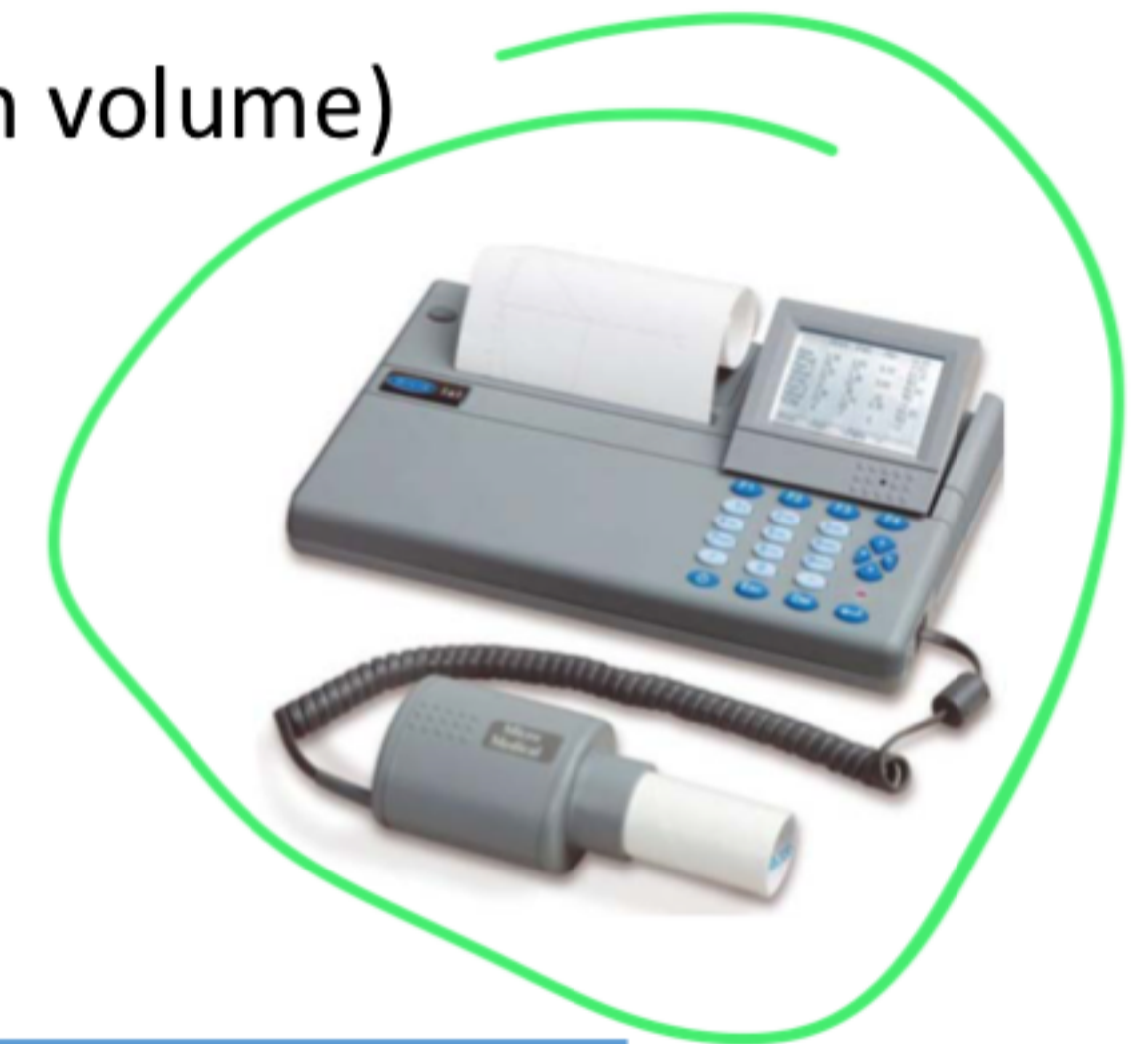


# Spirometry

- Performed for every patient with suspected asthma
- In general practice, spirometry aims to:
  - **Assess variability** of airflow obstruction
  - Measure the **degree of airflow obstruction** compared to normal
- Allows differentiation between **asthma** and **COPD**
- Allows differentiation between obstructive and restrictive disease
- Can determine if airflow limitation is reversible
- The following video from the Asthma Management Council shows how spirometry is performed (4:15 minutes).
- <https://www.nationalasthma.org.au/living-with-asthma/how-to-videos/performing-spirometry-in-primary-care>

