KEYNOTE

Pulmonary Function Tests: A Critical Tool in the Patient Pathway

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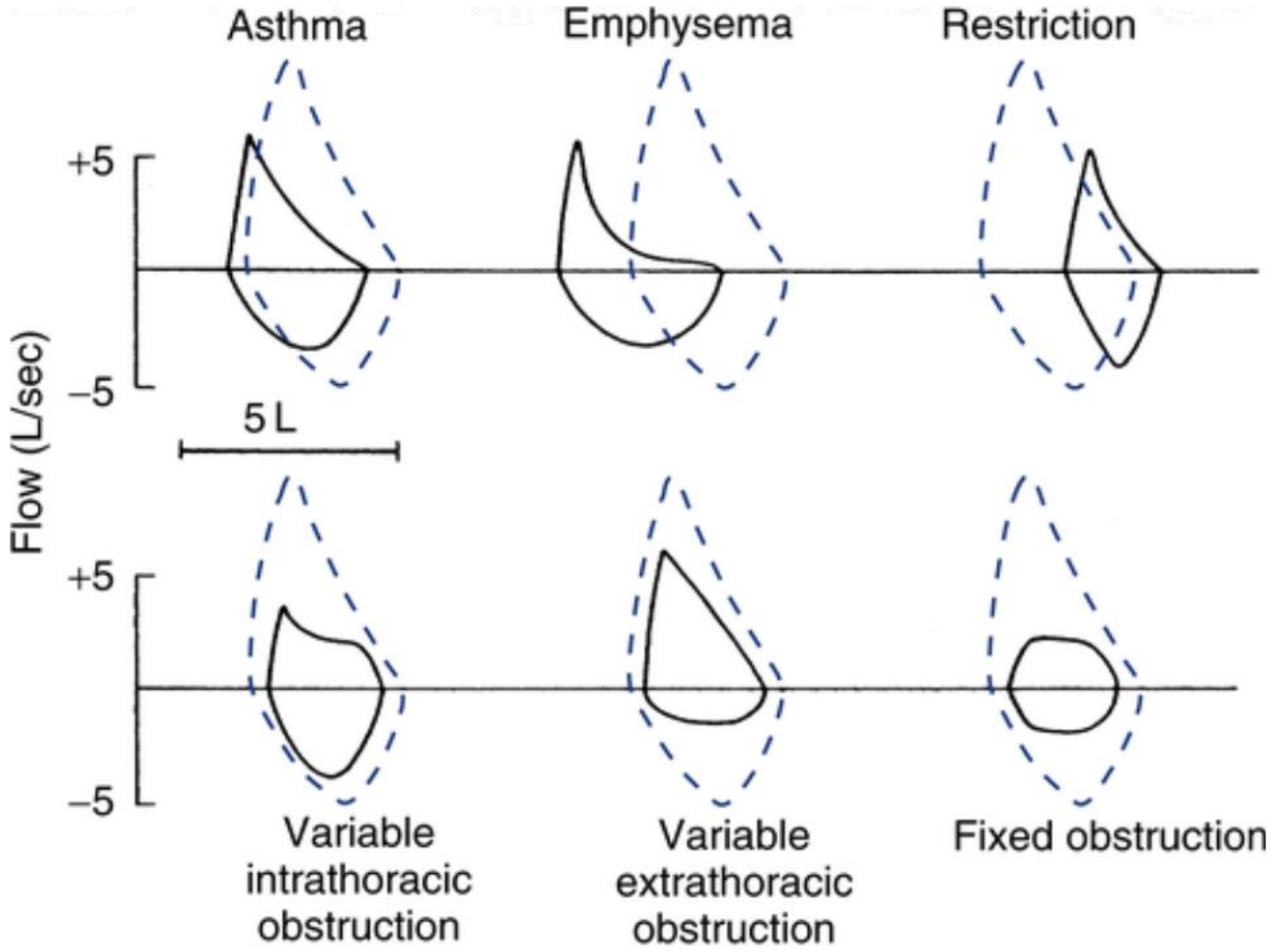
Spirometry



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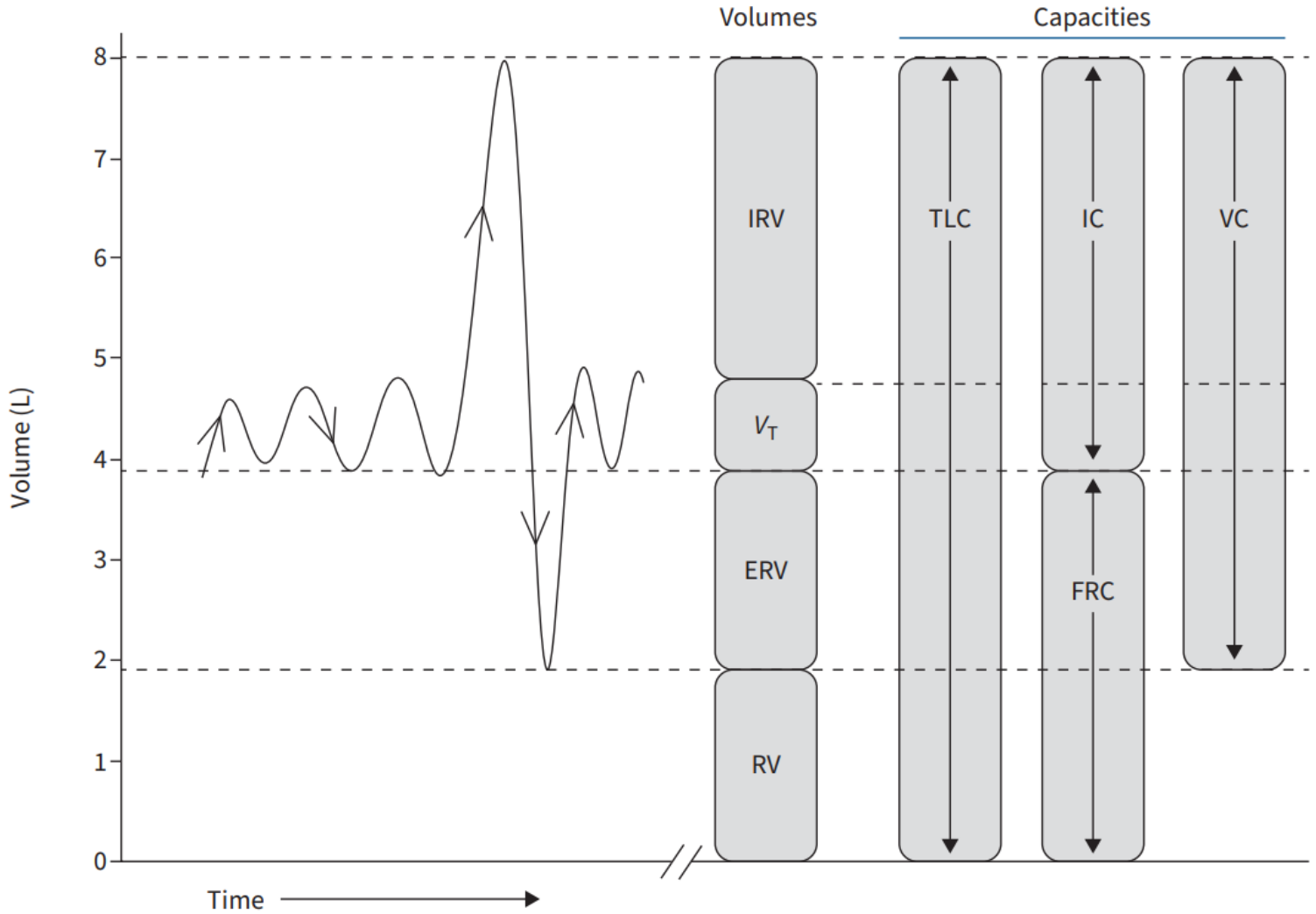
https://thoracickey.com/pulmonary-function-testing-5/

Body Plethysmography



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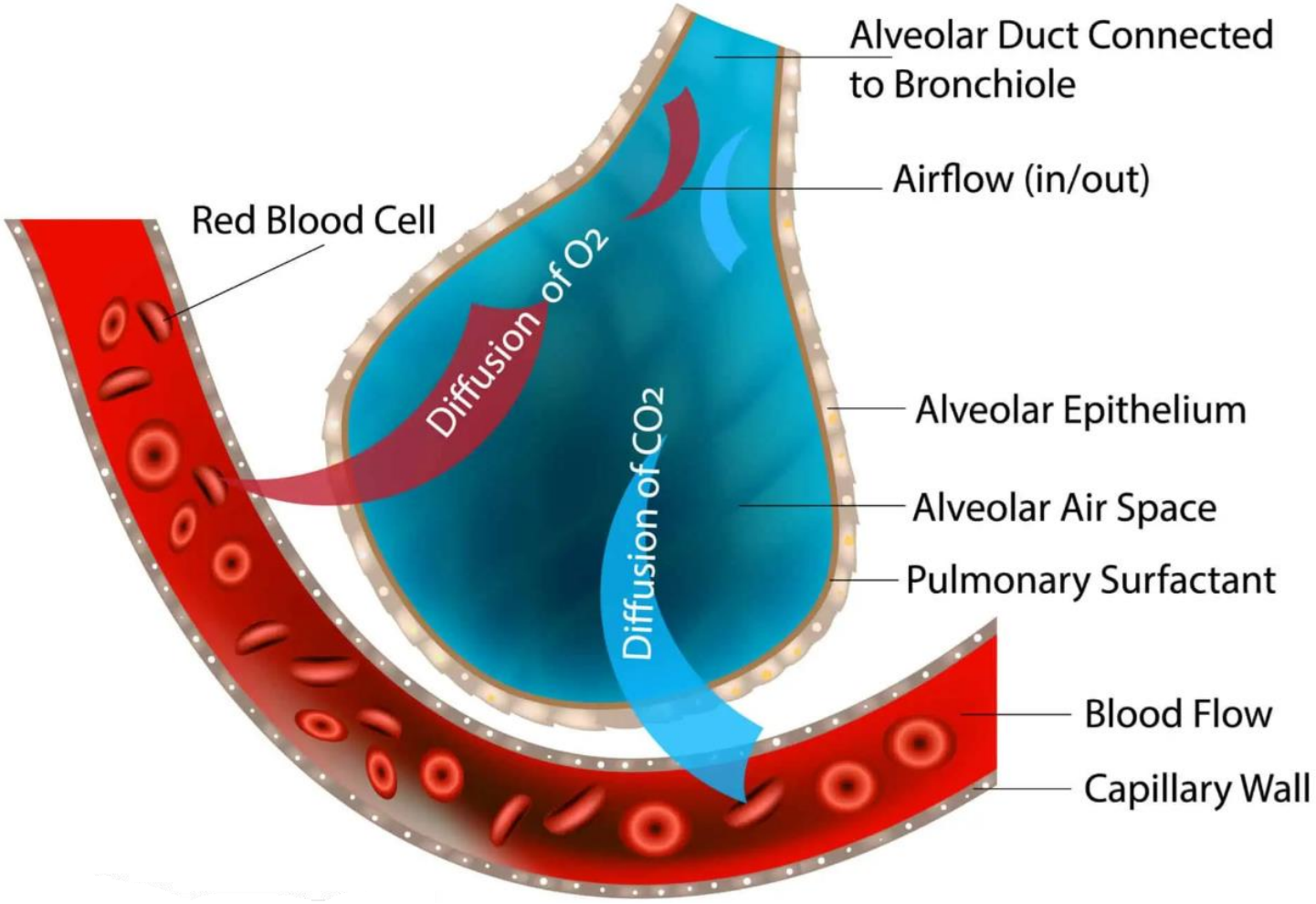
Bhakta et al. (2023)

