



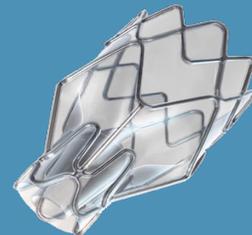
GÖTEBORGS UNIVERSITET



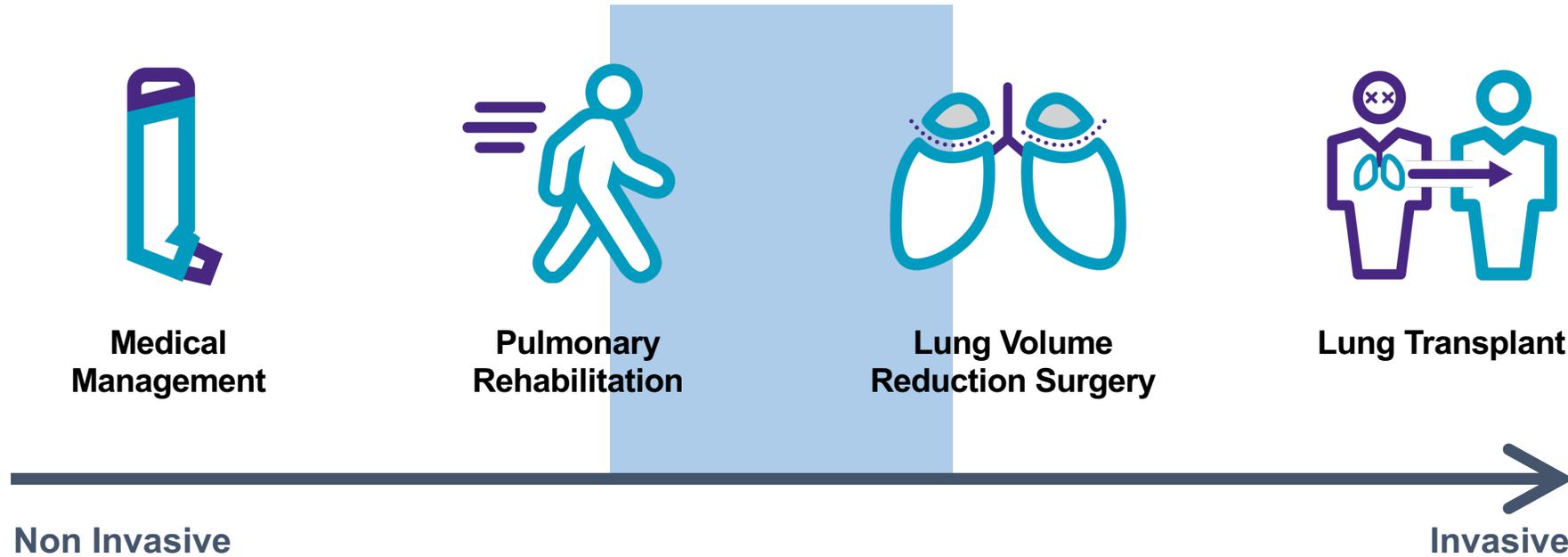
REGION  
VÄSTRA GÖTALAND  
SAHLGRENKA UNIVERSITY HOSPITAL

# Bronchoscopic lung volume reduction with endobronchial valves

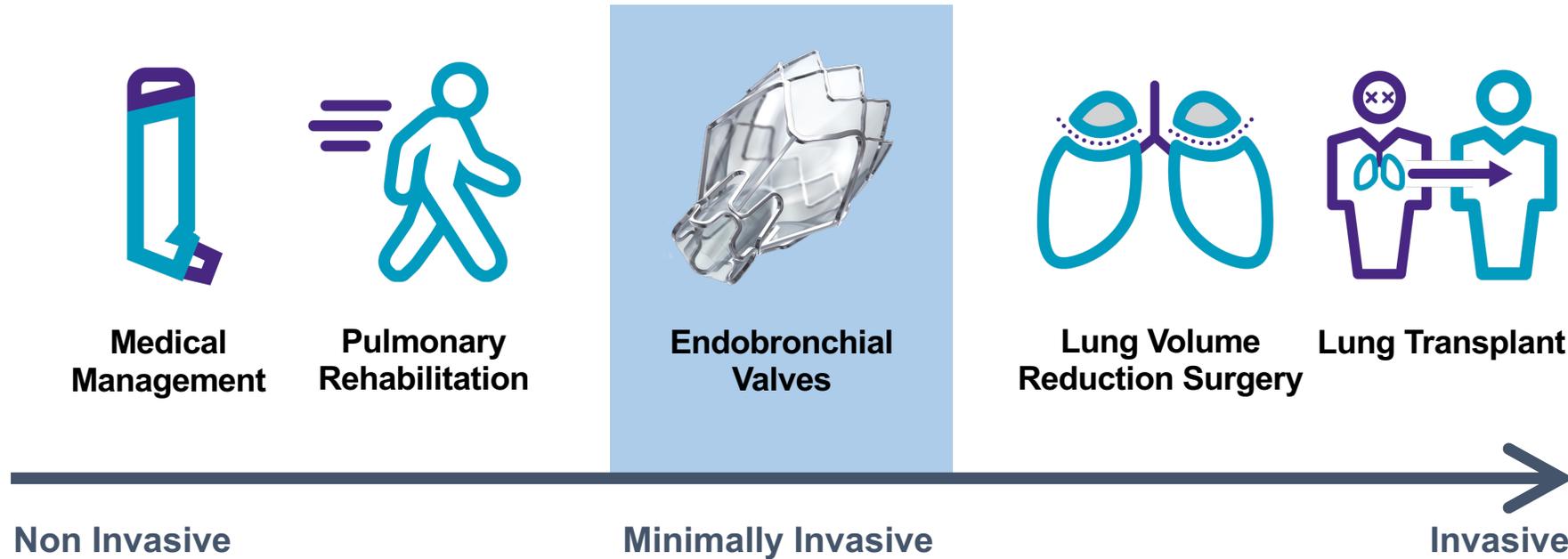
Lowie Vanfleteren, MD, PhD,  
COPD Centre, Sahlgrenska University hospital,  
Institute of Medicine, Gothenburg University



# Spectrum of Treatment Options for COPD

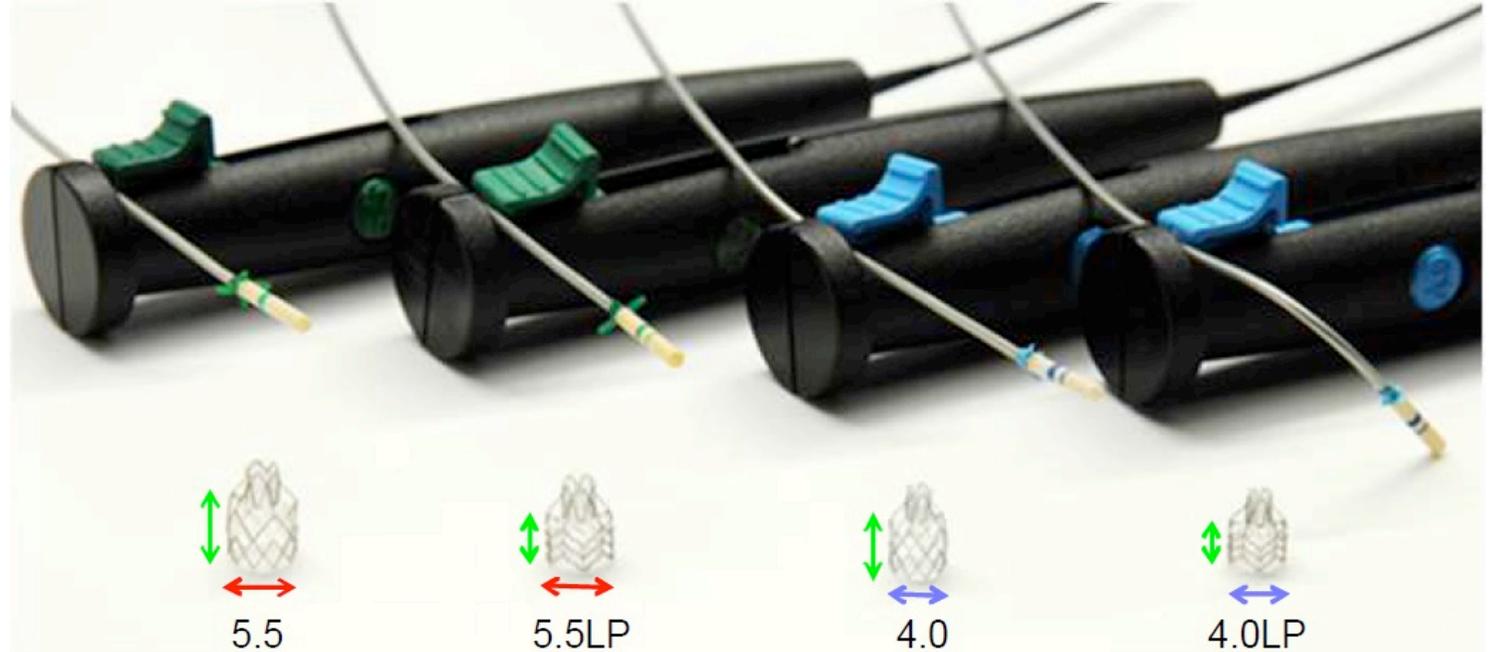


# Spectrum of Treatment Options for COPD



# Endobronchial Valve Treatment

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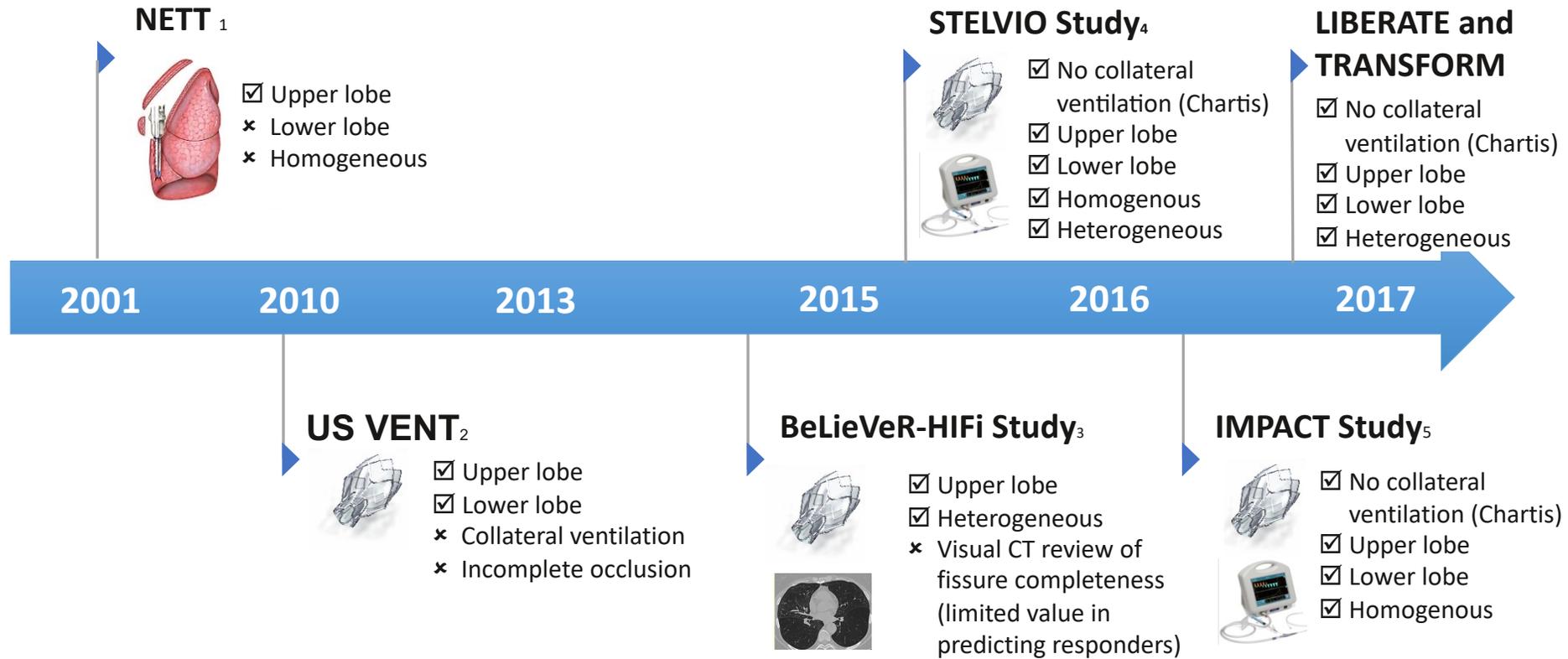
# Endobronchial Valve Treatment

Tiny, one-way valves are placed in the lungs through a bronchoscope to a diseased lobe.