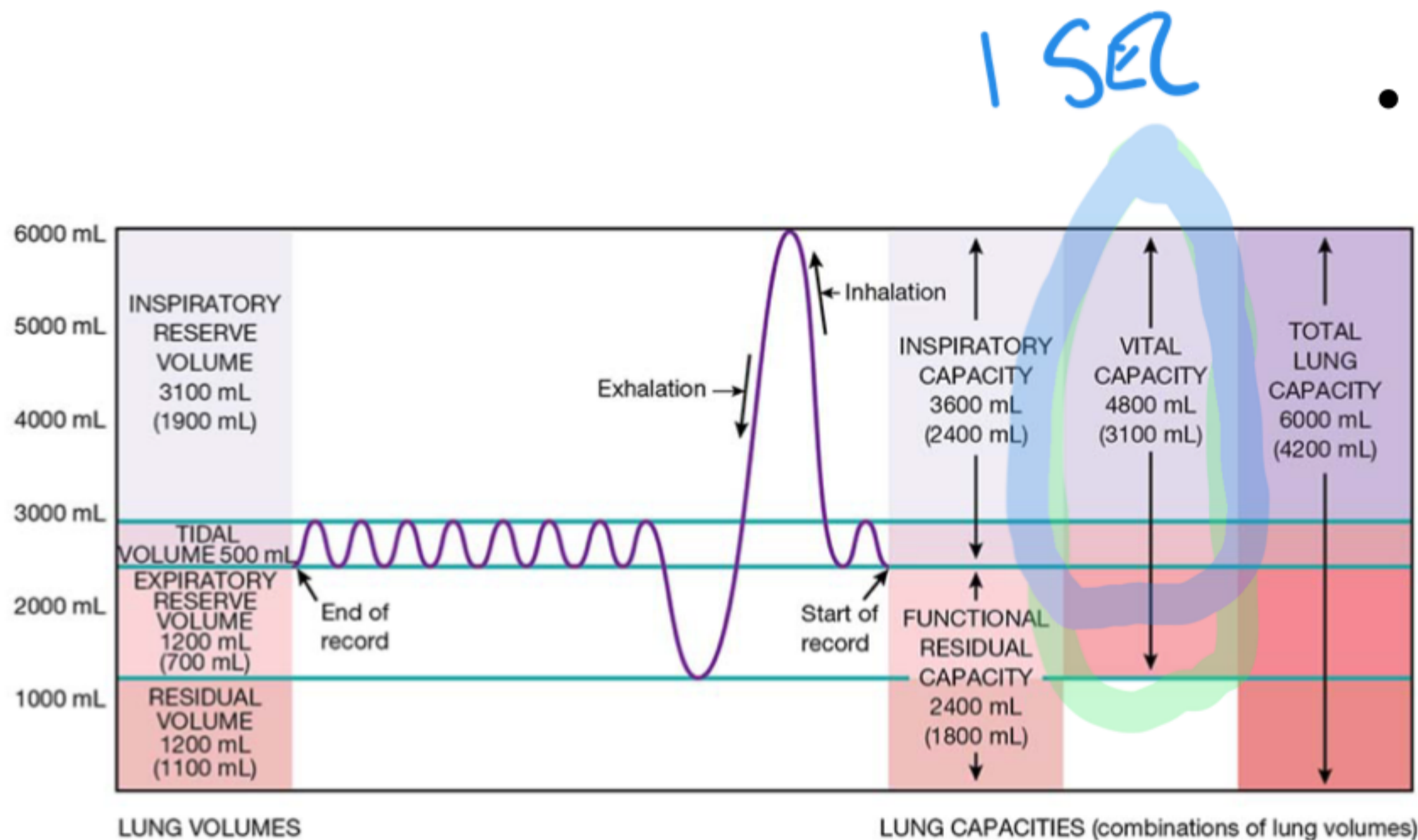
# Spirometry

- Measures lung volume (directly) and capacity (inferred from volume)
- Average lung capacity of an adult male = 6 litres
- Average lung capacity of an adult female = 4.5 litres
- Allows differentiation between:



Obstructive Pulmonary Disease	Restrictive Pulmonary Disease
Asthma	Interstitial lung disease
COPD	Respiratory muscle weakness

# Important lung volumes



- Figure 23.15

- Tidal volume
- Inspiratory reserve volume
- Forced Vital Capacity (FVC)
- Forced Expiratory Volume<sub>1</sub> (FEV<sub>1</sub>)
- Ratio of FEV<sub>1</sub>/FVC
- Peak flow

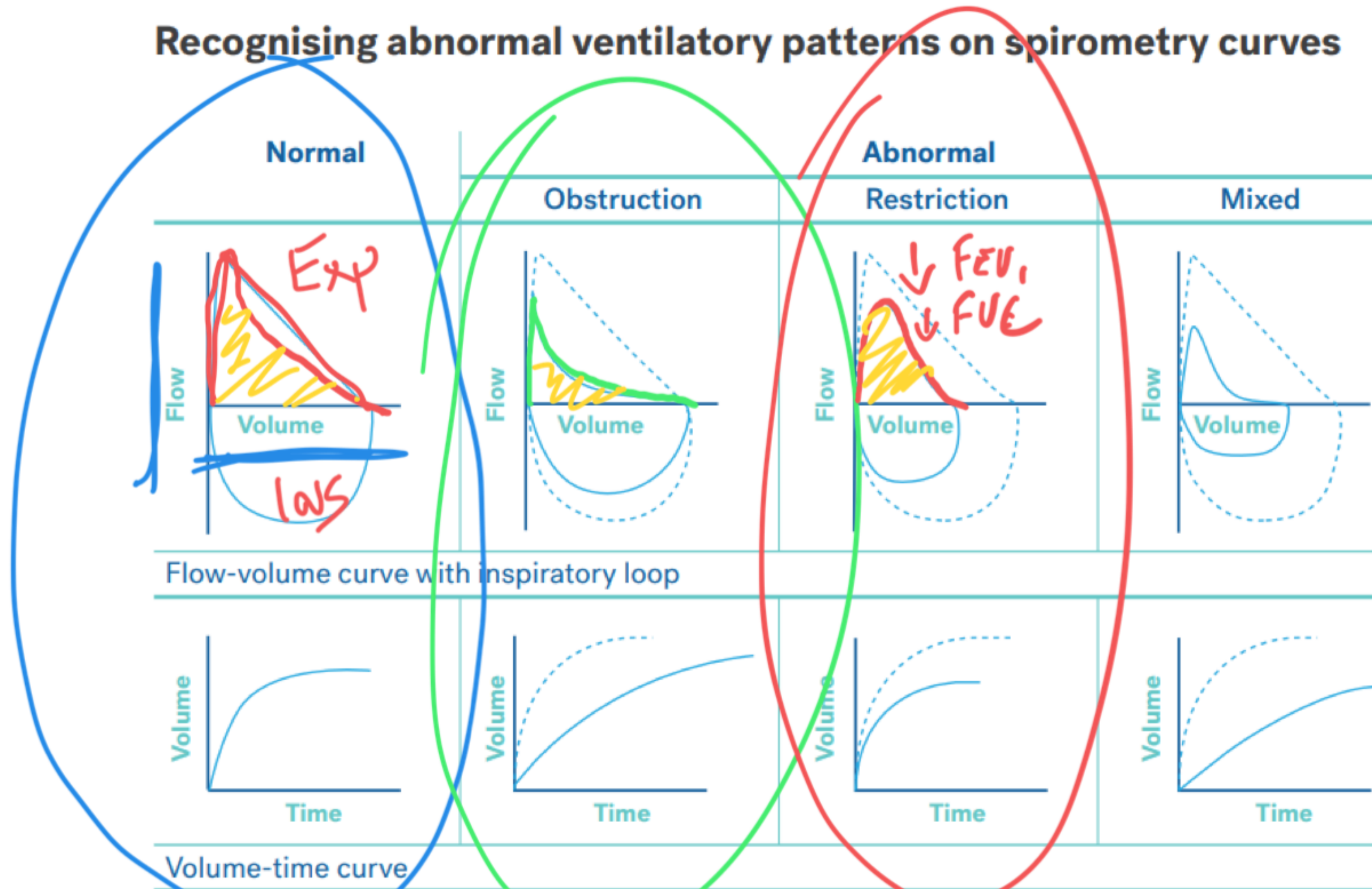
Images taken from Tortora, GJ., Derrickson, B., Burkett, B., Peoples, G., Dye, D., Cooke, J., et al. Principles of anatomy and physiology. Second Asia-Pacific ed. Queensland, Australia: John Wiley & Sons; 2019.