Diffusing capacity carbon monoxide



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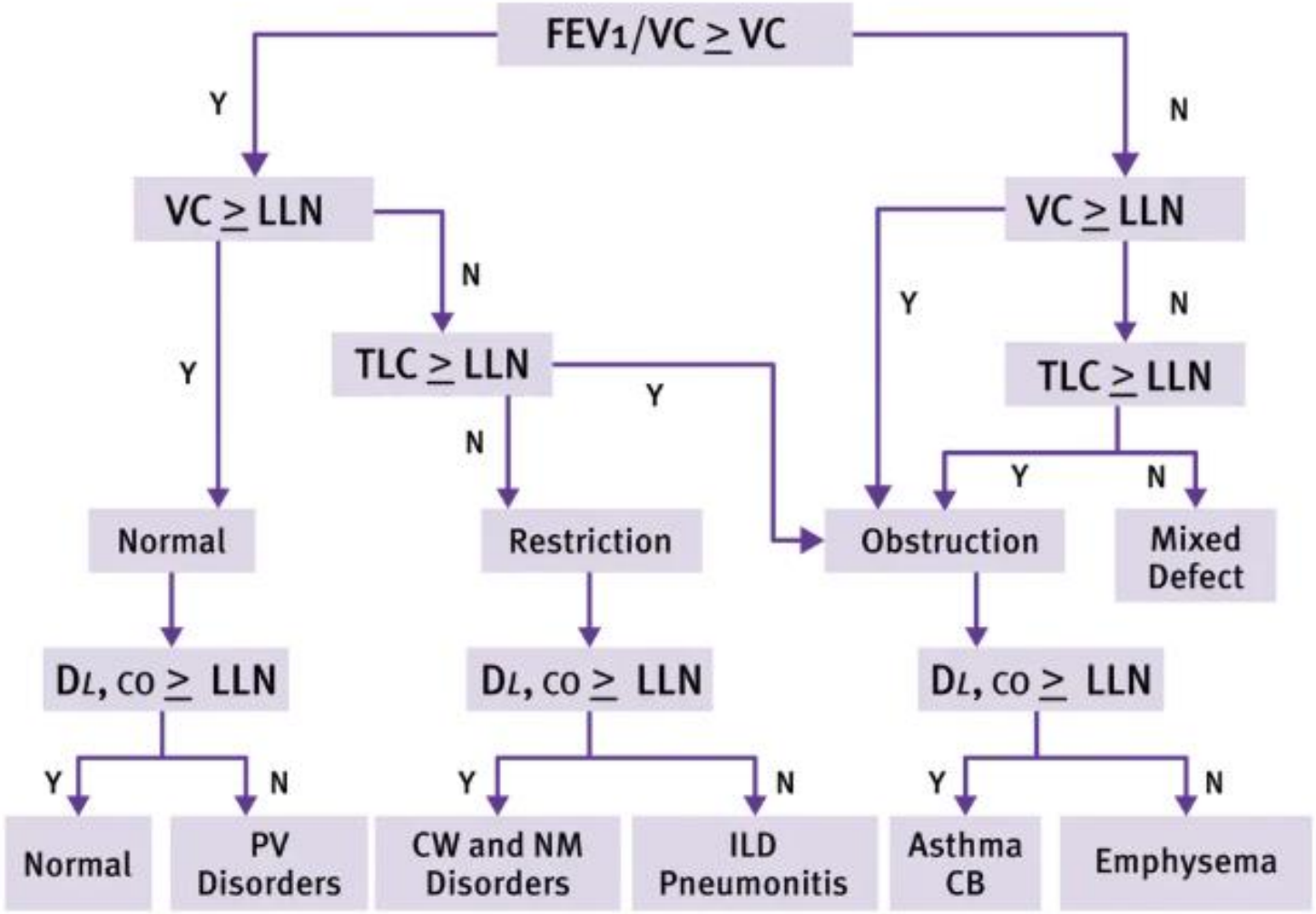
https://pfwarriors.com/lung-function-test-diffusing-capacity-of-lung-dlco/

"Full PFTs"



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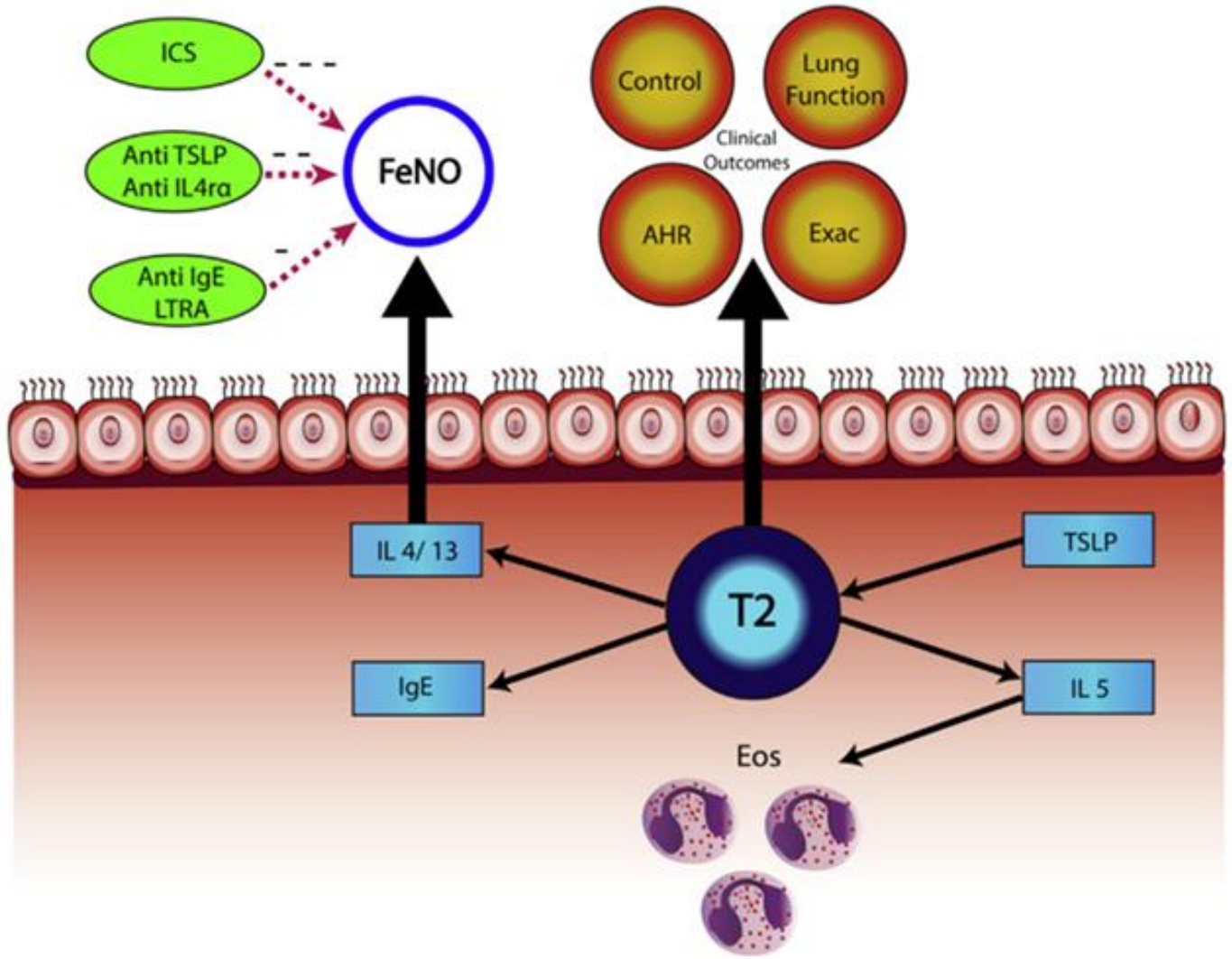
Graham et al. (2016)

Fractional exhaled nitric oxide (FeNO)



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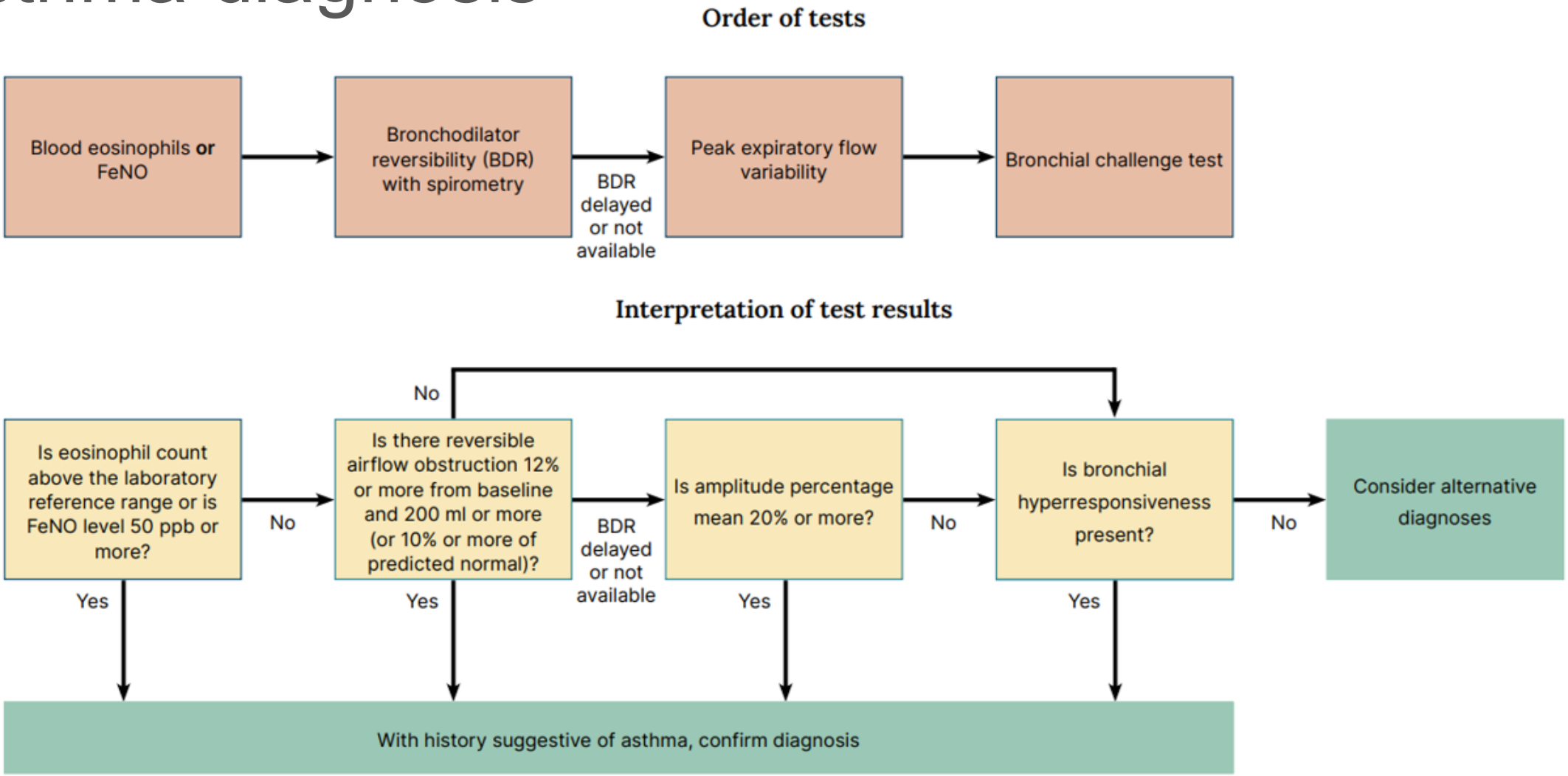
Lipworth et al. (2020)

Asthma diagnosis



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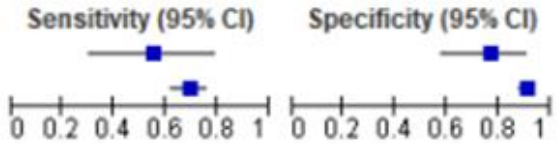
BTS/NICE/SIGN guidelines 2024

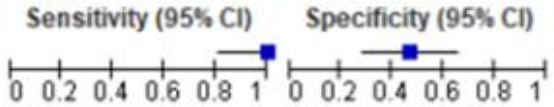
FeNO >50ppb

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Heffler 2006	10	7	8	23	0.56 [0.31, 0.78]	0.77 [0.58, 0.90]
Kowal 2009	123	31	55	331	0.69 [0.62, 0.76]	0.91 [0.88, 0.94]