This helps to reduce hyperinflation resulting in better breathing mechanics and improved quality of life.



# Learning Journey



1. Fishman A et al. N Engl J Med 2003; 348: 2059-73.

2. Sciurba FC et al. N Eng J Med 2010; 363:1233-1244 (including supplementary appendix).

3. Davey C et al. Lancet 2015; 386: 1066-1073.

4. Klooster K et al. N Engl J Med 2015; 373(24): 2325-2335.

6. Valipour A et al, AJRCCM 2016. 194: 1073–1082

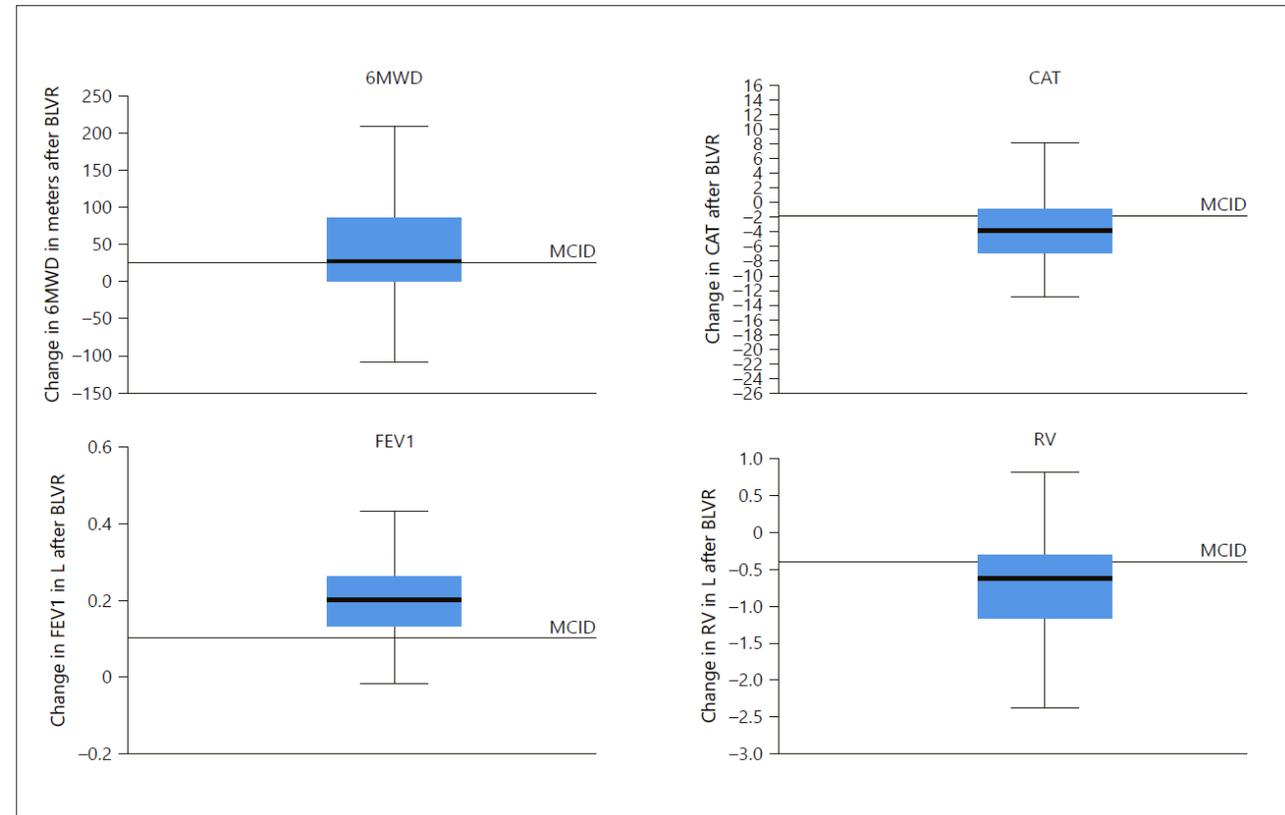
## Implementation of Bronchoscopic Lung Volume Reduction Using One-Way Endobronchial Valves: A Retrospective Single-Centre Cohort Study

Rein Posthuma<sup>a,b,c</sup> Anouk W. Vaes<sup>a</sup> Kim H.M. Walraven<sup>b,c</sup> Peyman Sardari Nia<sup>d</sup>  
Jan U. Schreiber<sup>e</sup> Hester A. Gietema<sup>f,g</sup> Geertjan Wesseling<sup>c</sup> Emiel F.M. Wouters<sup>a</sup>  
Lowie E.G. W. Vanfleteren<sup>i,j</sup>

A retrospective evaluation of patients treated with EBV between January 2016 and August 2019 was conducted.

Of 350 subjects screened, 283 (81%) were not suitable for intervention mostly due to lack of a target lobe.

The remaining 67 subjects (19%) underwent bronchoscopic assessment, and if suitable, valves were placed in the same session. In total, 55 subjects (16%) were treated with EBV.



Outcomes at 3 months. Shown are the changes in outcome at 3 months in subjects treated with EBV. Black horizontal lines represent the MCID

# Elegibility for BLVR with EBV

1. **Severe COPD in subjects younger than 75y of age**  
 FEV1 / FVC <70% och FEV1 <45%; >15% pred after bronchodilatation

2. **High symptom burden and impaired exercise capacity**  
 mMRC ≥2 och CAT ≥10 och 6MWT <450 meter

3. **Optimal treatment**

- Smoking cessation more than 6 months
- Optimized medical therapy
- Active exercise program



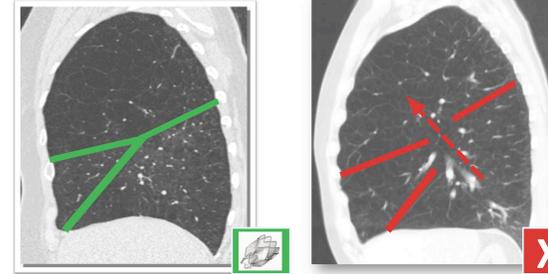
4. **Static hyperinflation (body box)**

- Total lungcapacity (TLC)> 100% pred
- Residual Volume (RV)> 175% pred
- RV / TLC> 55%

5. **Advanced emphysema (emphysema is needed)**



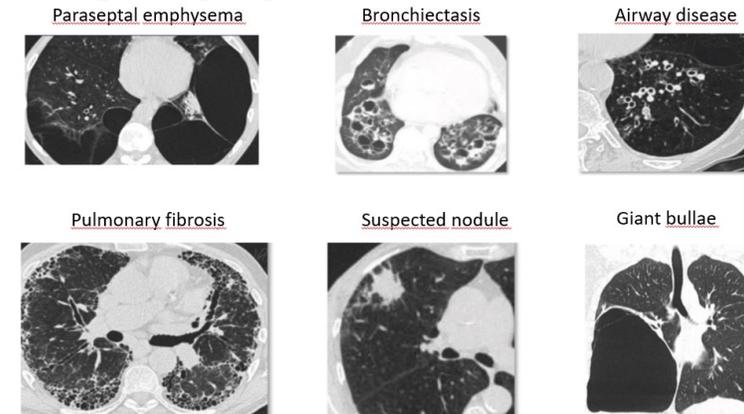
6. **Intact right or left major fissure**



7. **Absence of important comorbidity**

- PaCO2> 8,0 kPa | PaO2 <6,0 kPa
- Instable coronary artery disease or heart failure (LVEF <40%)
- Pulmonary hypertension (RVSP> 50 mmg Hg)
- Severe asthma, chronic bronchitis
- Morbid obesity (BMI> 35)
- Previous major lung surgery
- (repeated) respiratory infections, immunodeficiency

8. **Lungimaging that is not suitable for valves**



# Elegibility for BLVR with EBV

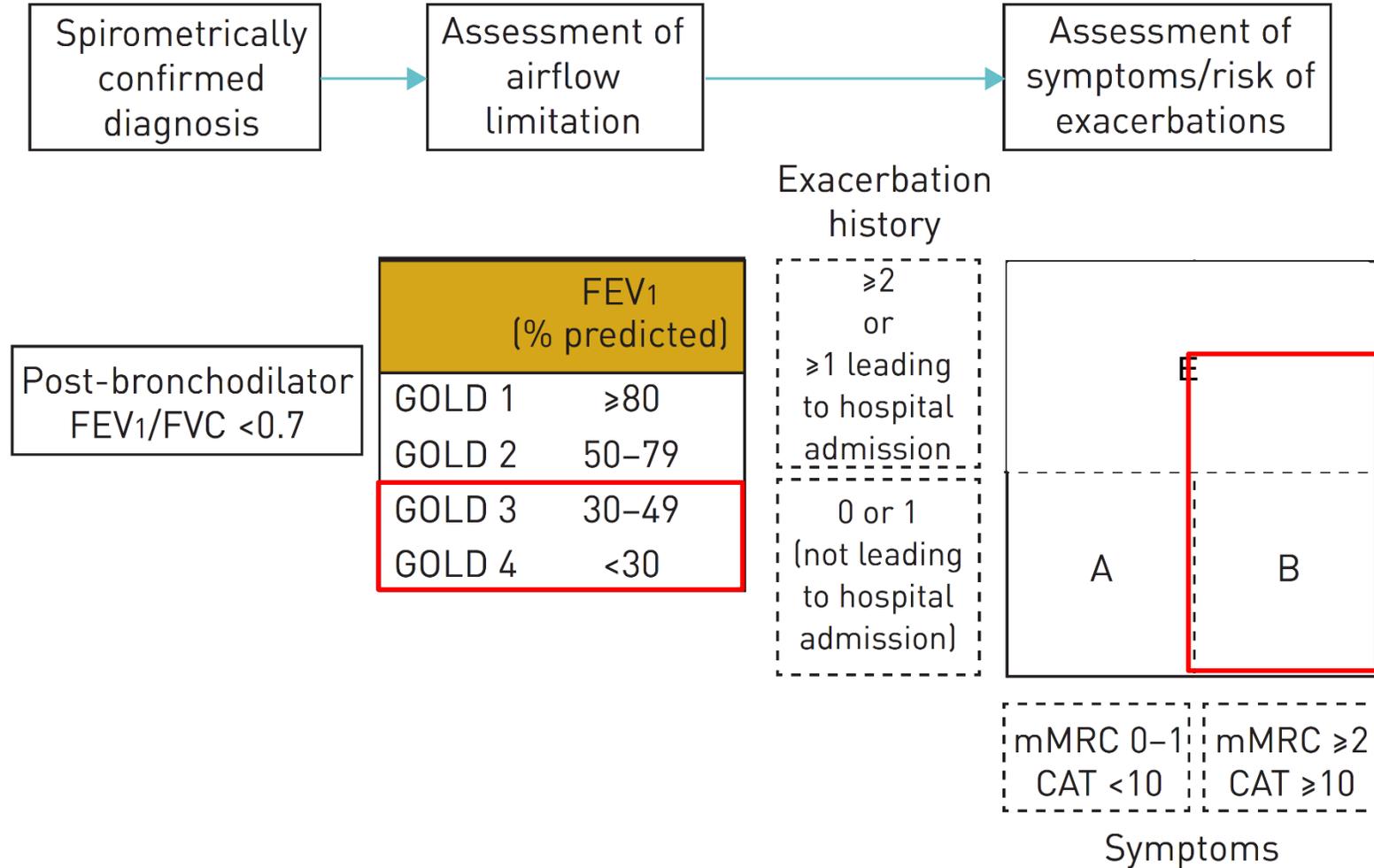
## 1. Severe COPD

FEV1 / FVC <70% och FEV1 <45%; >15% pred after bronchodilatation

## 2. High symptom burden and impaired exercise capacity

mMRC  $\geq 2$  och CAT  $\geq 10$  och 6MWT <450 meter

# The ABE assessment tool for COPD



# Symptom assessment

Table 2. Modified Medical Research Council dyspnea scale.