# Patterns of Respiratory disease

- Obstructive disease (COPD / Asthma)
  - Decreased FEV<sub>1</sub>,
  - Normal or decreased FVC,
  - Decreased FEV<sub>1</sub>/FVC ratio (normal is 70-80%)
- Restrictive disease (Interstitial lung disease, semi-paralysis of diaphragm or skeletal muscles)
  - Decreased Total lung capacity (FVC)
  - Decreased FEV<sub>1</sub> and FVC
  - Normal FEV<sub>1</sub> /FVC

## Recognising abnormal ventilatory patterns on spirometry curves



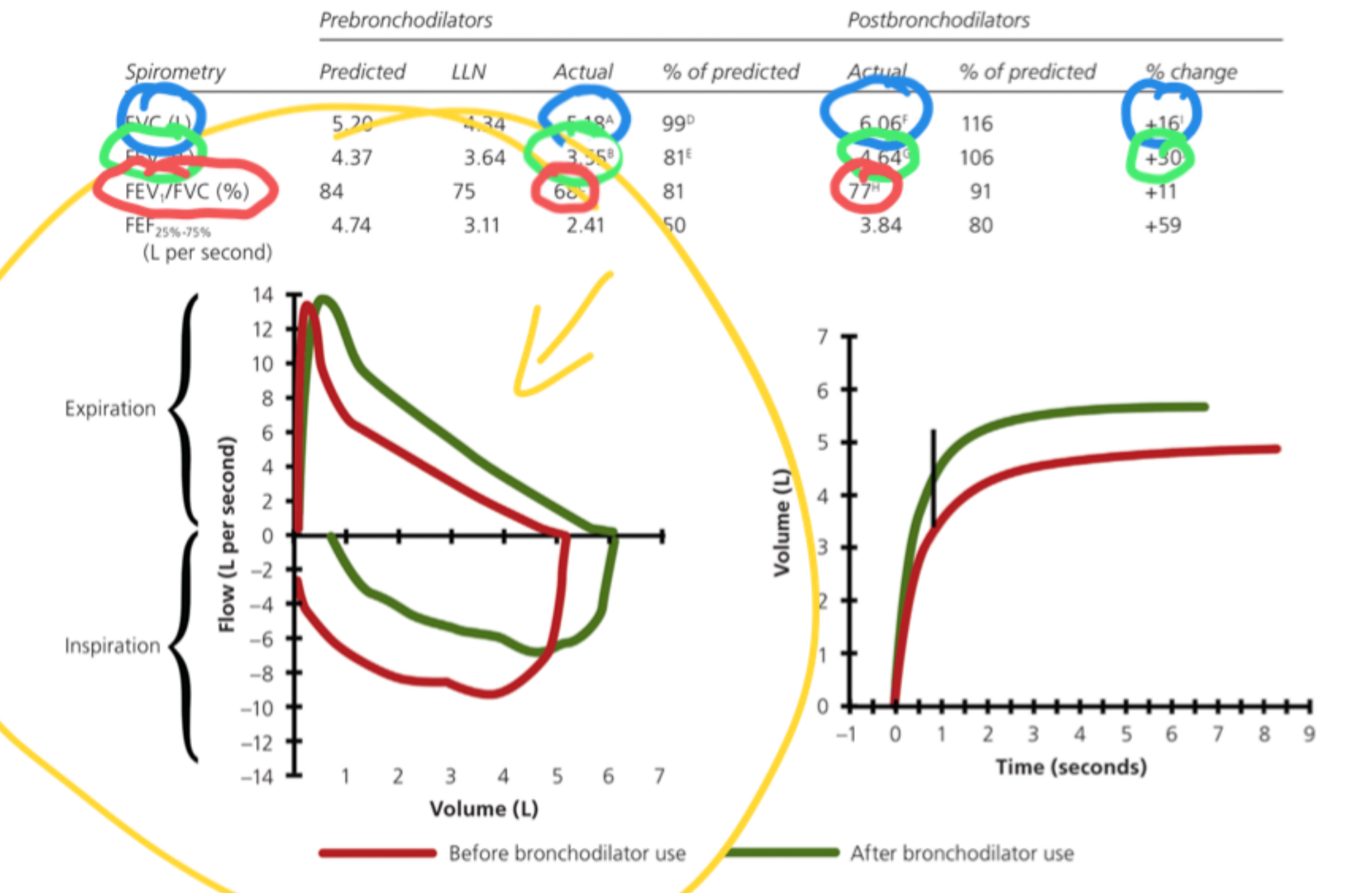
Taken from Spirometry quick reference guide. National Asthma Council Australia available at [https://d8z57tiamduo7.cloudfront.net/resources/NAC\\_Spirometry-Quick-Reference-Guide\\_2020.pdf](https://d8z57tiamduo7.cloudfront.net/resources/NAC_Spirometry-Quick-Reference-Guide_2020.pdf)