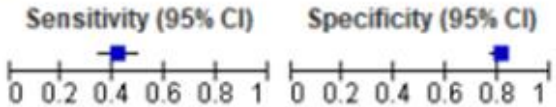
FeNO >25ppb

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Heffler 2006	18	16	0	14	1.00 [0.81, 1.00]	0.47 [0.28, 0.66]



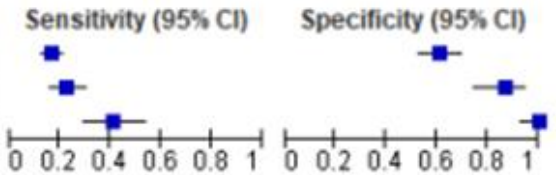
BEC >360 cells/µL

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Bao 2021	71	101	99	421	0.42 [0.34, 0.50]	0.81 [0.77, 0.84]



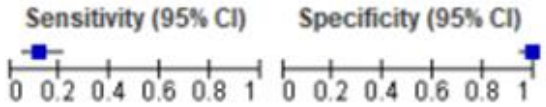
FEV_1 BDR ≥200ml and ≥12%

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Kim 2012	62	56	307	89	0.17 [0.13, 0.21]	0.61 [0.53, 0.69]
Louis 2020	32	7	109	46	0.23 [0.16, 0.31]	0.87 [0.75, 0.95]
Simpson 2024	29	0	41	48	0.41 [0.30, 0.54]	1.00 [0.93, 1.00]



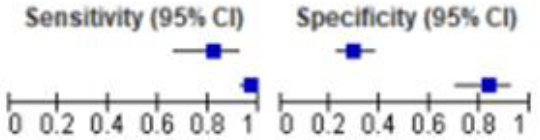
Diurnal PEF variability >20% on ≥3 days

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Thiadens 1998	8	1	61	100	0.12 [0.05, 0.22]	0.99 [0.95, 1.00]



MCT PC20 FEV_1 ≤8mg/mL

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Louis 2020	32	109	7	46	0.82 [0.66, 0.92]	0.30 [0.23, 0.38]
Popovic-Grle 2002	137	9	4	45	0.97 [0.93, 0.99]	0.83 [0.71, 0.92]



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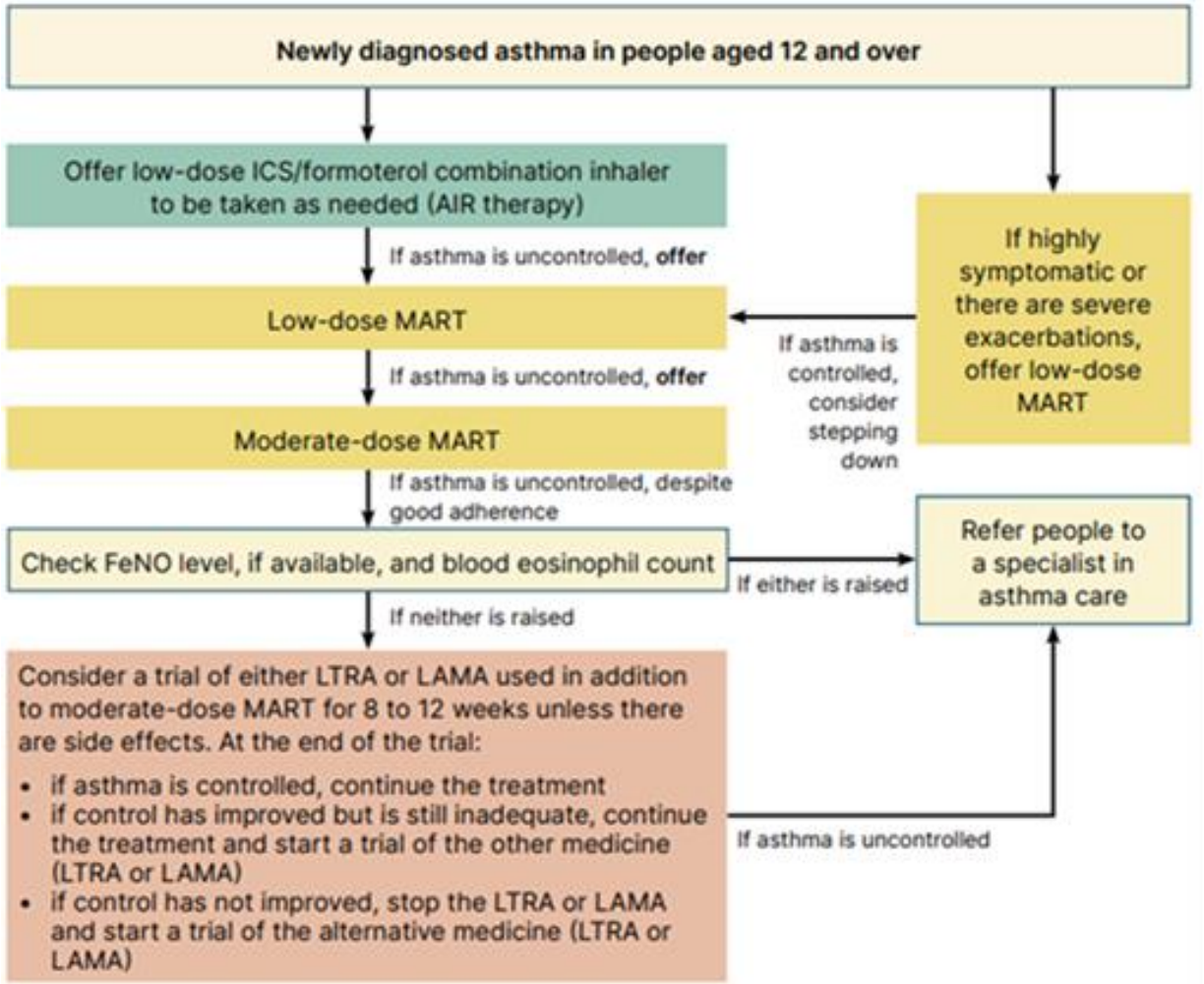
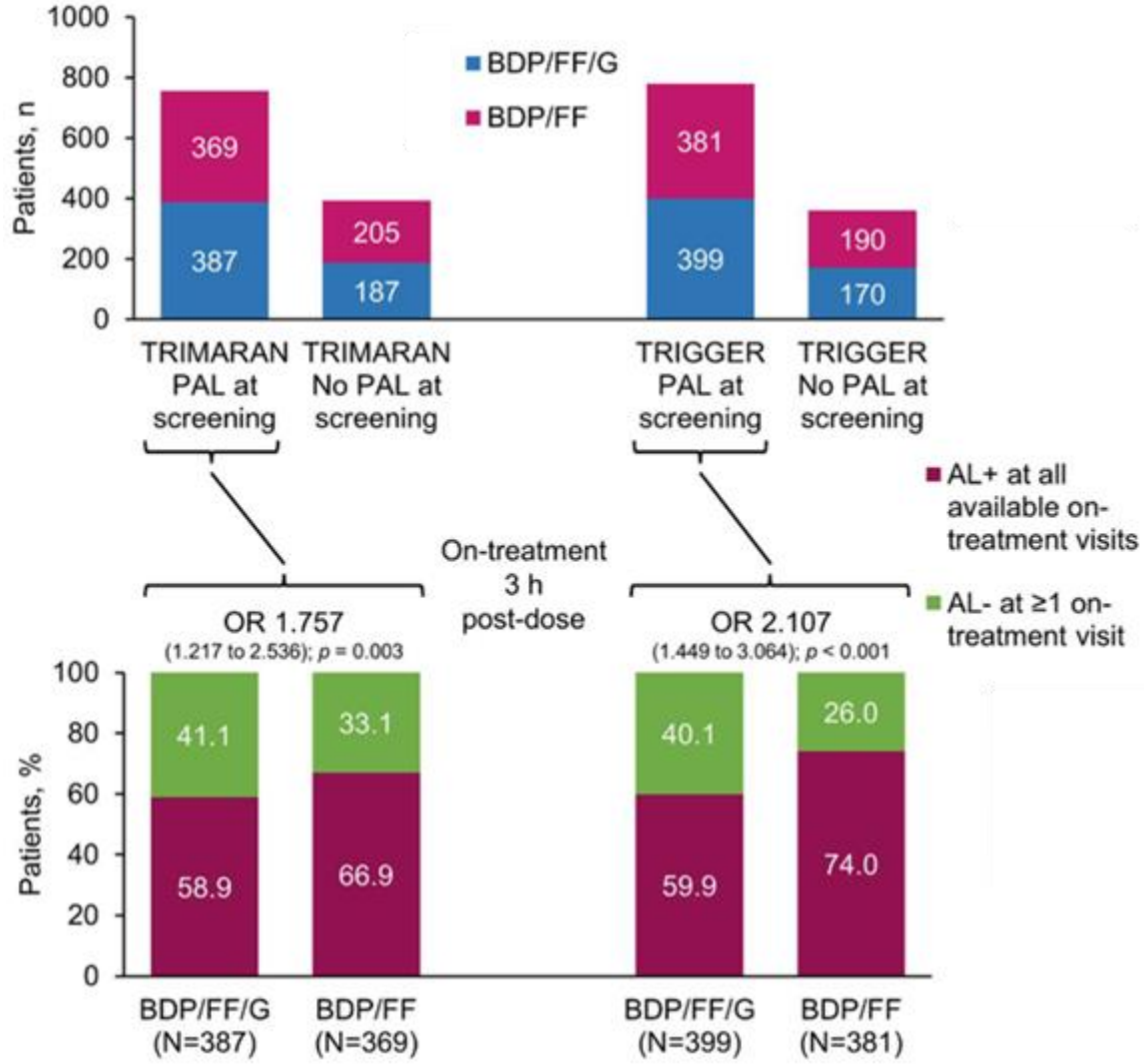
BTS/NICE/SIGN guidelines 2024