Grade	Description of breathlessness
0	I get breathless only with strenuous exercise.
1	I get short of breath if hurrying on level ground or walking up a slight hill.
2	On level ground, I walk slower than people of the same age because of breathlessness, or have to stop for breath if walking at my own pace.
3	I stop for breath after walking about 100 yards or after a few minutes on level ground.
4	I am too breathless to leave the house or I am breathless when dressing.

doi: 10.7573/dic.212243.t002

Example: I am very happy 0  1 2 3 4 5 I am very sad

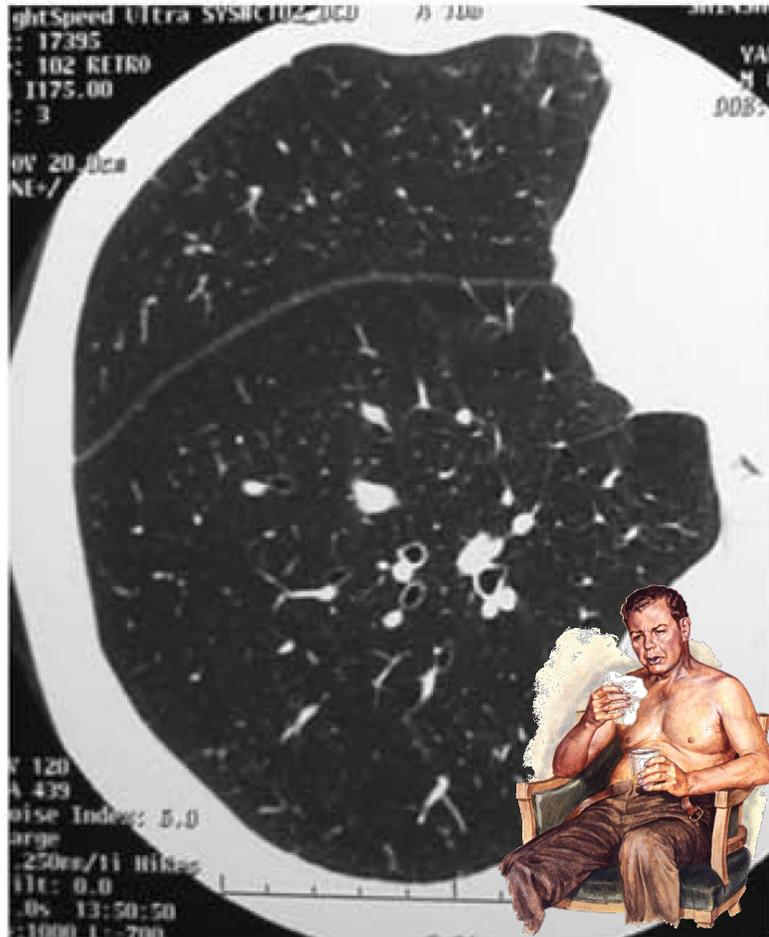
		SCORE					
I never cough	0 1 2 3 4 5	I cough all the time					
I have no phlegm (mucus) in my chest at all	<input checked="" type="radio"/> 1 2 3 4 5	My chest is completely full of phlegm (mucus)					
My chest does not feel tight at all	0 1 <input checked="" type="radio"/> 3 4 5	My chest feels very tight					
When I walk up a hill or one flight of stairs I am not breathless	0 1 2 3 4 <input checked="" type="radio"/> 5	When I walk up a hill or one flight of stairs I am very breathless					
I am not limited doing any activities at home	0 1 2 3 4 <input checked="" type="radio"/> 5	I am very limited doing activities at home					
I am confident leaving my home despite my lung condition	0 1 <input checked="" type="radio"/> 3 4 5	I am not at all confident leaving my home because of my lung condition					
I sleep soundly	<input checked="" type="radio"/> 1 2 3 4 5	I don't sleep soundly because of my lung condition					
I have lots of energy	0 1 <input checked="" type="radio"/> 3 4 5	I have no energy at all					
			<b>TOTAL SCORE</b>				

# Elegibility for BLVR with EBV

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- 5. Advanced emphysema (emphysema is needed)**



## Two COPD patients with a FEV<sub>1</sub> of 48% predicted



Airway phenotype



Emphysema phenotype

# Air Trapping and Hyperinflation in Emphysema

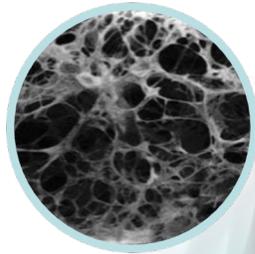


**Healthy Lung**



Tissue is elastic with large surface area

Breathing is easy; Lung expands and contracts normally



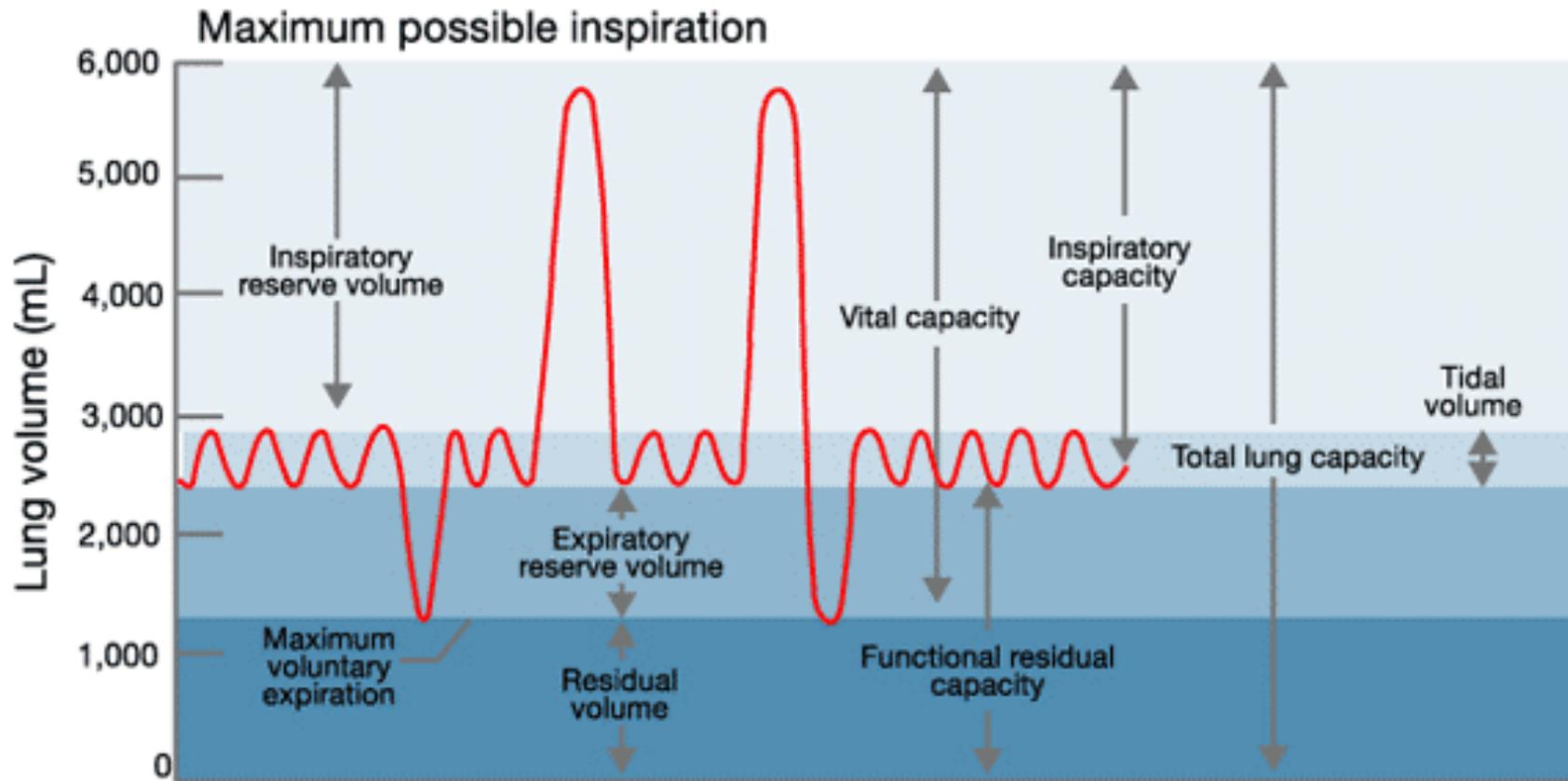
**Lung with Emphysema**



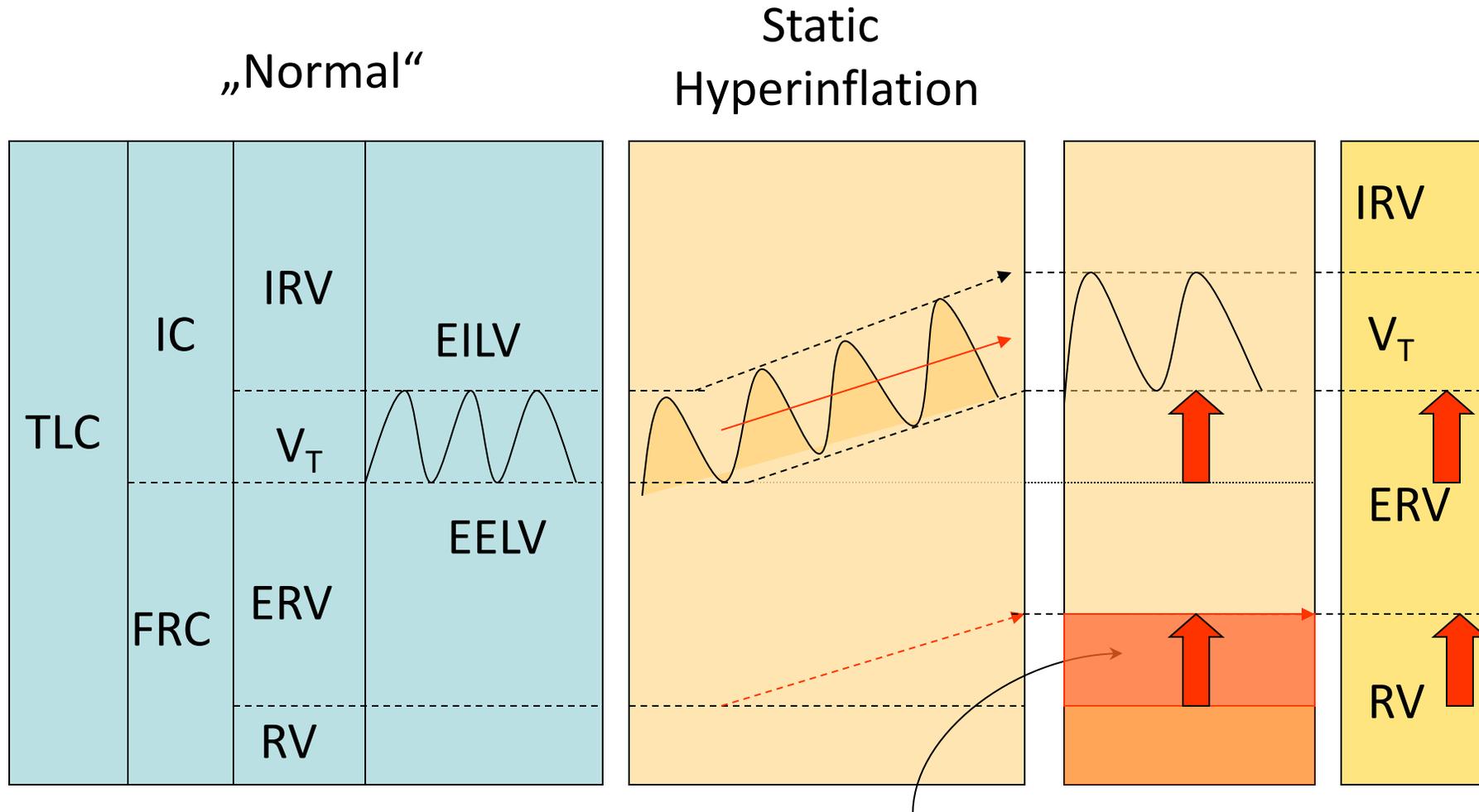
Tissue destruction reduces elasticity and gas exchange