# Spirometry – obstructive defect with reversibility

Age: 26 years Height: 5 ft, 8 in Weight: 197 lb Sex: Male Race: Hispanic

- Perform baseline spirometry
- Administer bronchodilator (4 puffs salbutamol via MDI and spacer)
- Wait 10-15 minutes
- Repeat spirometry
- The obstructive defect is reversible because at least one of the two measurements (FVC or FEV<sub>1</sub>) increased by at least 0.2 L and by at least 12%.



A = FVC (before bronchodilators), this is > LLN and thus does not show a restrictive pattern  
 B = FEV<sub>1</sub> (before bronchodilators)  
 C = FEV<sub>1</sub>/FVC ratio (before bronchodilators), this is < LLN and thus shows an obstructive defect  
 D = FVC percentage of predicted (before bronchodilators)  
 E = FEV<sub>1</sub> percentage of predicted (before bronchodilators)  
 F = FVC (after bronchodilators)

G = FEV<sub>1</sub> (after bronchodilators)  
 H = FEV<sub>1</sub>/FVC ratio (after bronchodilators)  
 I = A 0.88-L increase in FVC is a 16% increase  
 J = A 1.09-L increase in FEV<sub>1</sub> is a 30% increase  
 The above indicates reversibility because at least one of the two (FVC or FEV<sub>1</sub>) increased by at least 0.2 L and by at least 12%