When to prescribe a LAMA in asthma





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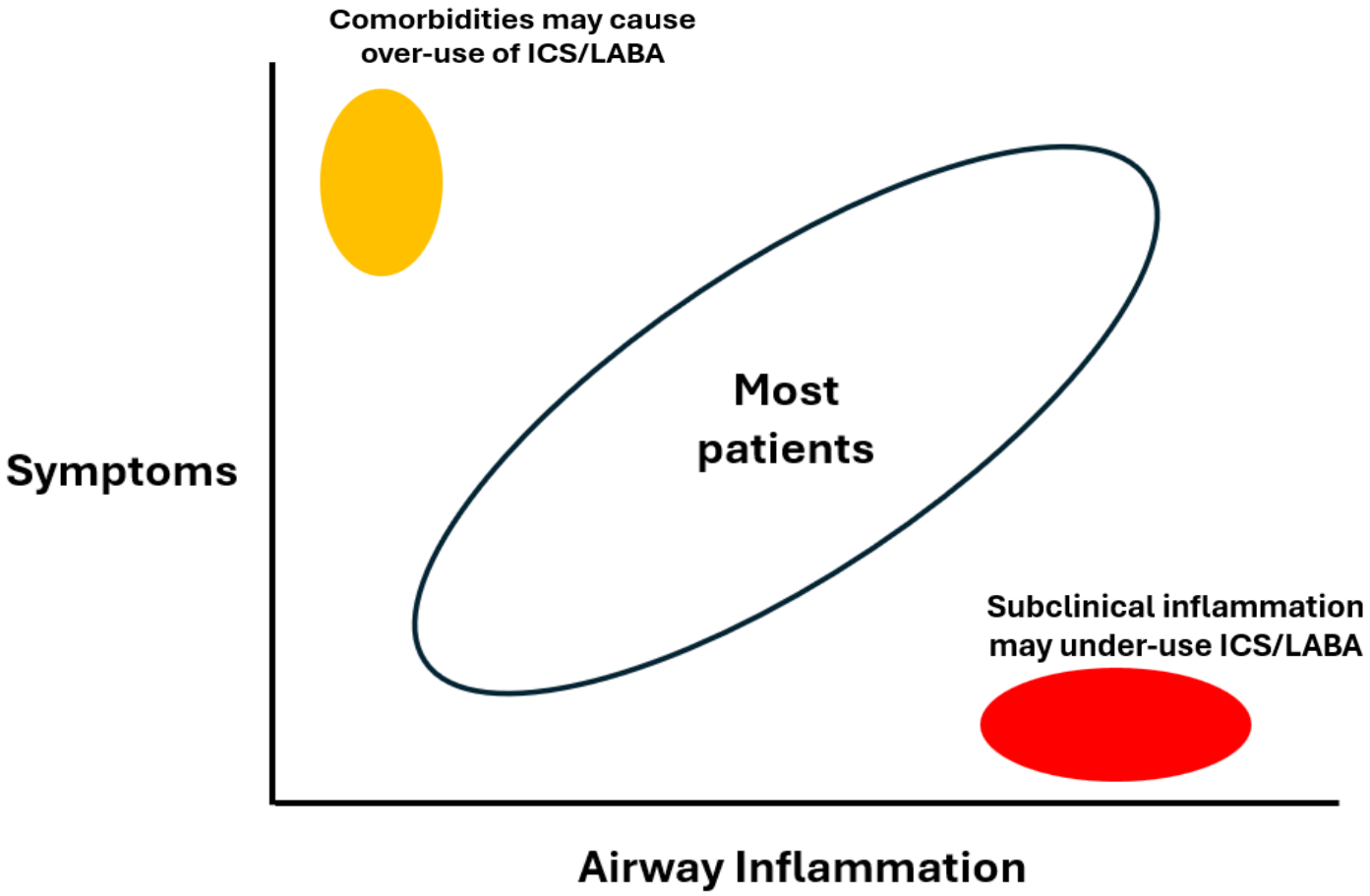
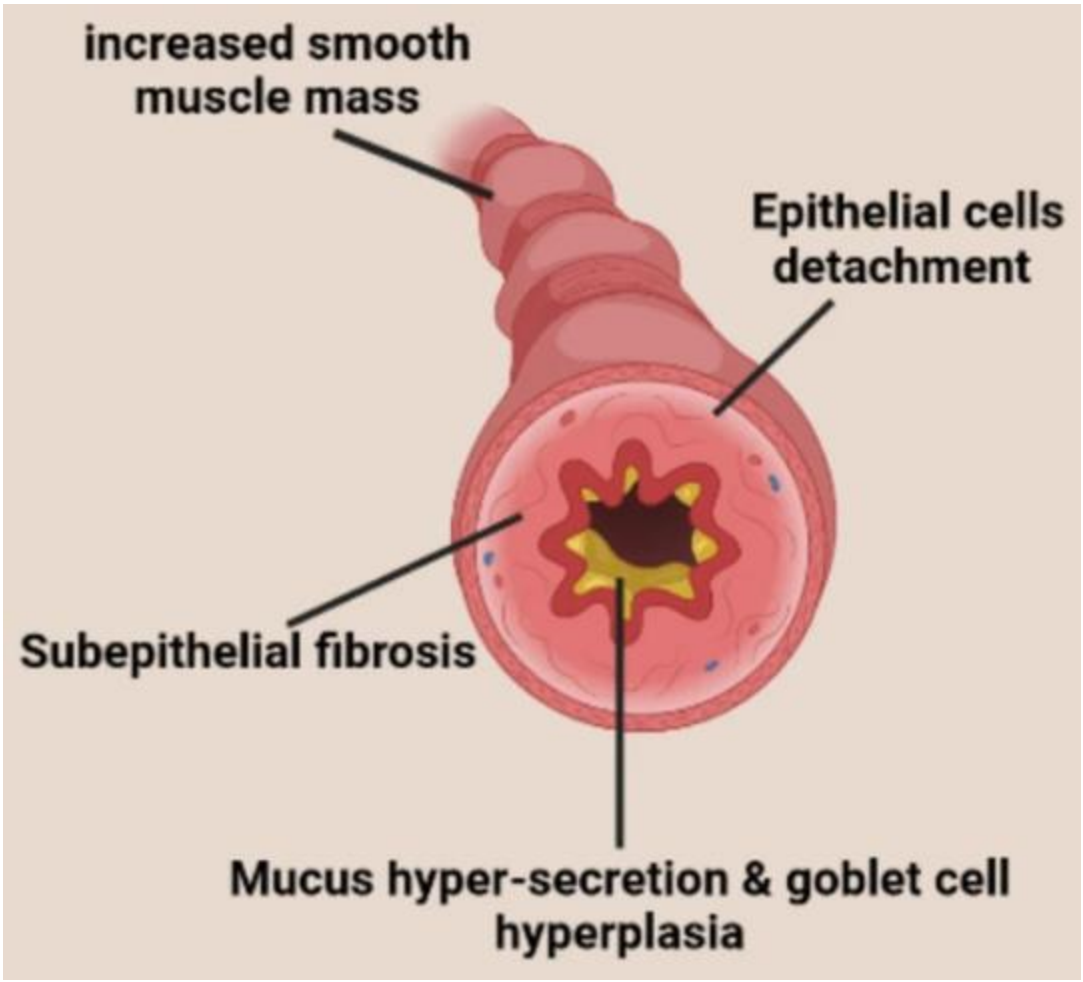
1. *BTS/NICE/SIGN guidelines 2024*
2. *Papi et al. (2022)*

Early spirometry prevents irreversible airway remodeling





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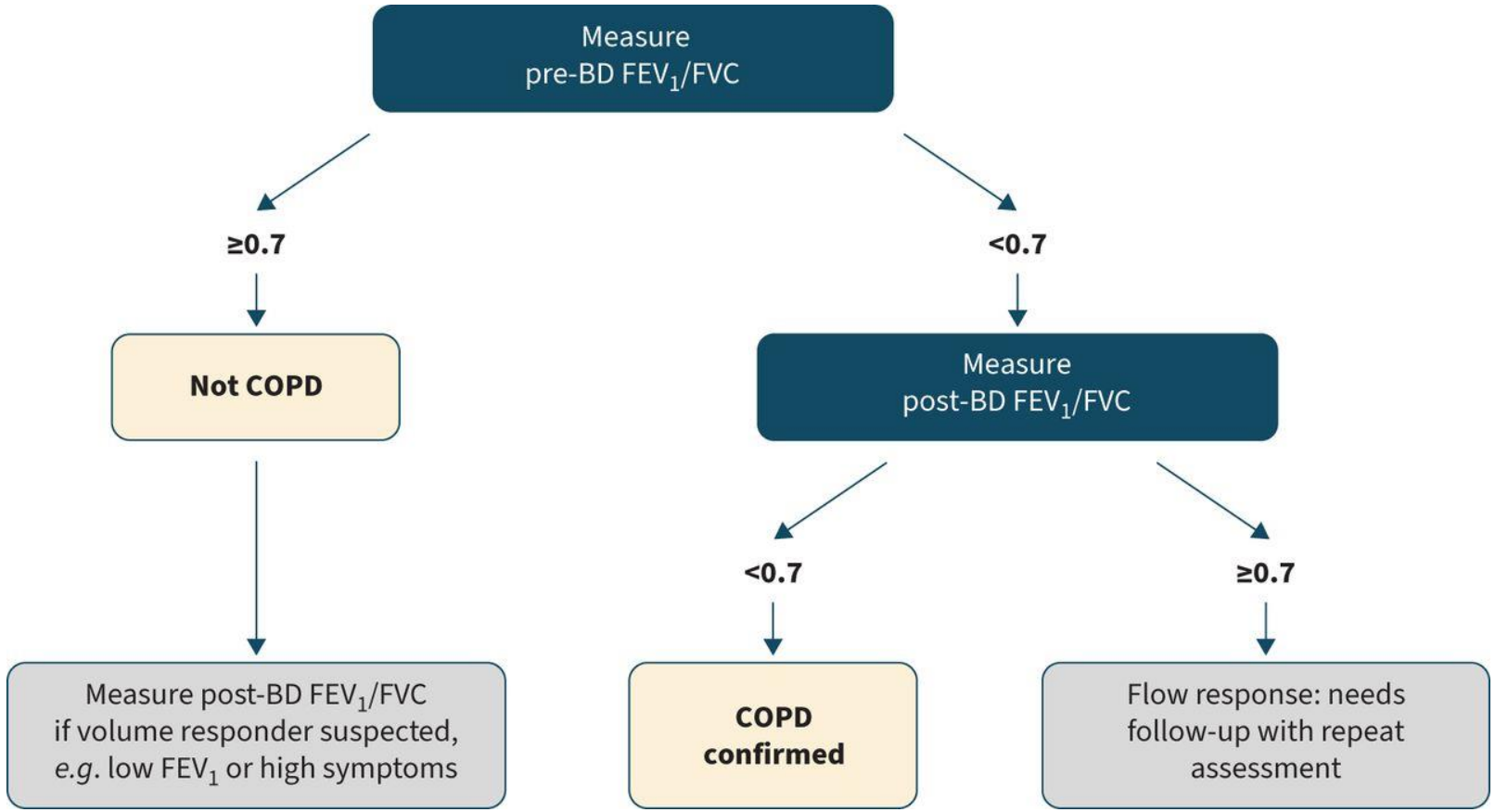
1. *Sahnoon et al. (2025)*

COPD diagnosis

- FEV_1/FVC <0.7 **<u>mandatory</u>** to establish a COPD diagnosis



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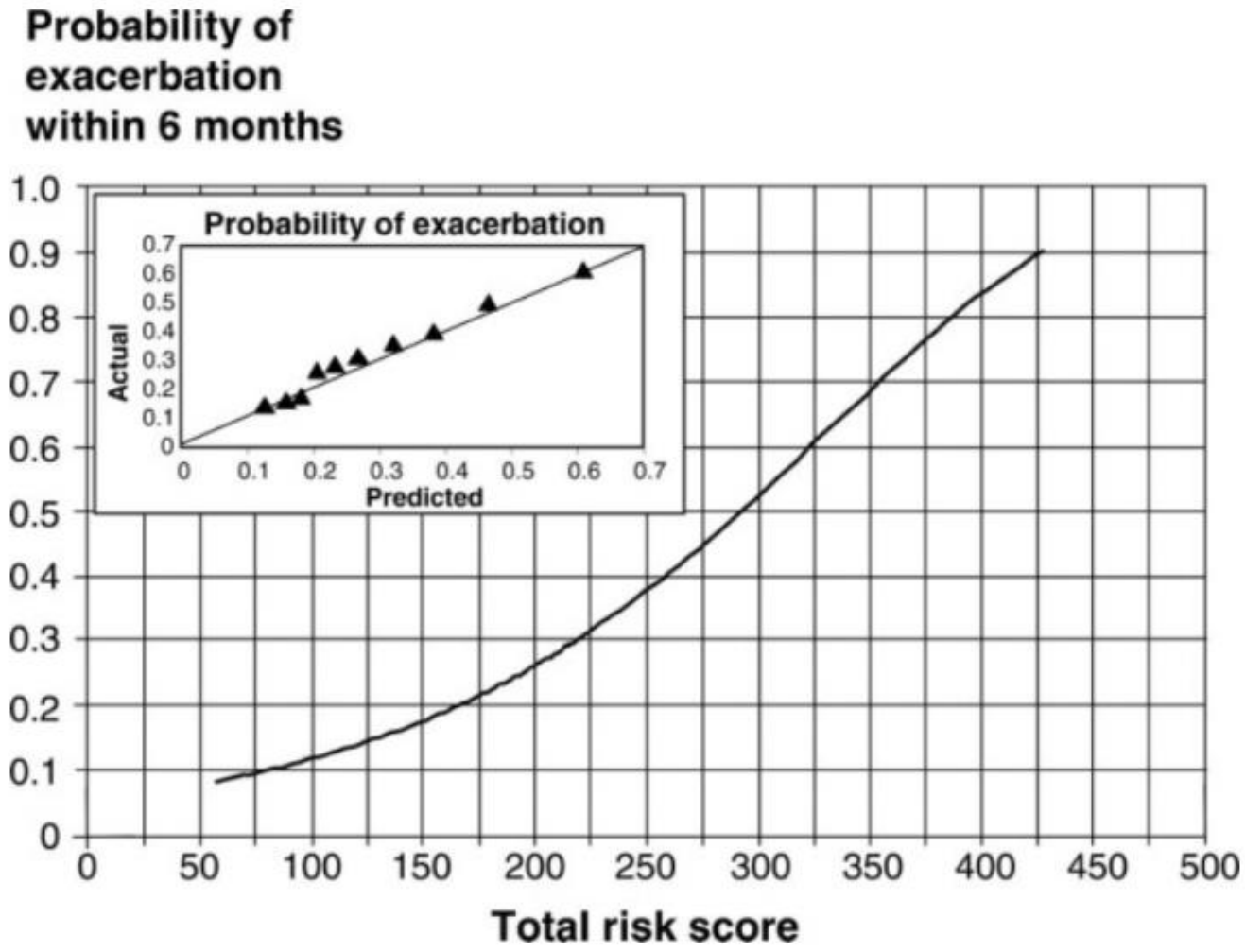
GOLD guidelines 2024/ Singh et al. (2025)