Air is trapped in the diseased portion of the lungs, increasing lung volume and putting pressure on the diaphragm, making patient persistently breathless

# Static lung volumes



# Static hyperinflation

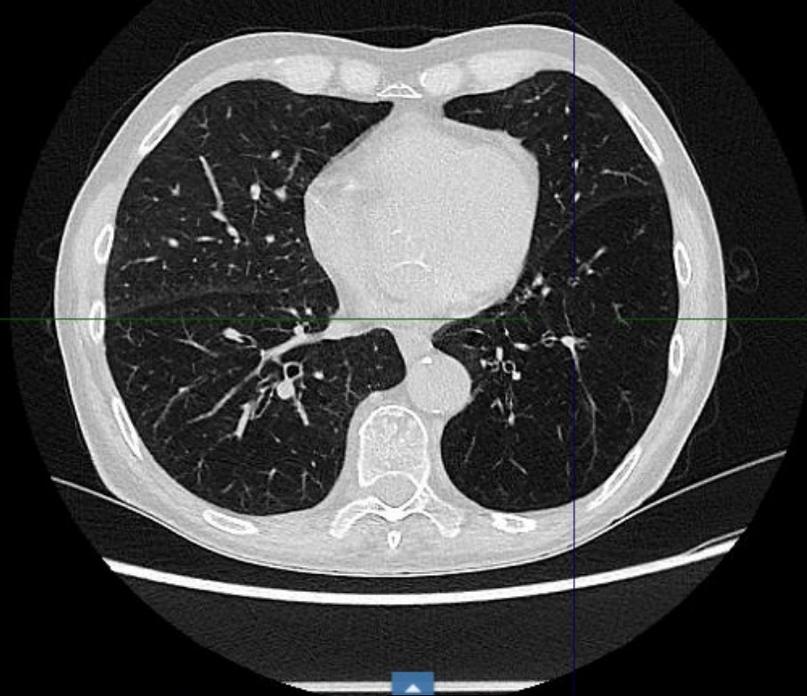


# Elegibility for BLVR with EBV

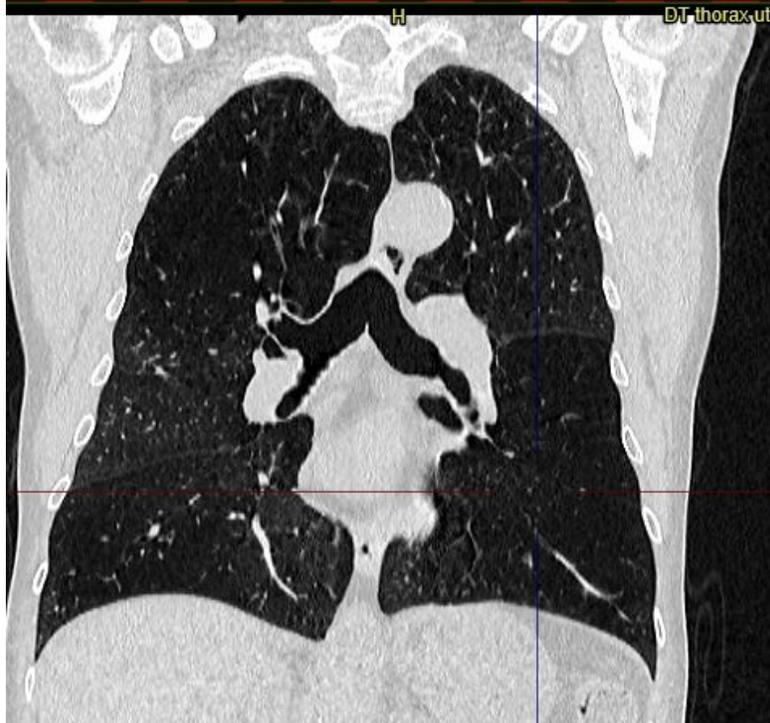
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# Emphysema, target lobe!



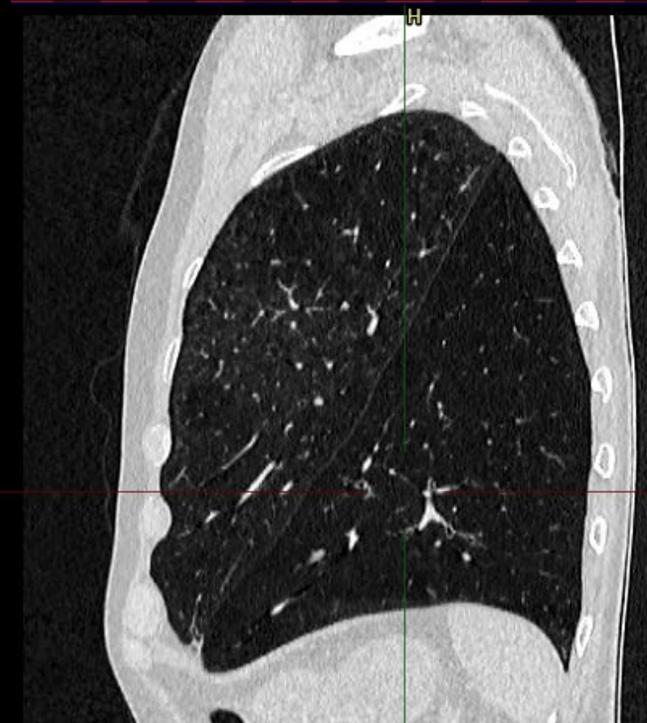
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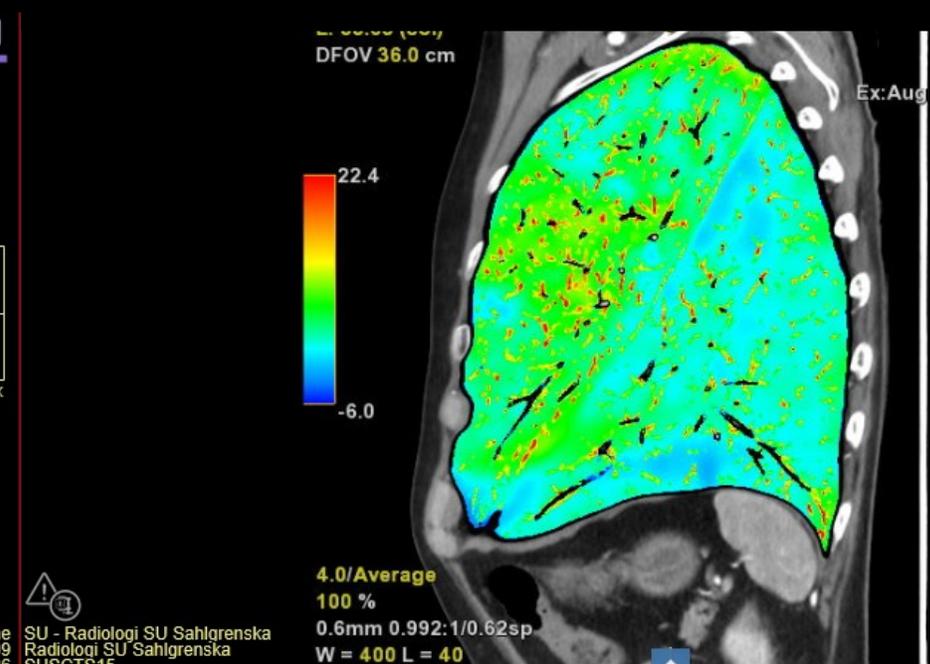
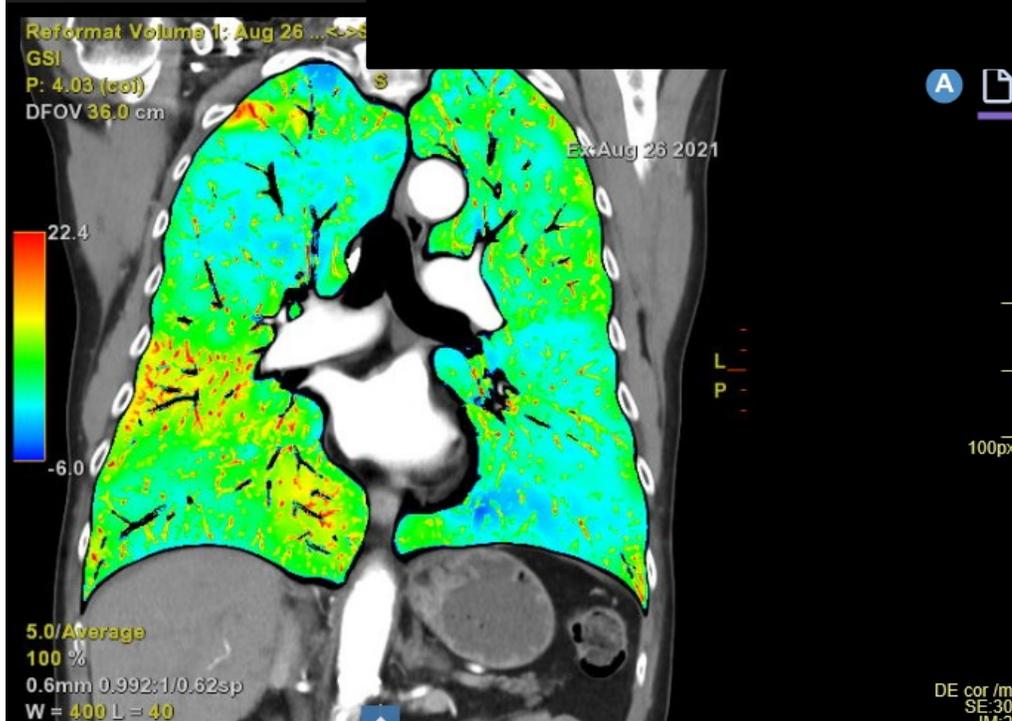
DT-thorax utan och med iv kontrast, dual ener  
ACC#-SU7860271  
2021-Aug-26 13:

A

80mm



# Pulmonary perfusion



# Elegibility for BLVR with EBV

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### 3. Optimal treatment

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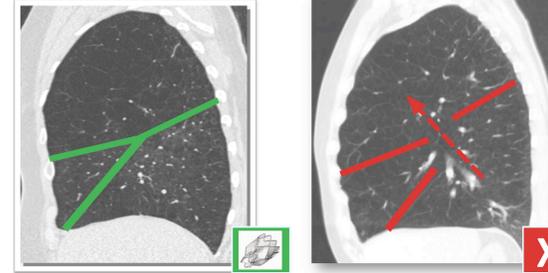
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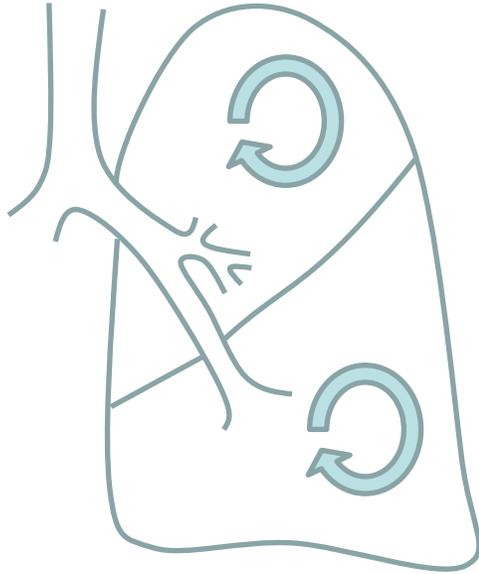


6. **Intact right or left major fissure**

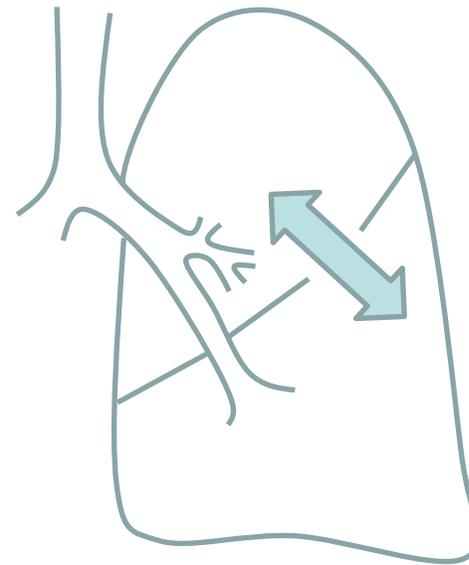


# Collateral Ventilation Screening

No Collateral Ventilation (CV-)

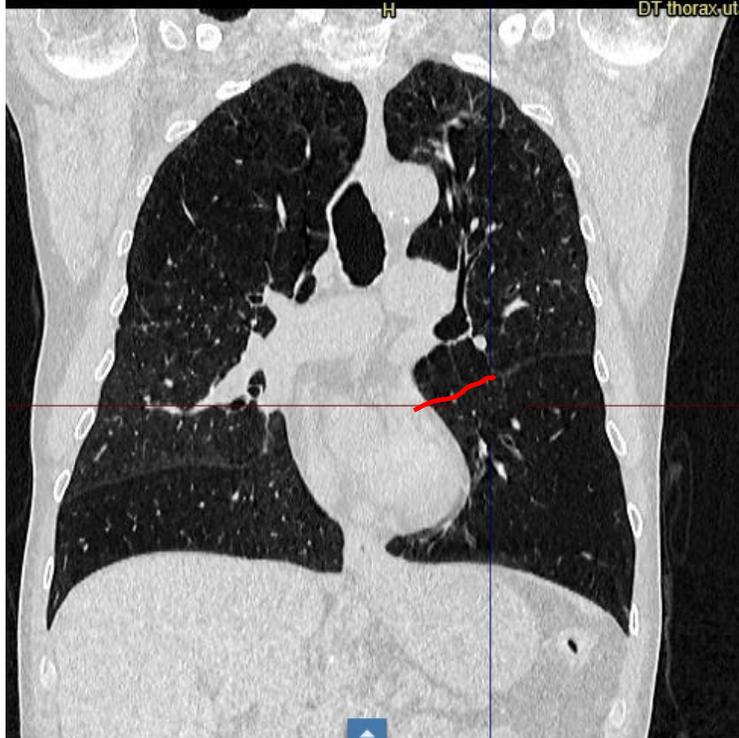
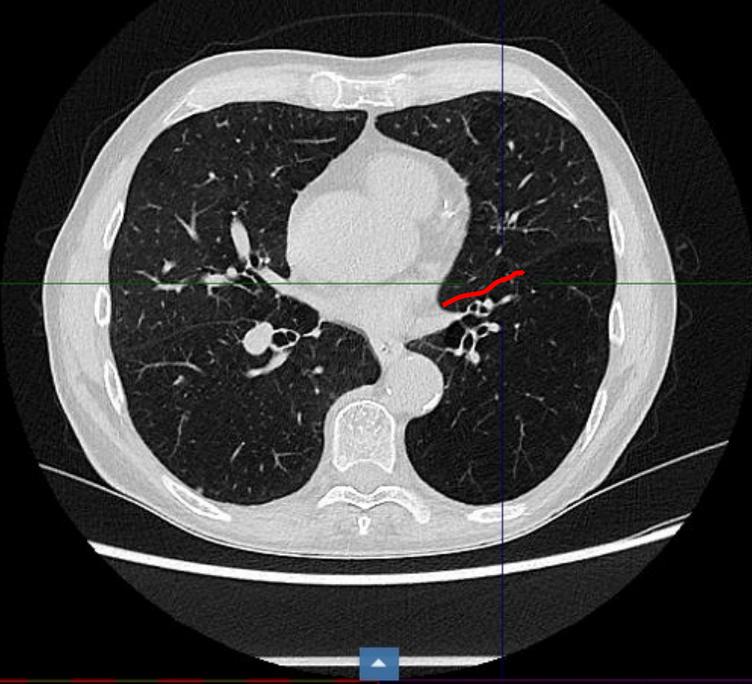


Collateral Ventilation (CV+)



- **Collateral ventilation is airflow between lobes** “through channels that bypass normal airways”<sup>1</sup>
- If a lobe with collateral ventilation is treated, it can re-fill with air
- **Only lobes with little to no collateral ventilation should be treated with Zephyr valves**

# Fissure integrity, target lobe!



DT thorax, utan och med iv kontrast, dual energy  
ACC# SU78602703  
2021-Aug-26 13:11  
Dennis Edvin Johansson (M)  
1951-Nov-30  
PID: 195111305198



Tc1 Thorax 0.625mm  
SE:2  
W:1400/L:-400 HU



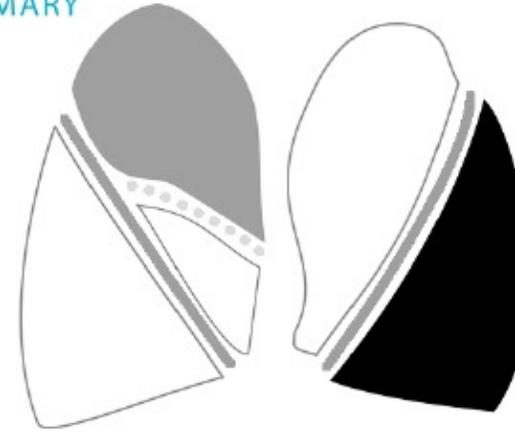
SU - Radiologi SU Sahlgrenska  
Radiologi SU Sahlgrenska  
SUSCTS15



# Quantitative CT analysis

Patient ID	18DJ5198	Upload Date	Jan. 10, 2023
Scan ID	87.243	Report Date	Jan. 12, 2023
CT Scan Date	Dec. 10, 2022	Scan Comments	None

### SUMMARY



#### KEY

- ≥70% Voxel Density  
Less Than -910 HU
- 60-70% Voxel Density  
Less Than -910 HU
- 50-60% Voxel Density  
Less Than -910 HU
- <50% Voxel Density  
Less Than -910 HU
- ≥95% Fissure Completeness
- 80-95% Fissure Completeness
- <80% Fissure Completeness

### RESULTS

	RIGHT LUNG				LEFT LUNG	
	RUL	RUL+RML	RML	RLL	LUL	LLL
% Fissure Completeness	65.8	91.4	69.4	91.4	81.4	81.4
% Voxel Density Less Than -910 HU	63	47	9	47	35	74
% Voxel Density Less Than -950 HU	40	29	2	18	15	52
Inspiratory Volume (ml)	1392	1988	596	1068	1107	1604

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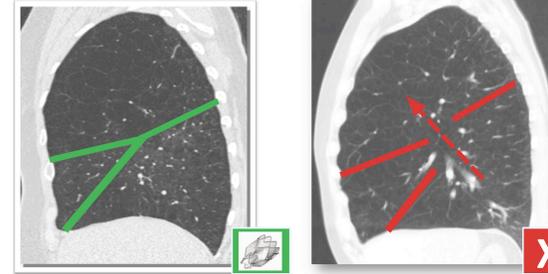
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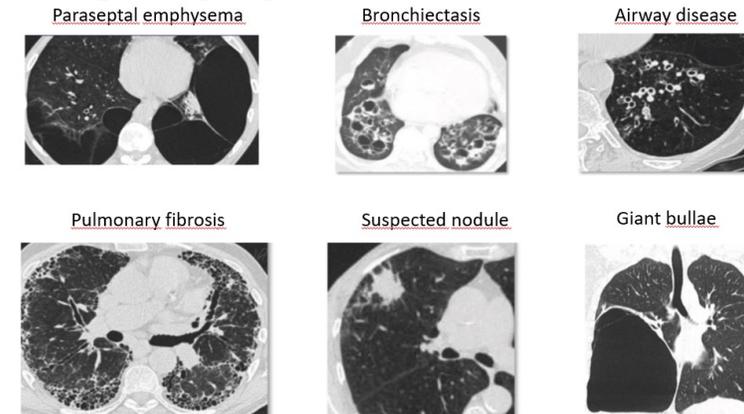
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7. **Absence of important comorbidity**

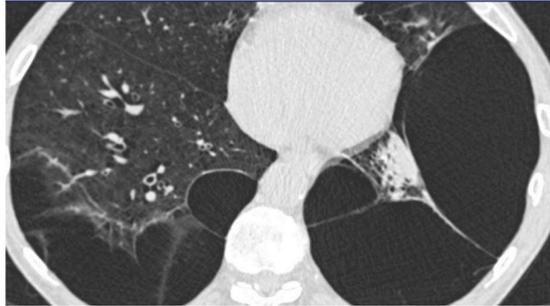
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- Morbid obesity (BMI> 35)
- Previous major lung surgery
- (repeated) respiratory infections, immunodeficiency