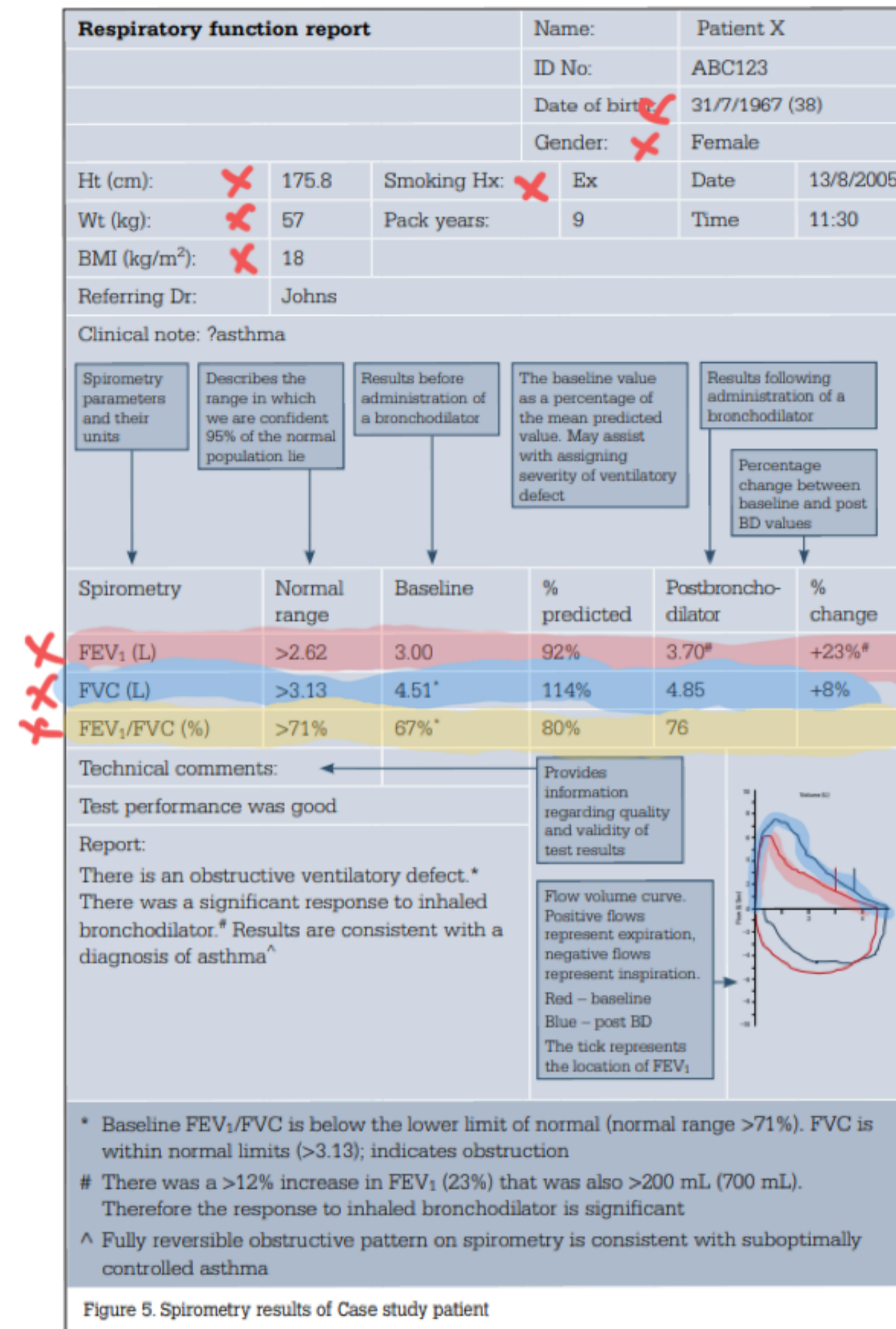
Figure taken from Johnson, J. and Theurer, W. A stepwise approach to the interpretation of pulmonary function tests. American Family Physician. 2014 Mar 1;89(5):359-366.



# Example respiratory report

- Things to note
  - Low baseline FEV1
  - Low baseline FEV1/FVC
  - Post-bronchodilator
    - Improvement in FEV1
    - Improvement in FVC
    - FEV1/FVC ration improvement

Figure 5 taken from: Borg, B. & Maughton, M. Spirometry. Australian Family Physician. 2011, April;40:4;216-219.