Exacerbation risk in COPD

Percentage of predicted FEV_1	
10–19	89
20–29	78
30–39	67
40–49	56
50–59	44
60–69	33



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1. *Niewoehner et al. (2007)*

BODE score

	0	1	2	3
FEV_1 (% of predicted)†	≥65	50–64	36–49	≤35
Distance walked in 6 min (m)	≥350	250–349	150–249	≤149
MMRC dyspnea scale‡	0–1	2	3	4
Body-mass index§	>21	≤21		

- HR for death from any cause per one-point increase in BODE was 1.34 (1.26,1.42)
- HR for death from respiratory causes was 1.62 (1.48,1.77)

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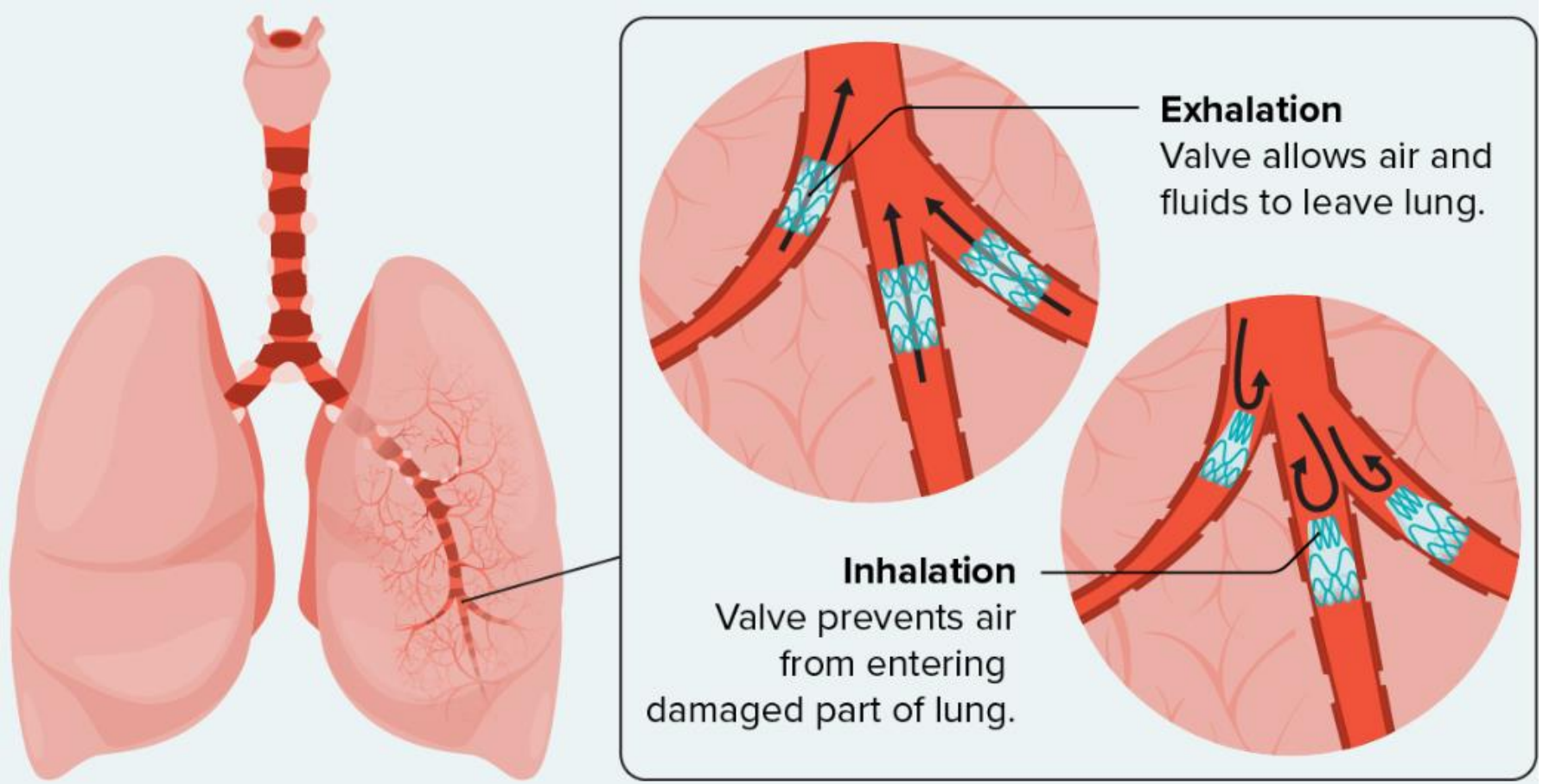
1. *GOLD guidelines 2024*
2. *Celli et al. (2004)*

Endobronchial valves

postbronchodilator **FEV_1 15 – 45% and evidence of hyperinflation** on body plethysmography



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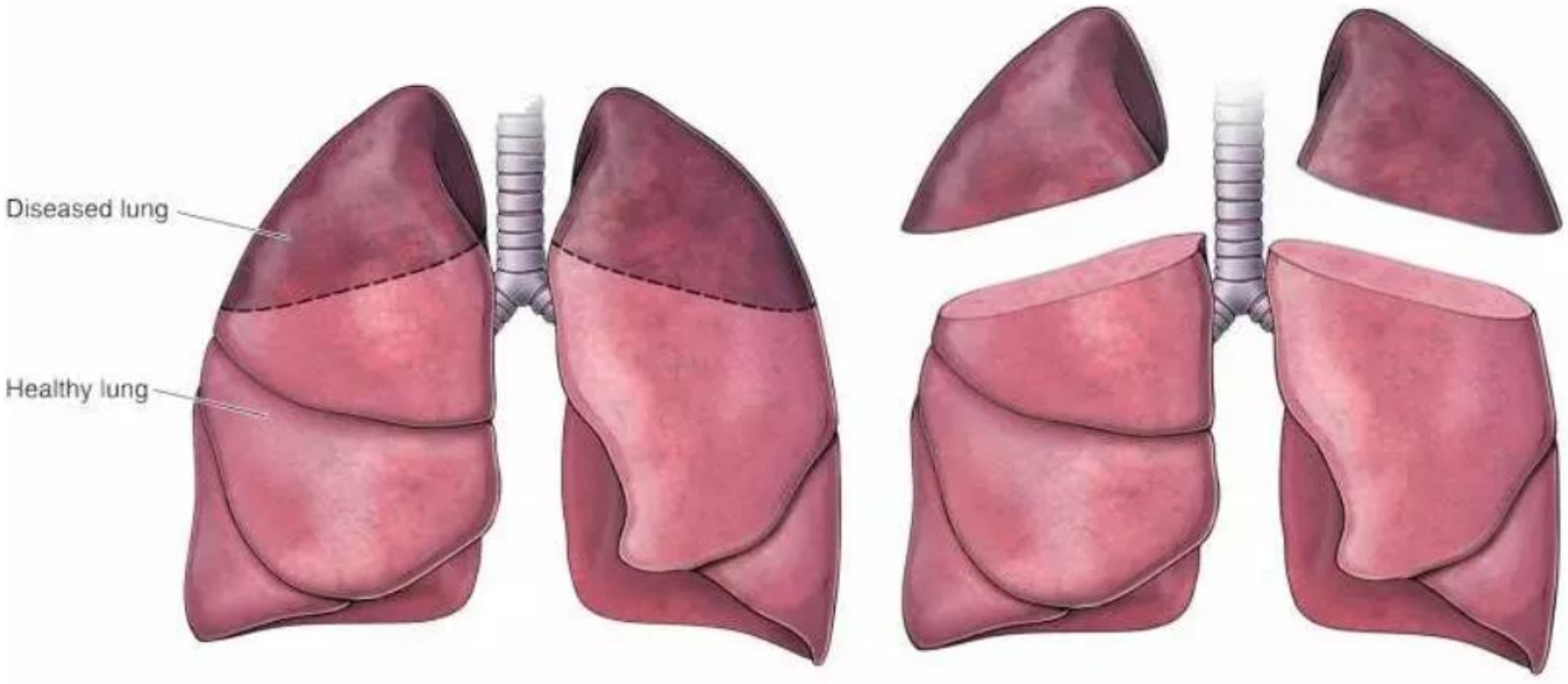
1. *GOLD guidelines 2024*
2. *Klooster et al. (2015)*

Lung volume reduction

Higher mortality if

- $FEV_1 \leq 20\%$ or
- DLCO ≤20%



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1. *Fishman et al. (2001)*
2. *https://www.templehealth.org/services/treatments/lung-volume-reduction-surgery*

DLCO predicts post-operative pulmonary complications

TABLE 4. Logistic regression analysis of pulmonary complications

Parameter	Odds ratio	Lower CI	Upper CI	*P* value
Age	1.01	1.01	1.02	<.0001
Performance status≥2	1.56	1.10	2.21	.014
ASA class IV or V	1.26	1.04	1.51	.017
Hypertension	1.01	0.88	1.17	.84
Coronary artery disease	1.11	0.93	1.34	.25
Congestive heart failure	1.58	1.20	2.10	.0014
Diabetes mellitus	1.18	0.98	1.41	.079
Recent smoking history	1.30	1.14	1.50	.0001
Preoperative chemotherapy and/or radiotherapy	1.51	1.27	1.8	<.0001
FVC%	1.00	1.00	1.01	.22
FEV_1%	0.99	0.98	1.00	.005
COPD	1.16	0.94	1.43	.16
DLCO% (10 point decrease)	1.12	1.09	1.16	<.0001
Pneumonectomy	0.92	0.71	1.20	.56

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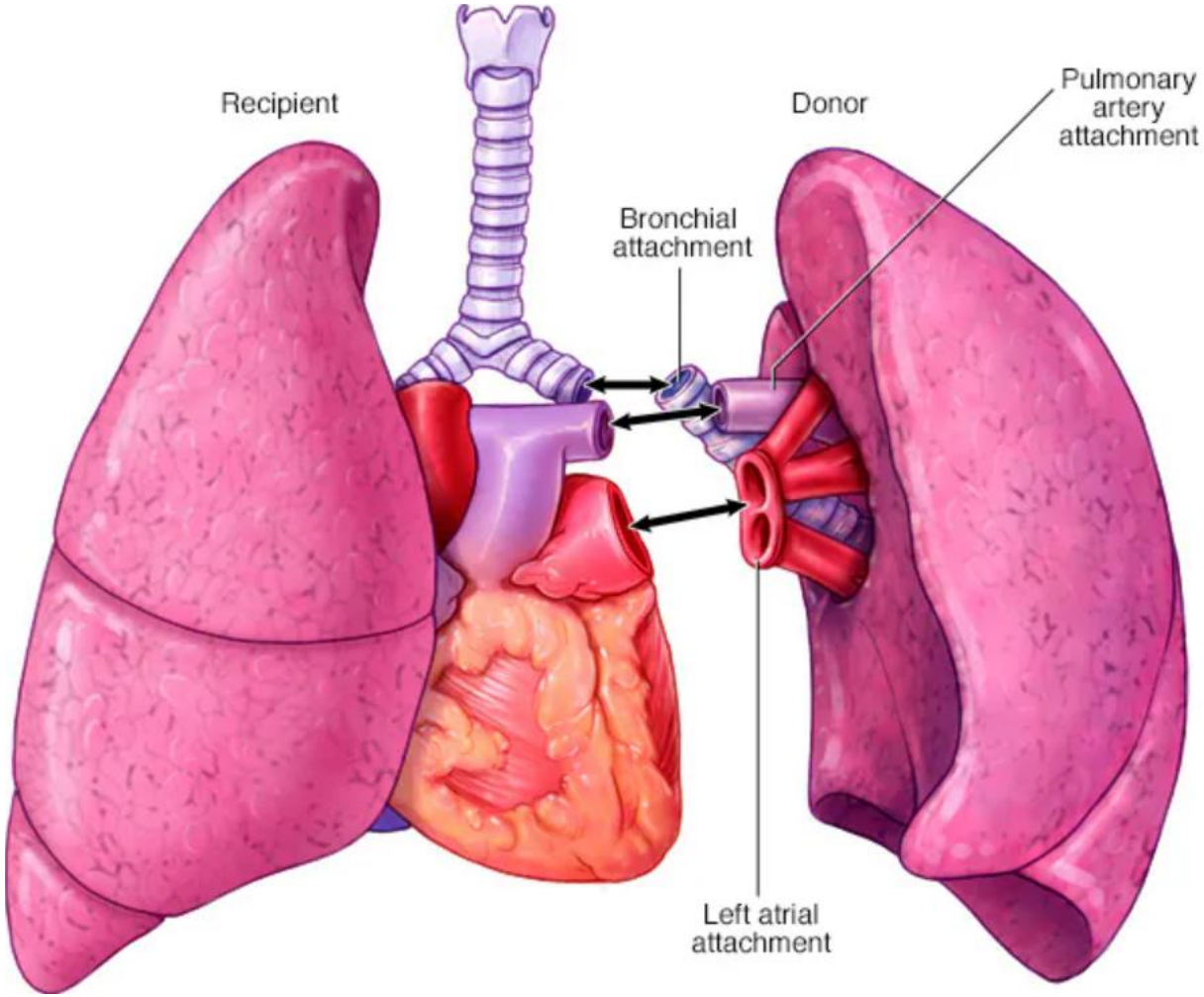
1. *Ferguson et al. (2009)*