8. **Lungimaging that is not suitable for valves**

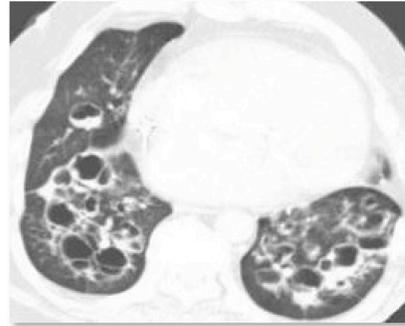


# Do not treat!

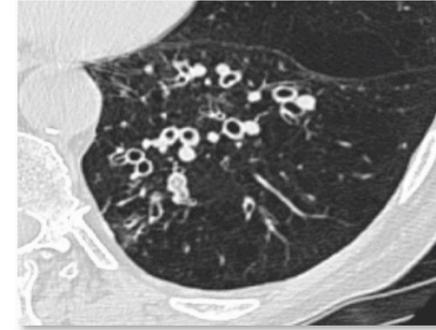
Paraseptal emphysema



Bronchiectasis



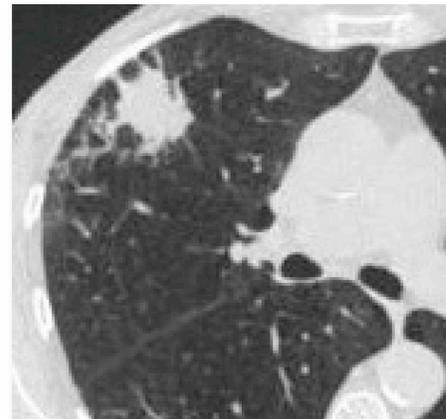
Airway disease



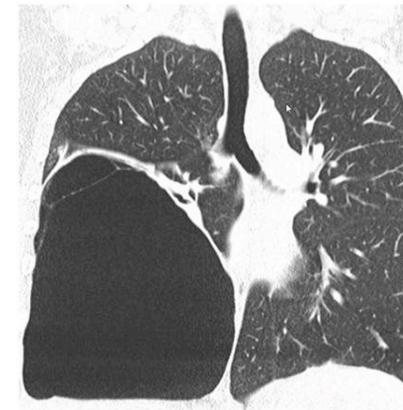
Pulmonary fibrosis



Suspected nodule



Giant bullae



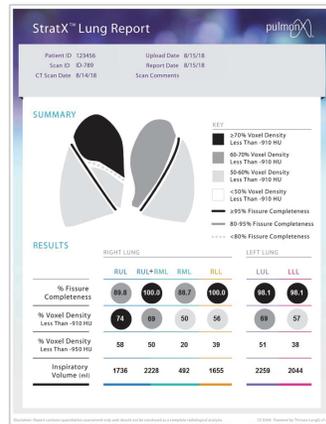
# Patient Selection

## Clinical Screening

15-45% FEV<sub>1</sub>  
≥175% RV  
≥ 100% TLC  
(Spirometry, PFTs)

Diagnosis of  
Emphysema  
(CT Scan)

Medically Stable,  
No Disqualifying  
Comorbidities



Noninvasive:  
**Quantitative CT  
Analysis Platform**

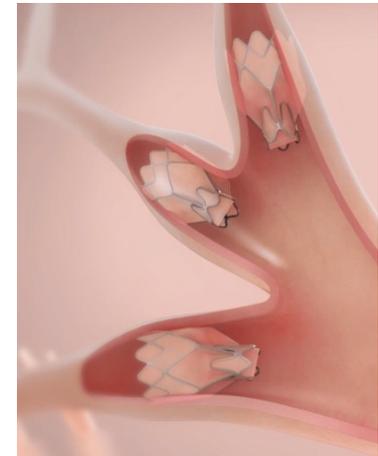
➔  
MDC

## Lobe Evaluation

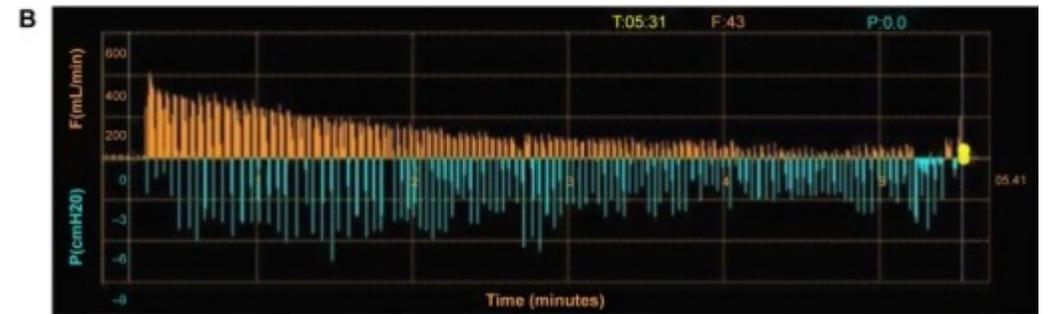
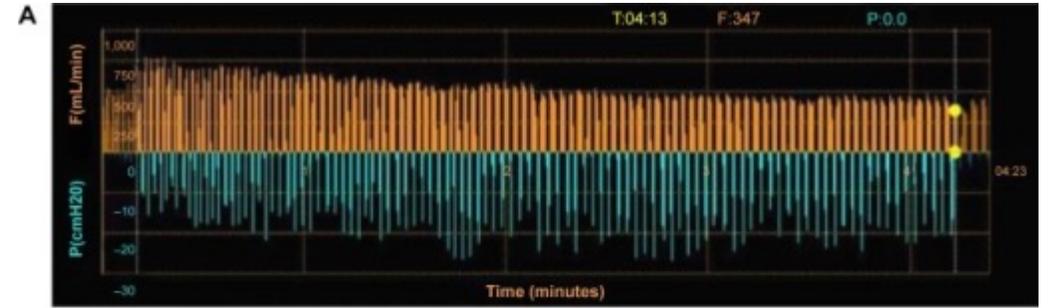
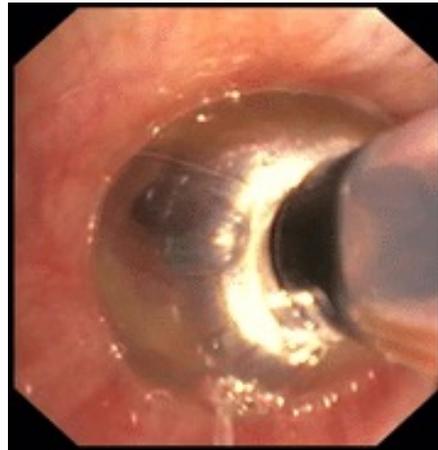
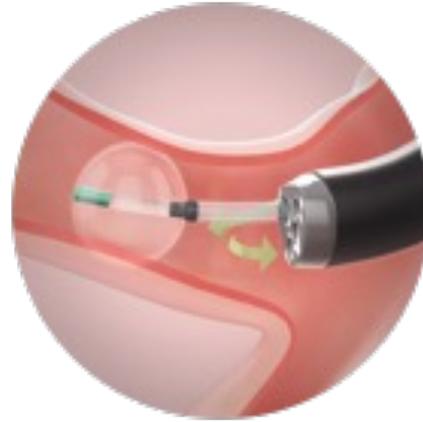