# Peak flow meters

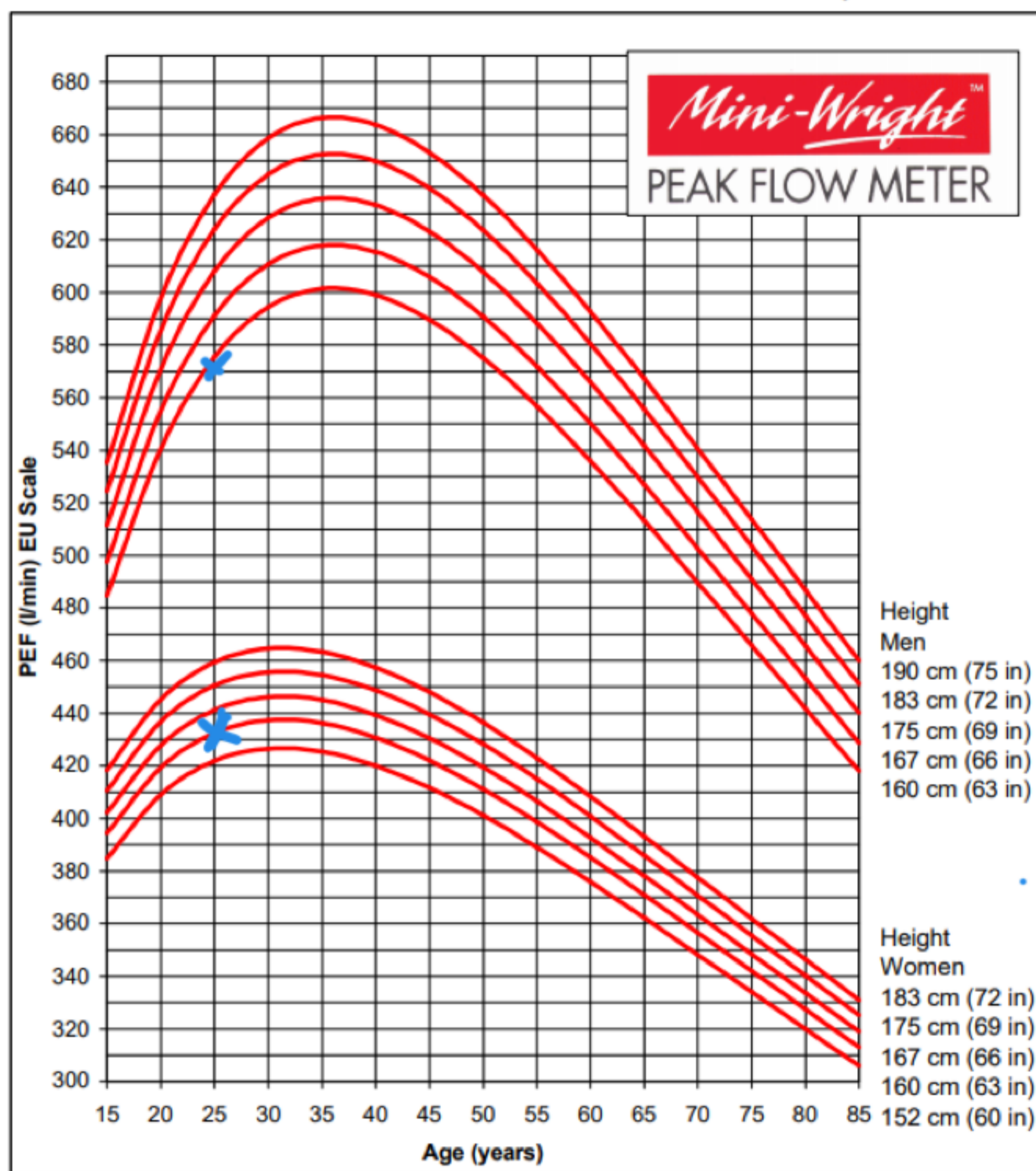
- Measures peak (maximum) rate at which a person can expel air
- Provides an indication of the degree of obstruction in
  - Asthma
  - COPD
- Only used by a minority of patient
  - Can objectively identify disease flares
  - Disease progress over time (spirometry better for this)
- Not diagnostic for asthma or COPD
- Just useful for home measurement





## PEAK EXPIRATORY FLOW RATE - NORMAL VALUES

For use with EU/EN13826 scale PEF meters only



Adapted by Clement Clarke for use with EN13826 / EU scale peak flow meters from Nunn AJ Gregg I, Br Med J 1989:298;1068-70

In men, readings up to 100 L/min lower than predicted are within normal limits. For women, the equivalent figure is 85 L/min. Values are derived from Caucasian populations.