Lung transplant

Should be listed for transplant

- FEV_1 <15-20%
- BODE>7
- ≥3 EXAC
- ≥1 EXAC w T2RF
- Mod-severe pHTN



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1. Weill et al. (2015)
2. https://www.mayoclinic.org/tests-procedures/lung-transplant/about/pac-20384754

Spirometry in ILD

Pirfenidone for treating idiopathic pulmonary fibrosis

Technology appraisal guidance

Published: 6 February 2018

- the person has a forced vital capacity (FVC) between 50% and 80% predicted
- treatment is stopped if there is evidence of disease progression (an absolute decline of 10% or more in predicted FVC within any 12-month period).

Nintedanib for treating idiopathic pulmonary fibrosis

Technology appraisal guidance

Published: 27 January 2016

- the person has a forced vital capacity (FVC) between 50% and 80% of predicted
- treatment is stopped if disease progresses (a confirmed decline in percent predicted FVC of 10% or more) in any 12-month period.

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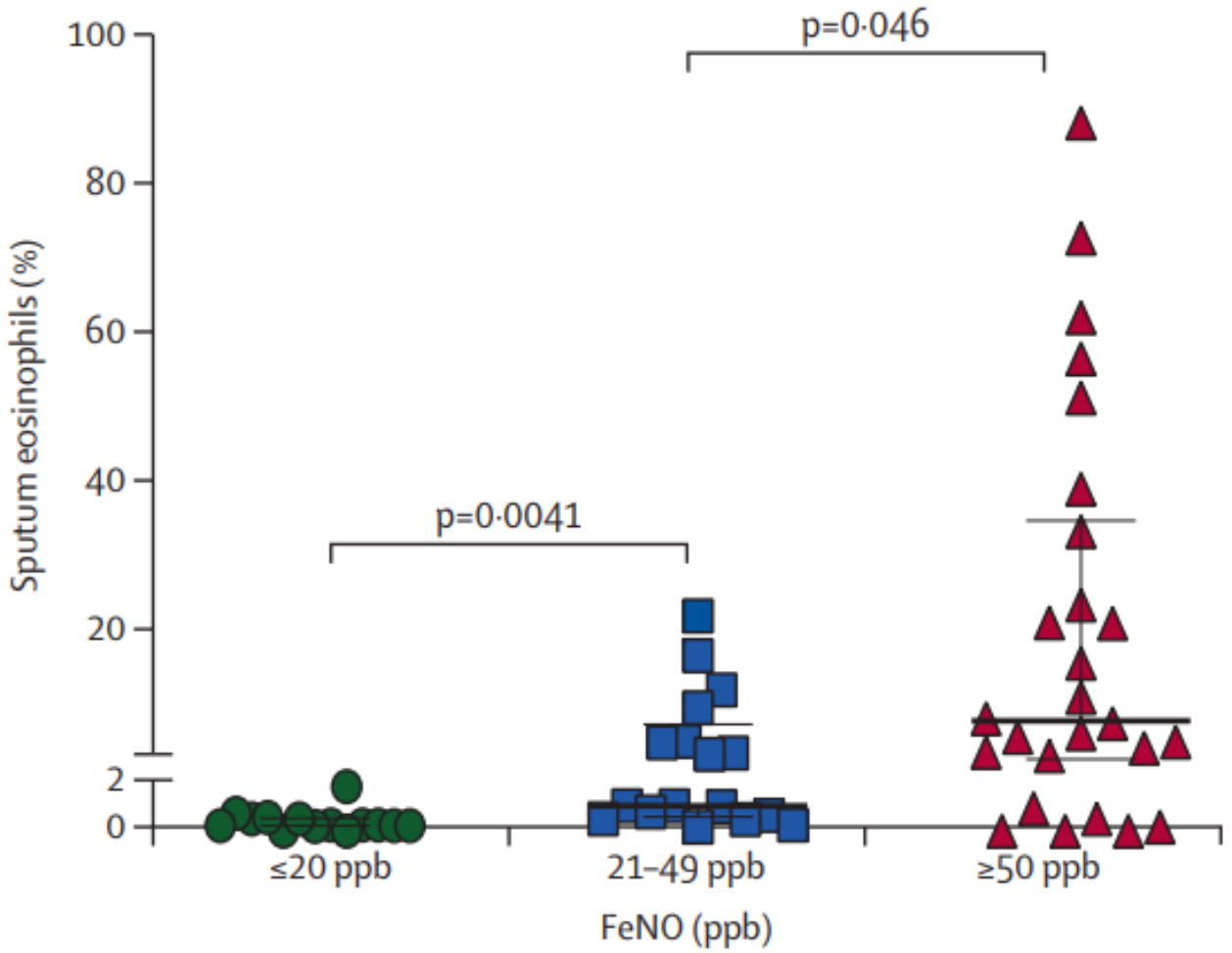
1. *NICE (2018)*
2. *NICE (2016)*

FeNO in the acute setting



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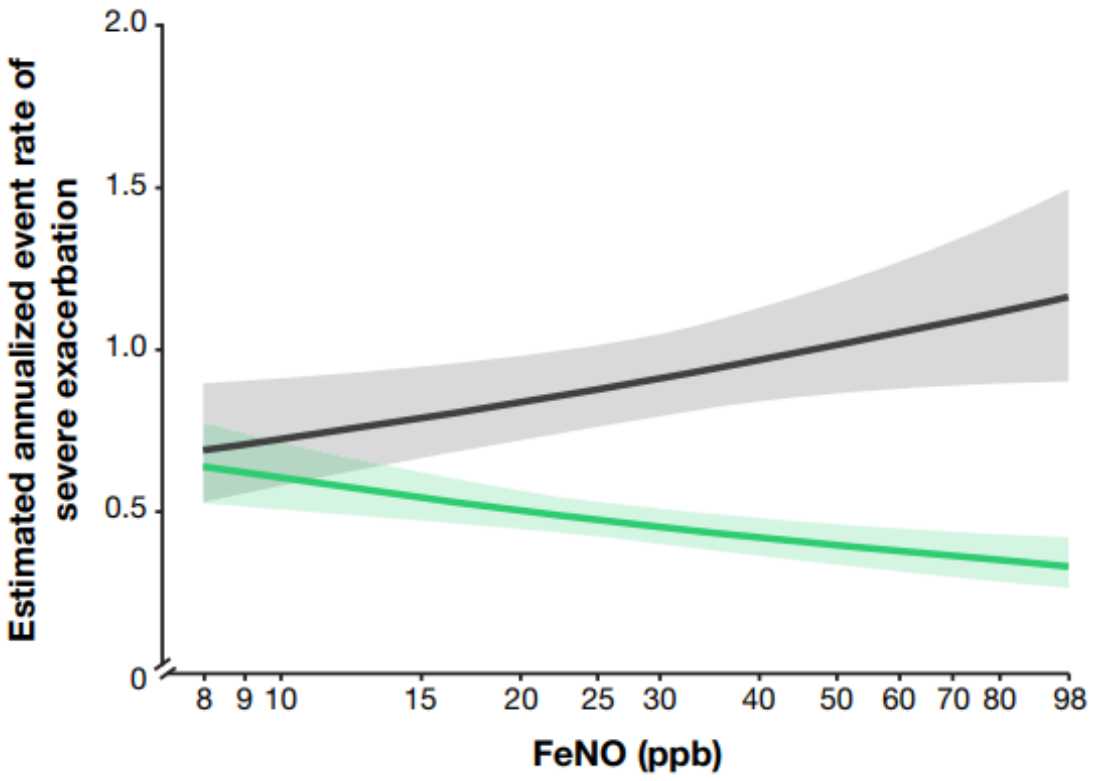
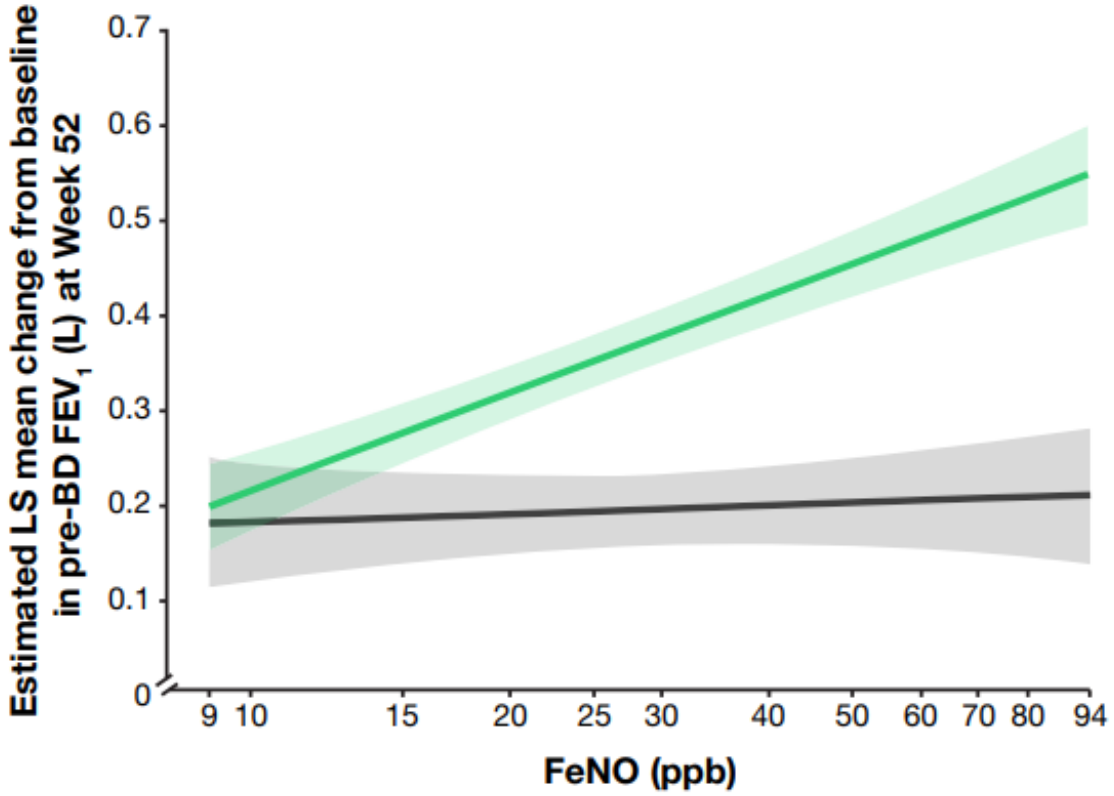
McDowell et al (2021)