Procedure:  
**Chartis® Pulmonary  
Assessment System**

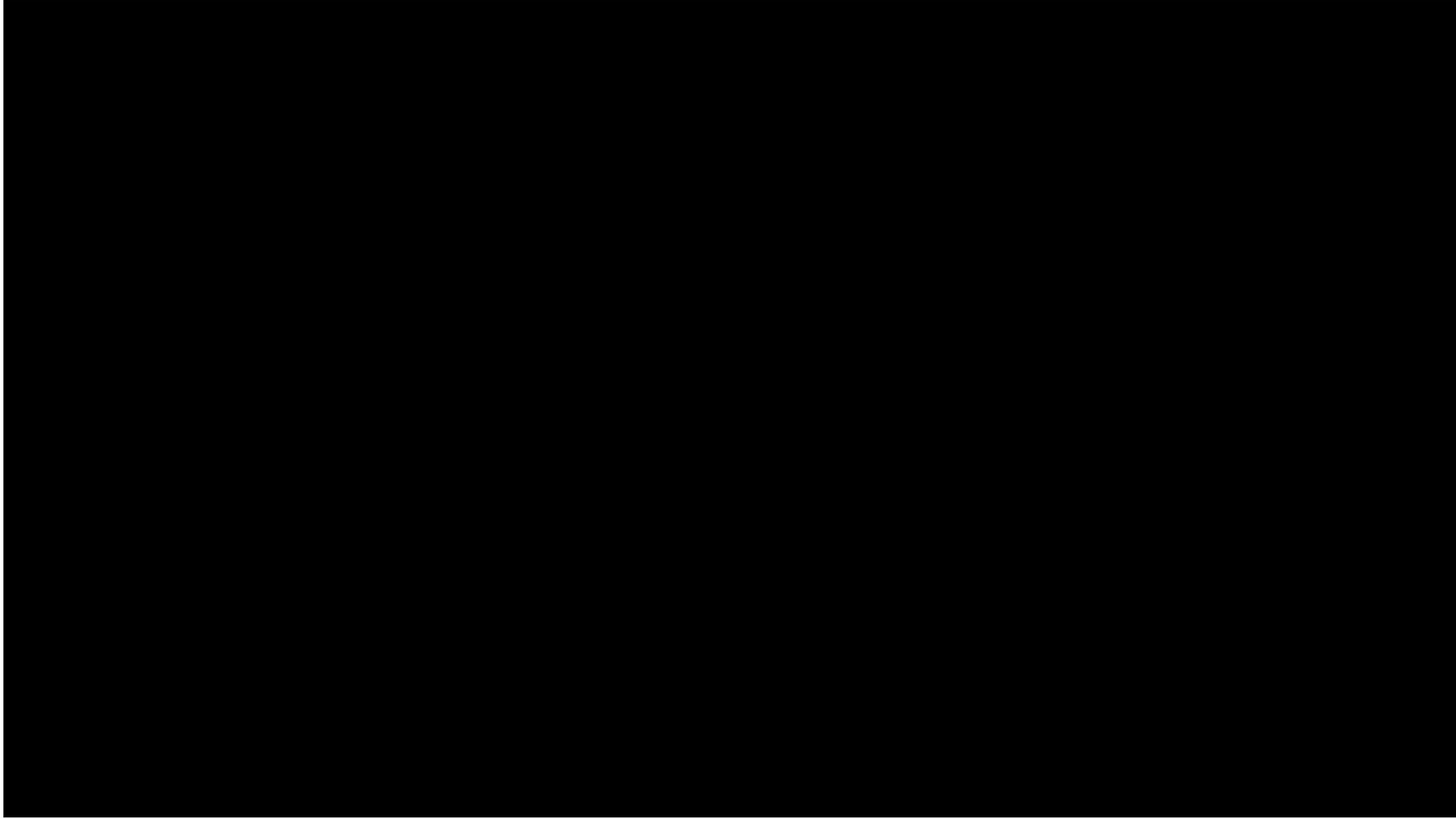
## Treatment



# Chartis



# Endobronchial Valve treatment

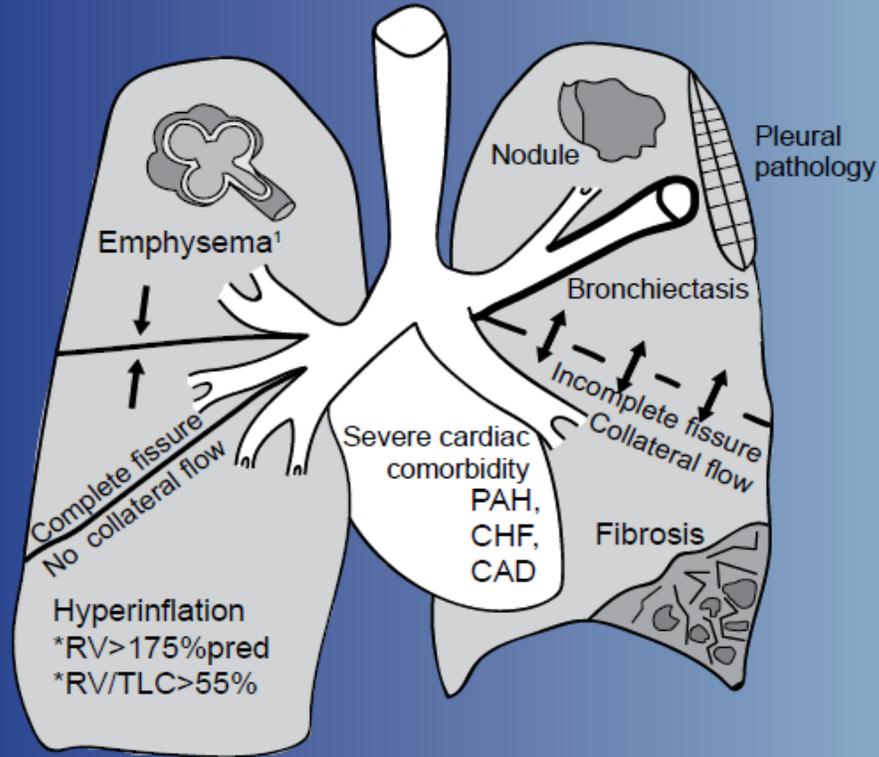




# ENDOBRONCHIAL VALVE TREATMENT FOR EMPHYSEMA



## Selection



### DO

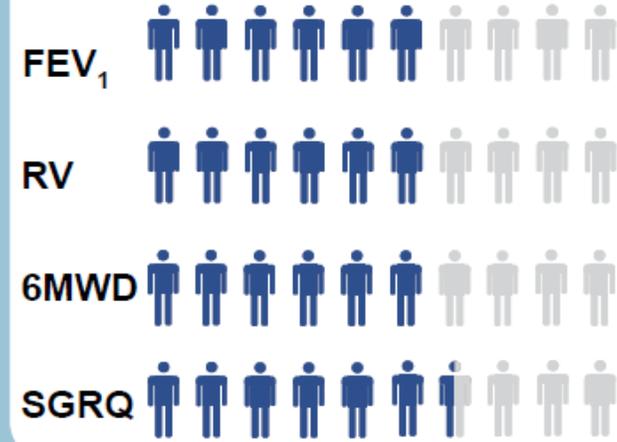
- Symptomatic<sup>2</sup>
- Non-smoking
- Optimal treatment
- Stable condition

### DON'T

- Infectious lung disease
- Chronic bronchitis/ Astma
- Prior lobectomy/ LVRS on treatment side
- Hypercapnia/hypoxemia<sup>3</sup>
- Immunocompromized

## Outcome

### Responder rates



### Risks related to EBV

- Pneumothorax rate 18-34%
- Re-bronchoscopy 19-35%
- Valve removal 3-21%

### Future challenges

- Advanced patient selection
- Predictors of pneumothorax
- Positioning pulmonary rehabilitation
- Bronchoscopy or surgery?
- Long term follow-up and survival



# Endobronchial Valve Treatment

First BLVR outside clinical studies in  
Gothenburg in may 2022

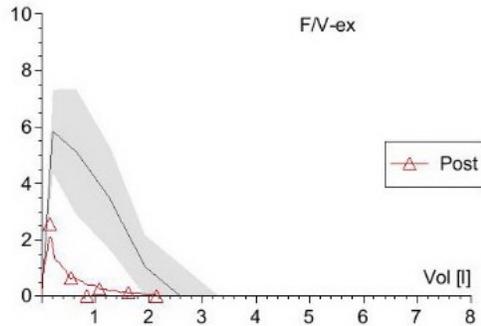
10 patients have been treated so far

# CASE :

## Medical history

- COPD and severe emphysema
- GOLD stage: 3
- mMRC: Grade 3
- CAT score: 26 points
- Nr of exacerbation in the past 12 months: 1
- Nr of hospitalisations for exacerbations: 0
- GOLD quadrant classification: B
- Quit smoking since: 2015
- Nr of pack years: 30
- LTOT: No
- Pulmonary medication: LABA/LAMA and rescue SABA
- Extrapulmonary comorbidity: none

# CASE 1: Medical history



## Body composition:

Weight 69 kg

BMI 24.0 kg/m<sup>2</sup>

## 6 minute walking distance:

405 m Lowest oxygen saturation 93 %

## Blood gases:

pH 7,4; pCO<sub>2</sub> 5,2; pO<sub>2</sub> 11,0; Sat 97%

	Normal	LLN	ULN	Post	%Ref	SD
Substans				Ventoline		
Dos				0,1mg x6		
<b>Kroppspletysmografi</b>						
sRaw	kPa*s	0.96	0.96	0.96	5.75	598.5
TLC	l	5.17	4.18	6.15	7.24	140.2 3.46
FRC	l	2.79	1.97	3.61	5.32	190.4 5.05
RV	l	2.17	1.60	2.75	4.94	227.2 7.90
RV/TLC	%	43.78	34.19	53.37	68.18	155.7 4.19
<b>Dynamisk spirometri</b>						
IC	l	2.08	2.08	2.08	1.61	77.1
VC IN	l	2.70	2.01	3.39	2.15	79.4 -1.33
VC EX	l	2.70	2.01	3.39	2.14	79.2 -1.34
FVC	l	2.57	1.86	3.27	2.14	83.4 -0.99
FEV1	l	2.13	1.51	2.76	0.84	39.5 -3.40
FEV1/FVC	%	75.23	64.52	85.94	39.31	52.3 -5.52
FEV1/VC MAX	%	75.23	64.52	85.94	39.22	52.1 -5.53
<b>Diffusionskapacitet</b>						
DLCOSB	mmol/(min*kPa)	7.13	5.67	8.59	3.16	44.3 -4.46
KCO	mmol/(min*kPa*l)	1.58	1.19	1.98	0.90	57.1 -2.83

73 year old female with severe COPD, very severe static hyperinflation, highly symptomatic, impaired exercise capacity limited comorbidity, no resp. failure, DLCO > 20% predicted

-> good candidate for EBV on clinical grounds

CT



enska

DE\_Lun



H

DT thorax utan och med iv kontrast, dual energy  
ACC#:SU78379118  
2021-Feb-24 14:37



A

DE\_Lungemboli #PP 0.75 Qr40 3 A\_90kV  
SF:0

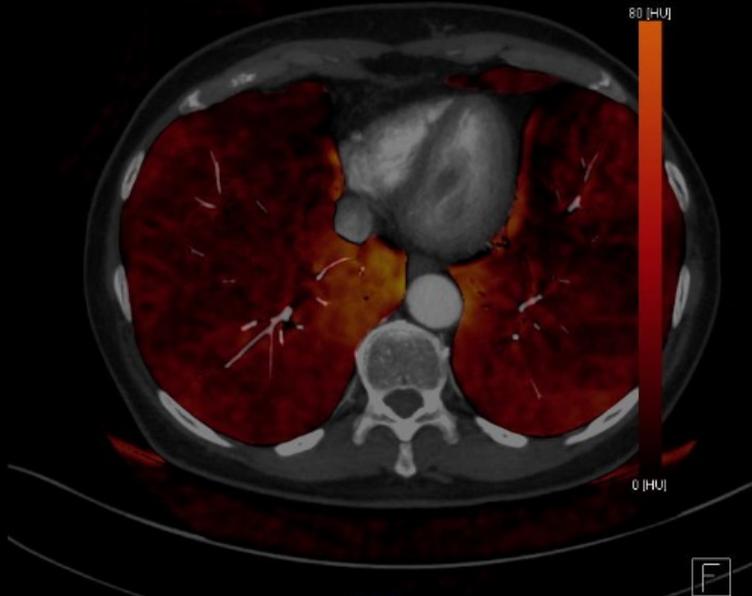


SU - Radiologi SU Sahlgrenska  
Bordlineri SU Sahlgrenska

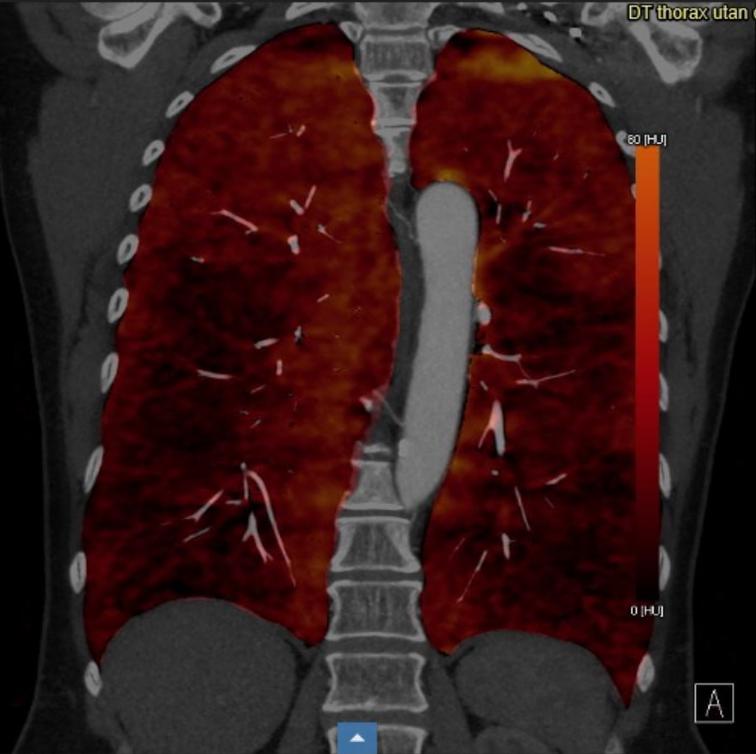


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# DECT perfusion



ska



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2021-Feb-24 14:36

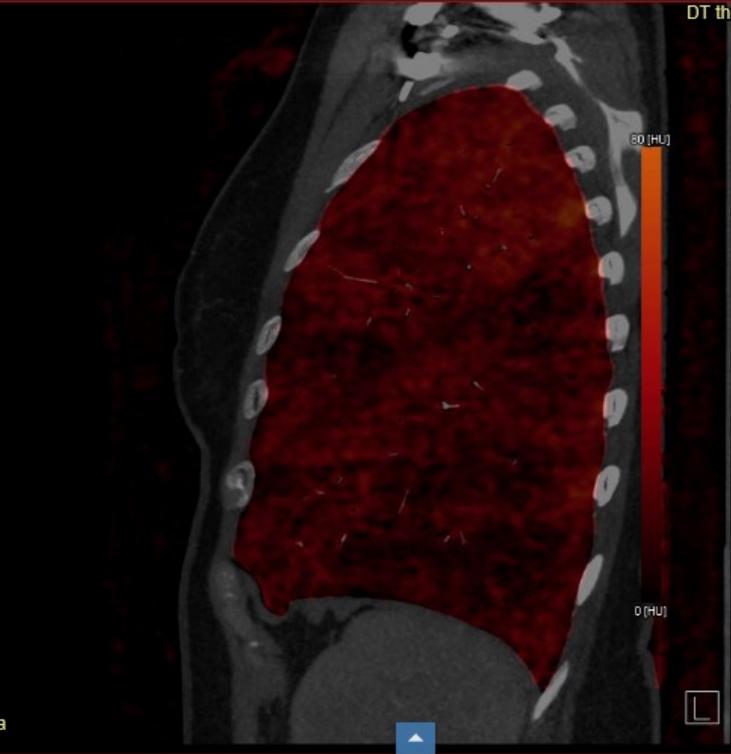
A

60mm

cor/mc  
SE:1068  
IM:47  
CONTRAST:iv Kontrast  
W:256/L:128 HU

Eva Kristina Holmstedt (F)  
1949-Jan-26  
PID: 194901267569

SU - Radiologi SU Sahlgrenska  
Radiologi SU Sahlgrenska

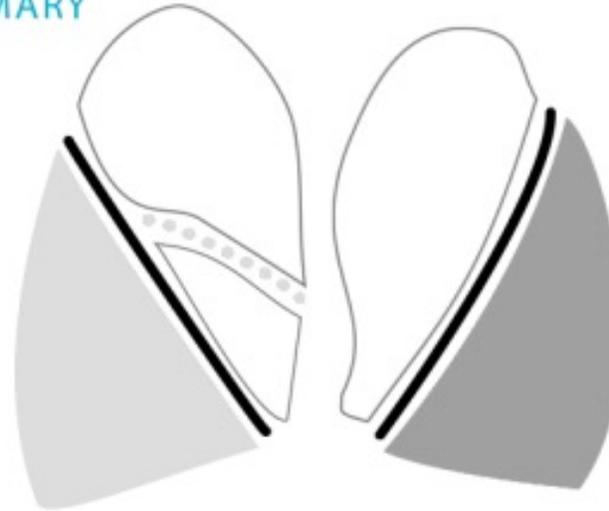


DT thi

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# Quantitative CT analysis

## SUMMARY



### KEY

- ≥70% Voxel Density  
Less Than -910 HU
- 60-70% Voxel Density  
Less Than -910 HU
- 50-60% Voxel Density  
Less Than -910 HU
- <50% Voxel Density  
Less Than -910 HU
- ≥95% Fissure Completeness
- 80-95% Fissure Completeness
- <80% Fissure Completeness