Mini-Wright  
(Standard Range)  
EU scale  
(EN 13826)

Blue text  
on a yellow  
background



Single Patient Use  
Part Ref: 3103388

Multiple Patient Use  
Part Ref: 3103387

NHS Logistics  
Code : FDD 609

Mini-Wright  
(Low Range)  
EU scale

Blue text  
on a yellow  
background



Single Patient Use  
Part Ref: 3104708

Multiple Patient Use  
Part Ref: 3104710

Clement Clarke has developed mathematical equations that will allow conversion of P.E.F. readings from Wright-McKerrow scale to EN 13826 scale, and vice-versa. Contact us directly, or visit the website

[www.peakflow.com](http://www.peakflow.com)

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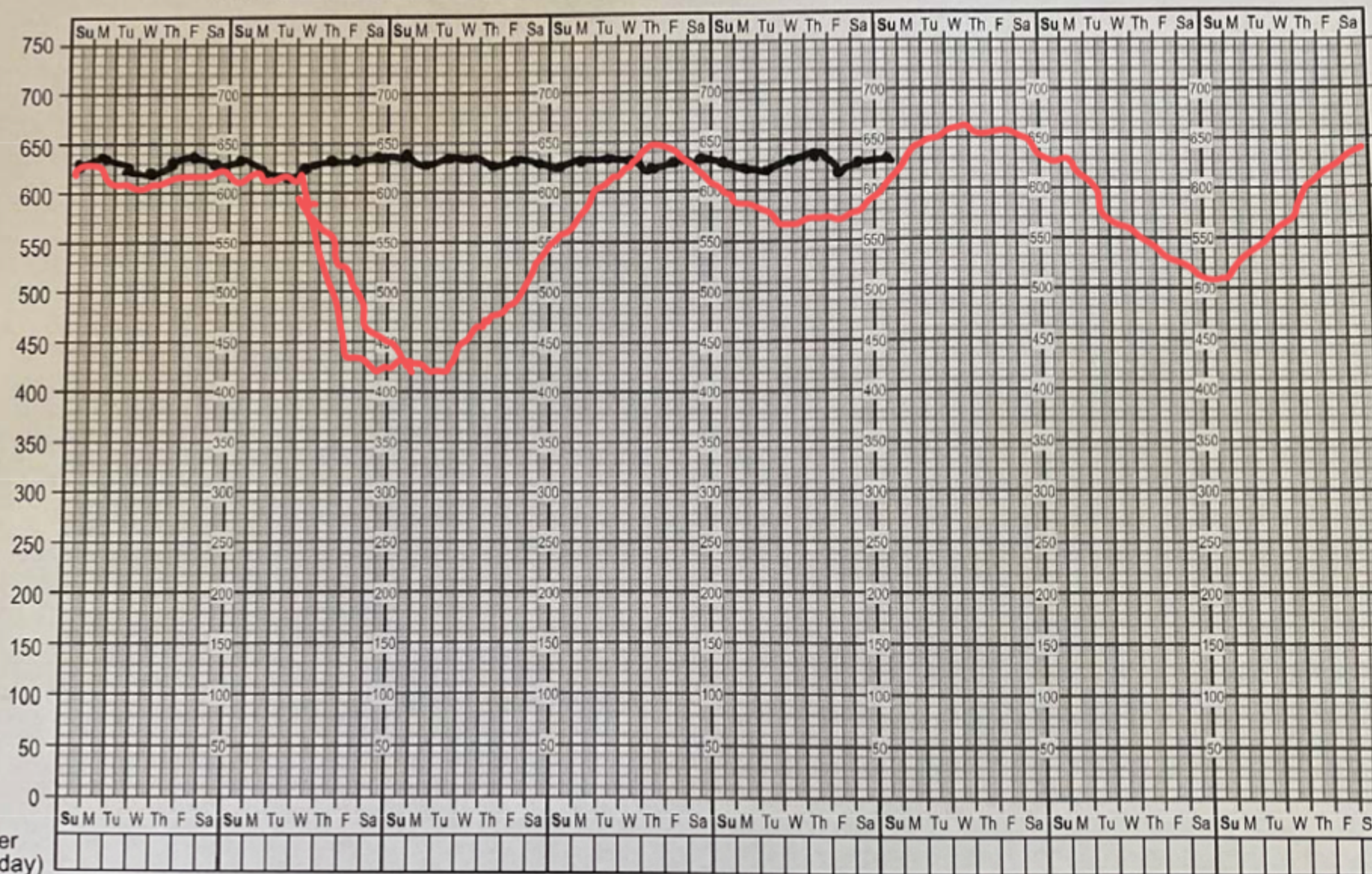
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Name JOHN

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**X** Reliever (puffs/day)

Other Medications NIL