FeNO predicts biologic response





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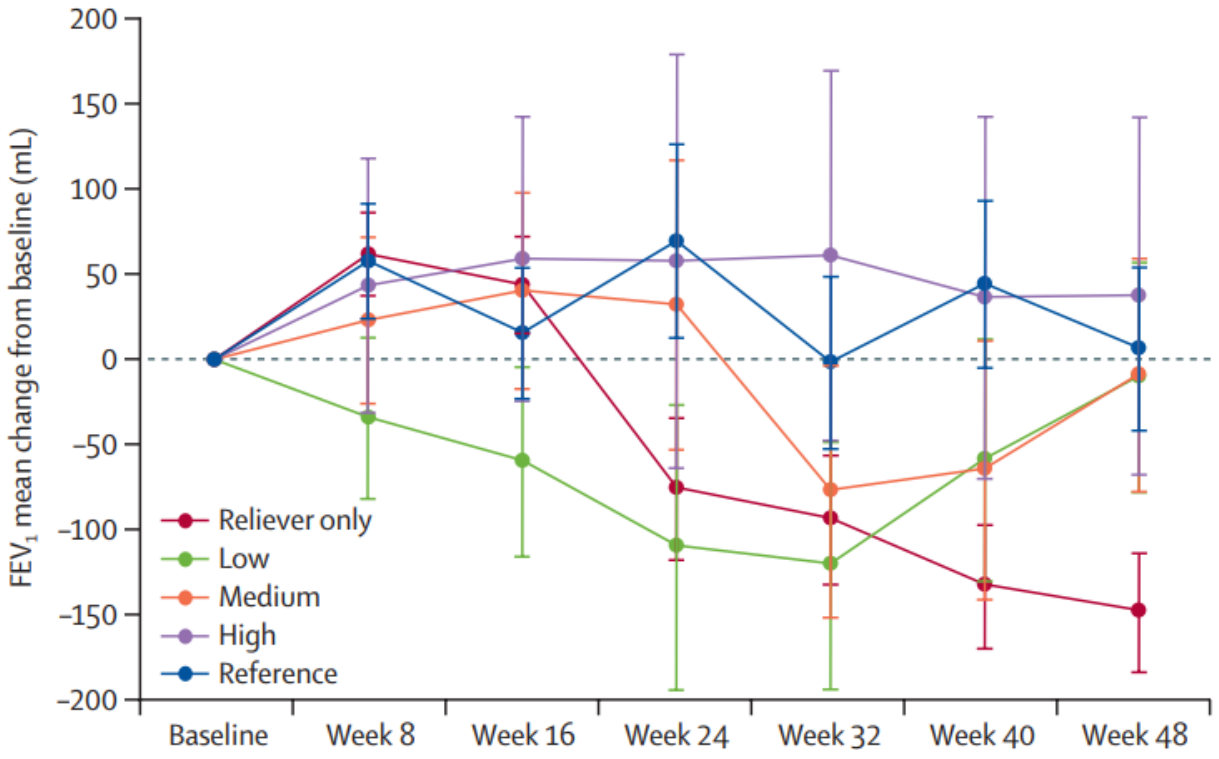
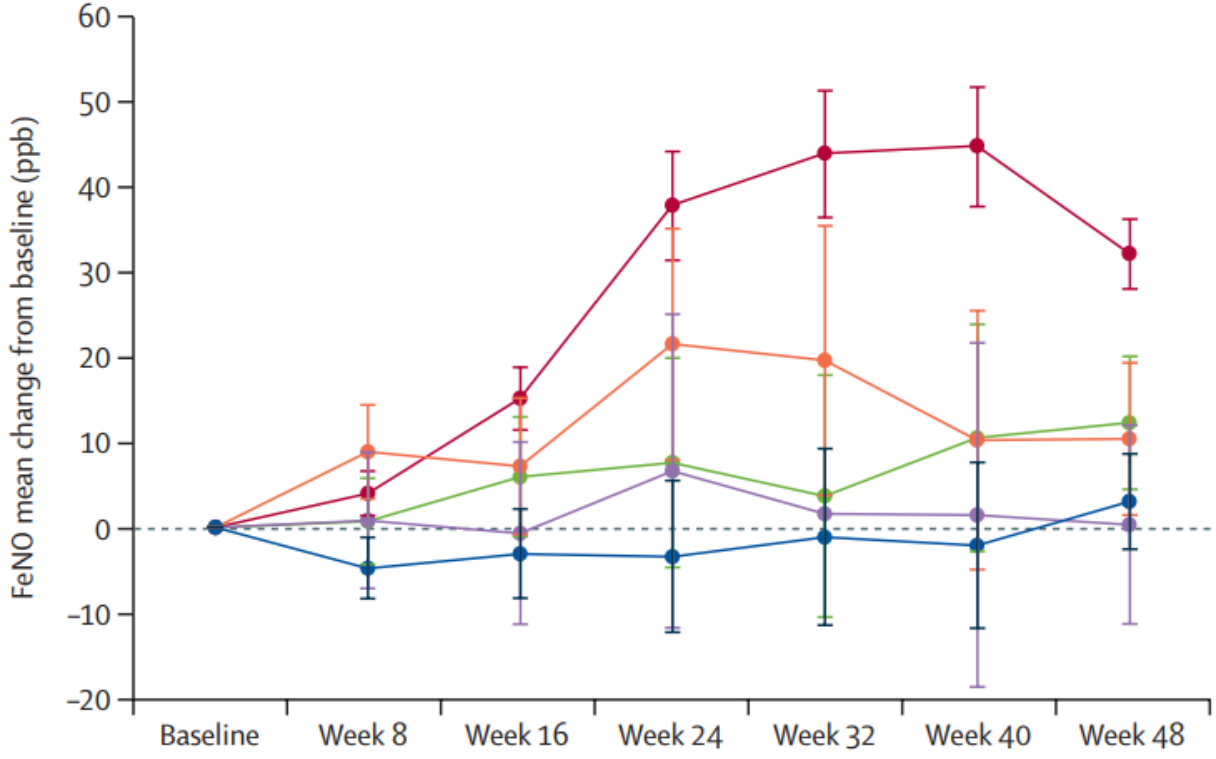
1. Pavord et al. (2023)

FeNO predicts lung function decline





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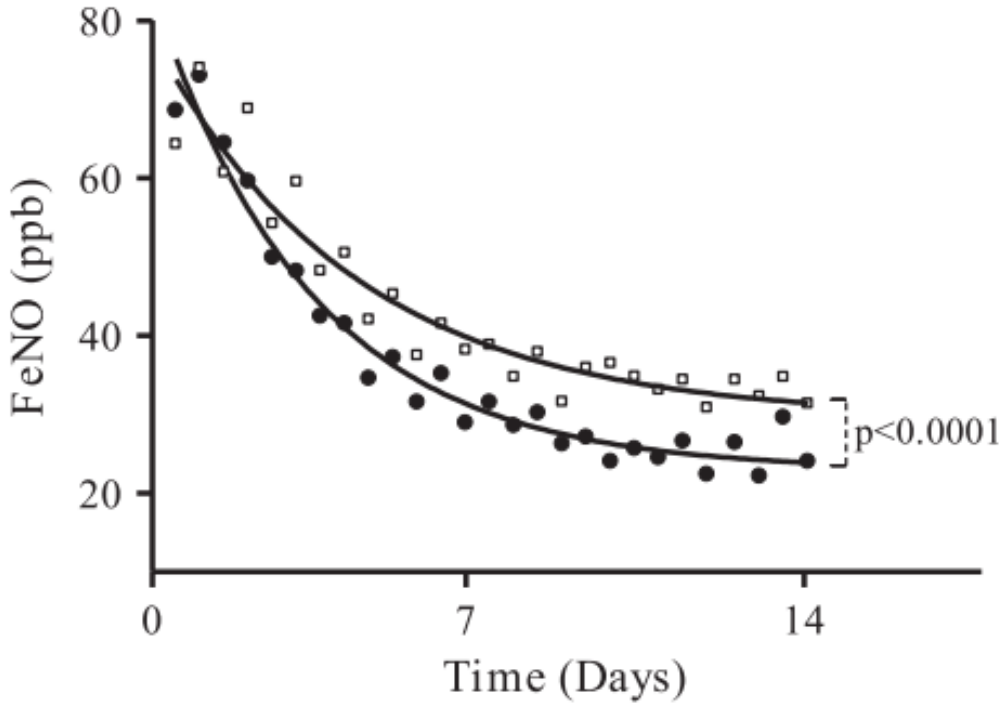
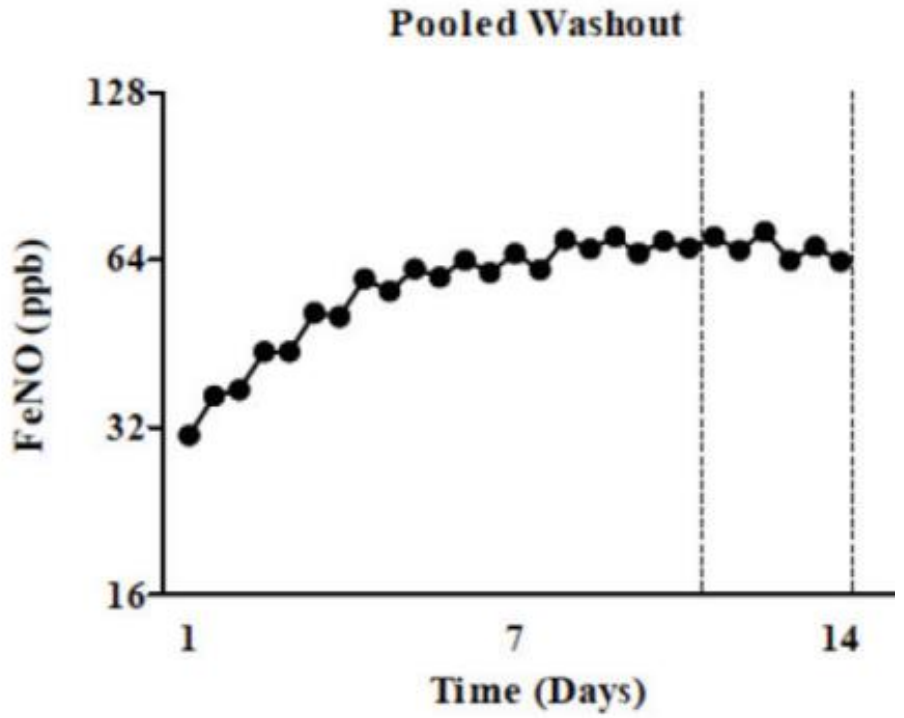
1. Jackson et al. (2023)

FeNO and inhaled corticosteroids





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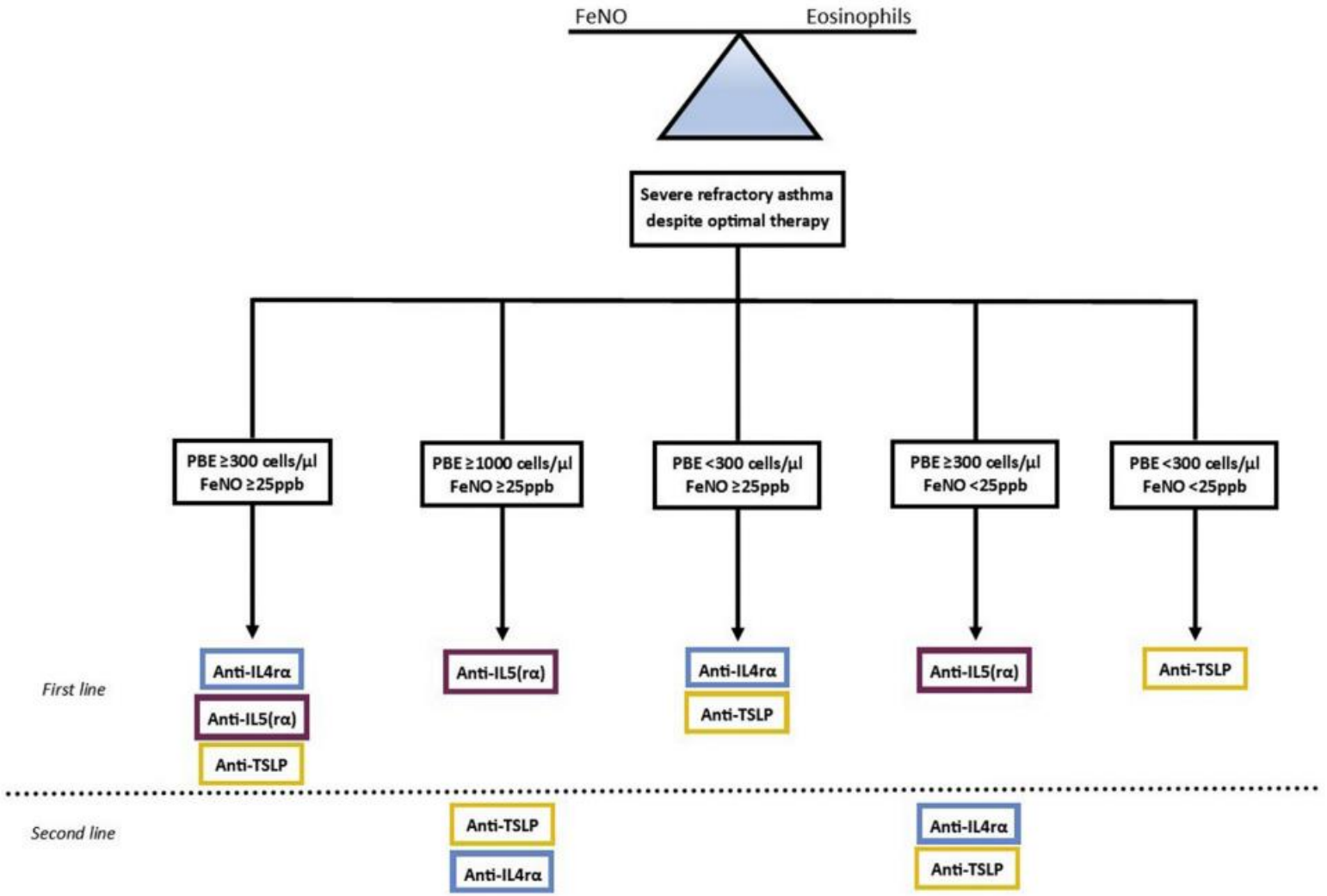
1. Anderson et al. (2012)

FeNO determines biologic choice



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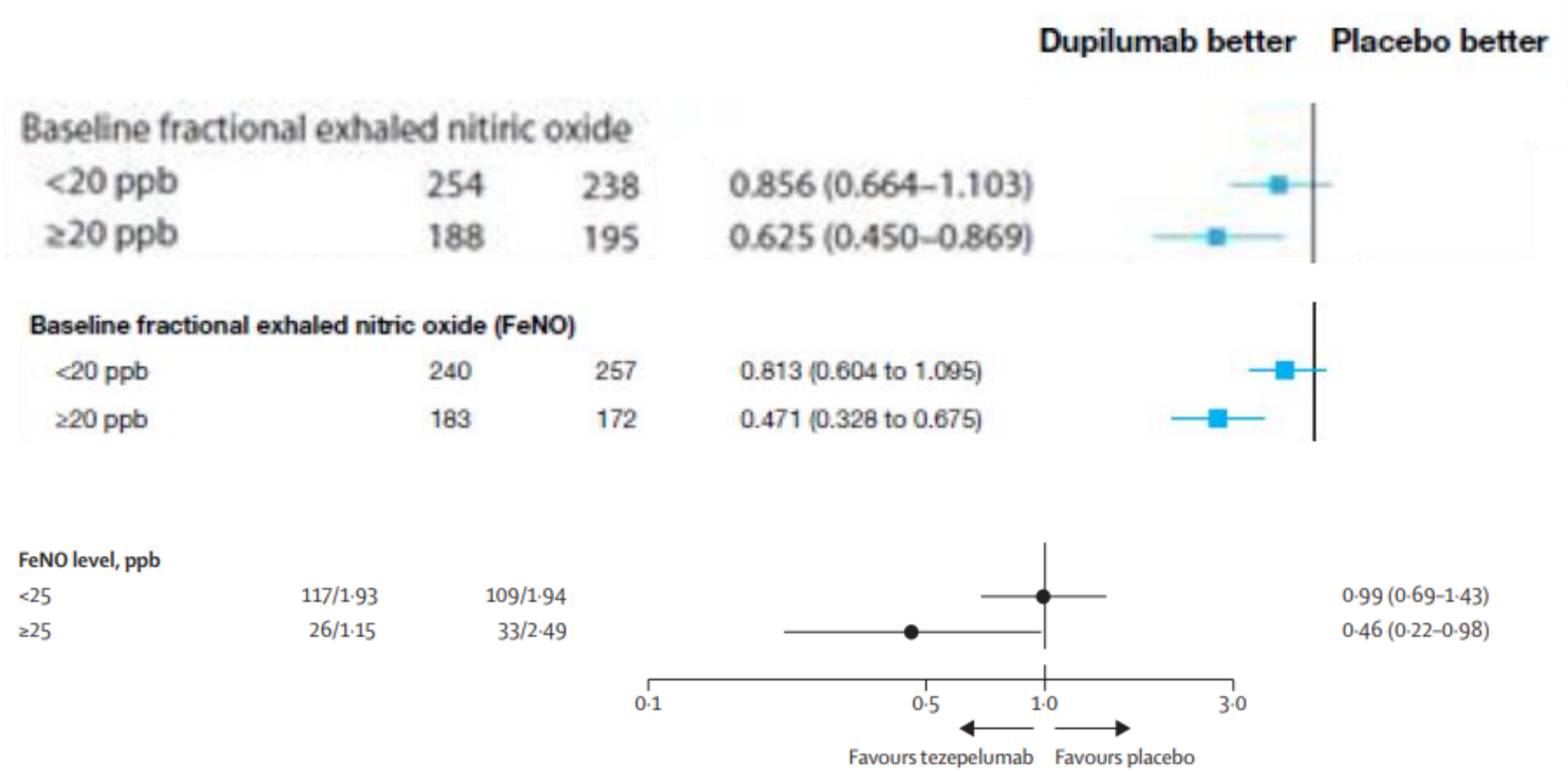
1. Chan et al. (2022)

FeNO in COPD



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1. *Bhatt et al. (2023)*
2. *Bhatt et al. (2024)*
3. *Singh et al. (2025)*

Case 1

- Andy is a thin 35-year-old flight attendant never smoker
- Exercises regularly on a treadmill at health clubs around the world
- During past 3 months, he has become short of breath, and his pulse rate has become higher than usual before finishing his exercise routine
- His medical history, review of systems, physical exam, chest radiographs, FBC, and ECG are all normal.

Case 1

- Denied having allergy or asthma symptoms
- Spirometry was normal
- Methacholine challenge test did not show bronchial hyperresponsiveness
- HRCT was also normal
- DLCO 34% predicted. In patients without anaemia, this pattern consistent with **pulmonary artery hypertension**

Case 1

- Echocardiogram showed right ventricular hypertrophy
- He then admitted to taking diet pills containing **fenfluramine** for more than a year

Case 2

- Charles is a 58-year-old retired shipyard worker with 40 pack smoking history
- Progressive dyspnoea, intermittent wheeze and dry cough
- Bibasal crackles at bases, finger clubbing, SPO2 93% on air
- FEV_1 1.8L 55%; FVC 2.4L 60%; FEV_1/FVC 0.75
- DLCO 48%

Case 2

- Body plethysmography

- TLC 5.8L 98%
- RV 3.0L 150%
- FRC 4.4L 135%

- Important for differentiating **true restriction** from **pseudorestriction**

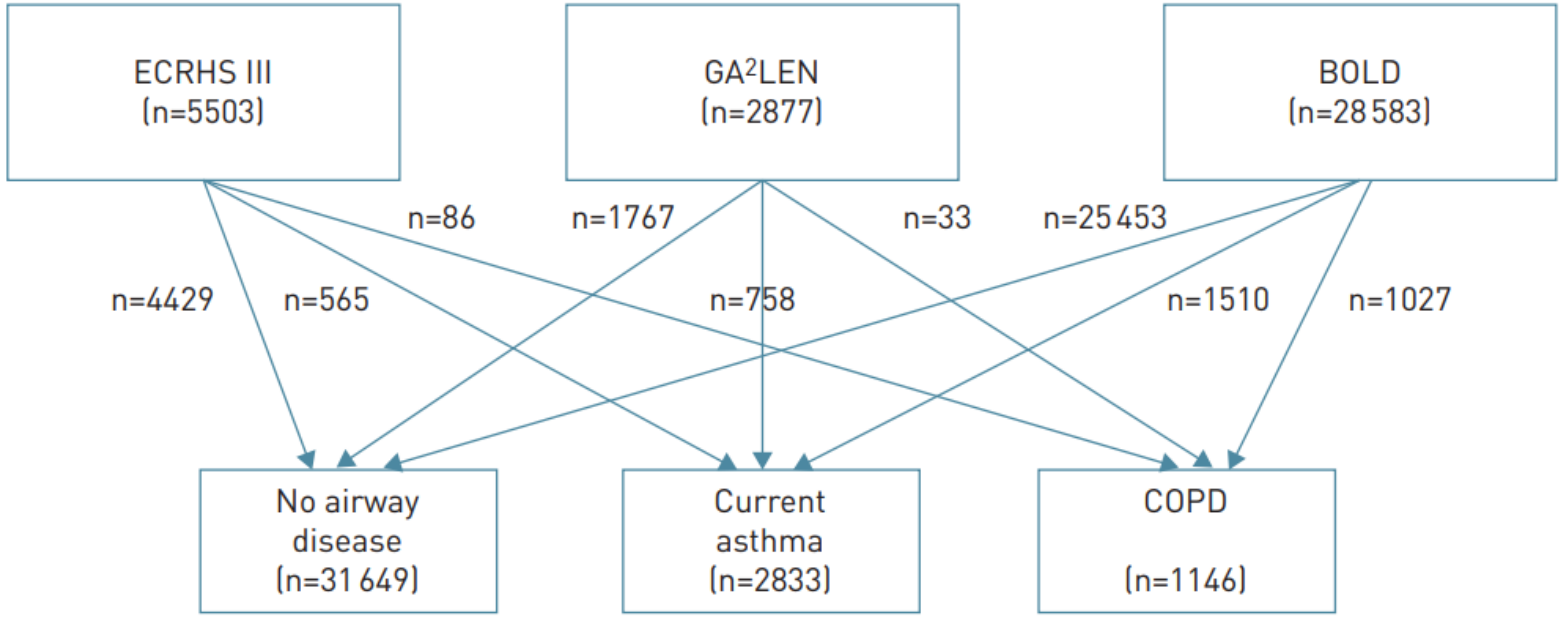
Case 3

- Andrea is a 65-year-old real estate agent referred by primary care
- Severe airway obstruction (FEV_1=1.3L) using an office spirometer
- Dyspnoea began several years ago and occurs when climbing stairs
- Overweight and had history of frequent childhood respiratory problems
- Smoked since age 25 and takes no medications

Case 3

- Obesity, yellow fingernails, frequent coughing, prolonged expiratory time but no stridor, some wheezing, and mild ankle oedema
- CXR shows clear lung fields but flat diaphragm
- Formal spirometry: FEV_1/FVC 0.52; FEV_1 35% predicted, improved by 12% ten minutes after administration of salbutamol

BDR cannot distinguish between COPD and asthma



Prevalence of BDR defined as FEV_1 ≥12% and 200mL

- 17.3% asthma
- 18.4% COPD
- 5.1% no airways disease

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1. *Janson et al. (2019)*

Case 3

- DLCO 96% predicted
- You prescribe ICS+LABA and 5 days of prednisolone
- Two weeks later, you see Bobby, a 65-year-old banker with a nearly identical history, CXR, physical exam, and spirometry results. However, DLCO 45%, and he did not have anemia to explain the low DLCO
- You diagnose his condition as the emphysema phenotype of COPD

Conclusion

- Spirometry, FeNO, Body Pleth, DLCO and oscillometry all have their unique clinical roles in the patient pathway

References

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