## RESULTS

	RIGHT LUNG				LEFT LUNG	
	RUL	RUL+RML	RML	RLL	LUL	LLL
% Fissure Completeness	86.9	100.0	89.4	100.0	100.0	100.0
% Voxel Density Less Than -910 HU	22	26	36	58	38	62
% Voxel Density Less Than -950 HU	2	3	5	23	8	23
Inspiratory Volume (ml)	1089	1455	366	1694	1373	1658

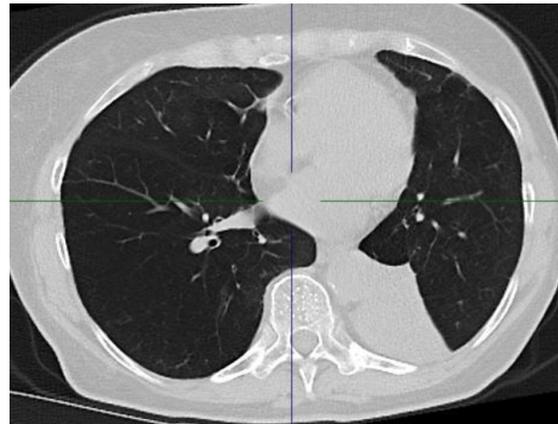
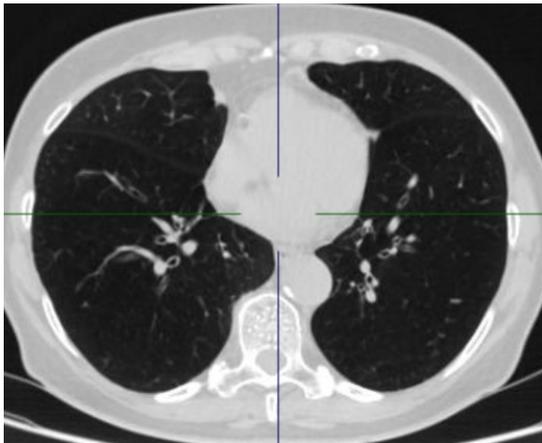
# Chartis and treatment

**Chartis measurement left lower lobe:**  
No collateral ventilation

→ **EBV treatment left lower lobe on november 3th 2022**

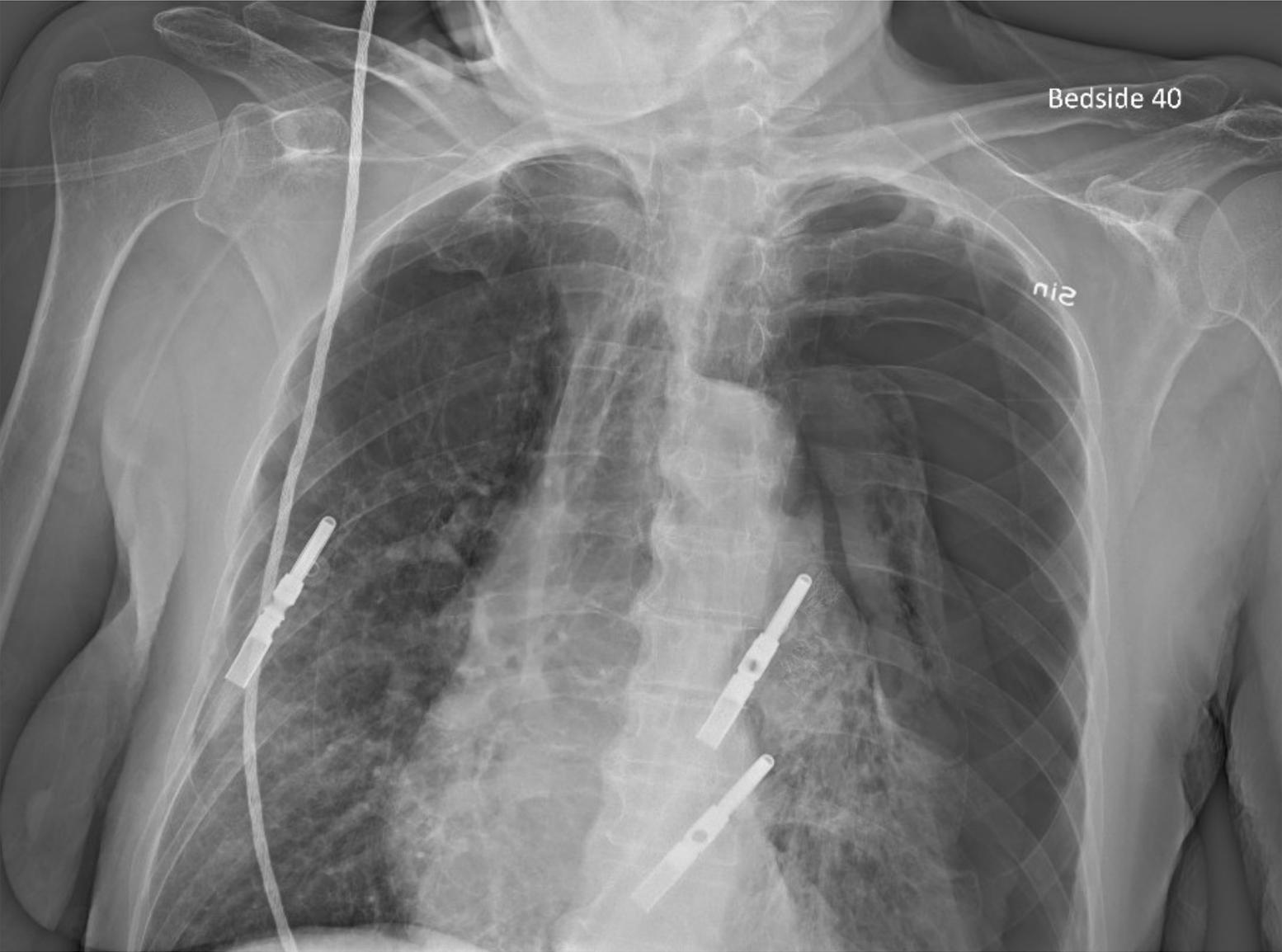
→ After treatment patient felt better and went for a walk in the mountains. She got lost and was found by the police after four days. Hospitalized and treated for urinary tract infection. Around Christmas she got COVID19 of which she is still recovering

→ Still relevant improvement in all parameters and room for further improvement.



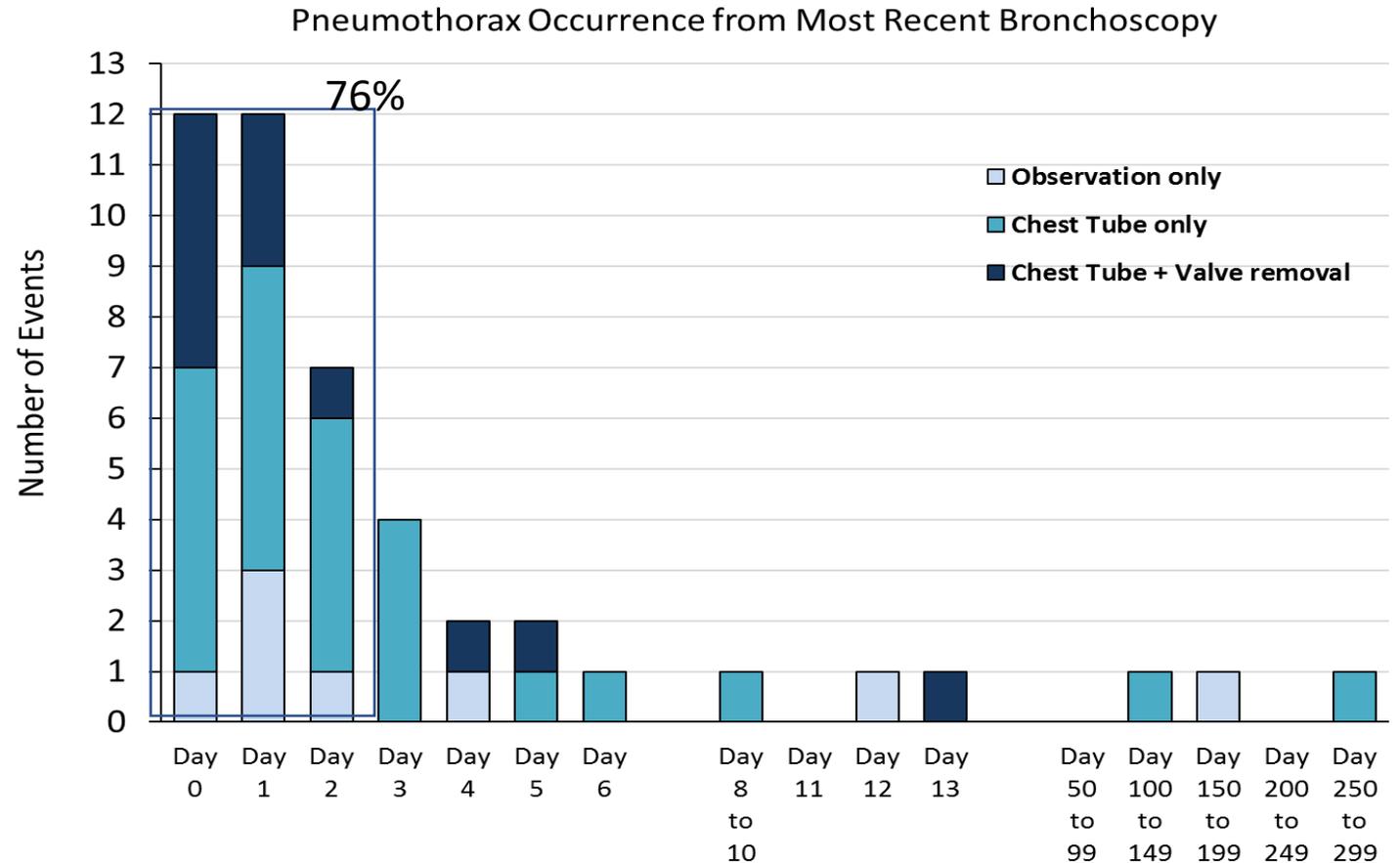
	Before treatment	After treatment
<b>Datum</b>	10-08-2022	23-01-2023
<b>FEV1</b>	0,84L (39%)	0,85L (40%)
<b>FVC</b>	2,14 (83%)	2,23 (87%)
<b>TLC</b>	7,24 (140%)	5,76 (111%)
<b>RV</b>	4,94L (227%)	3,59 (165%)
<b>FRC</b>	5,3L (190%)	4,22L (151%)
<b>DLCO</b>	3,16 (44%)	3,29 (45%)
<b>CAT</b>	26	17
<b>6MWD</b>	405	420

# Not always a straight road to success

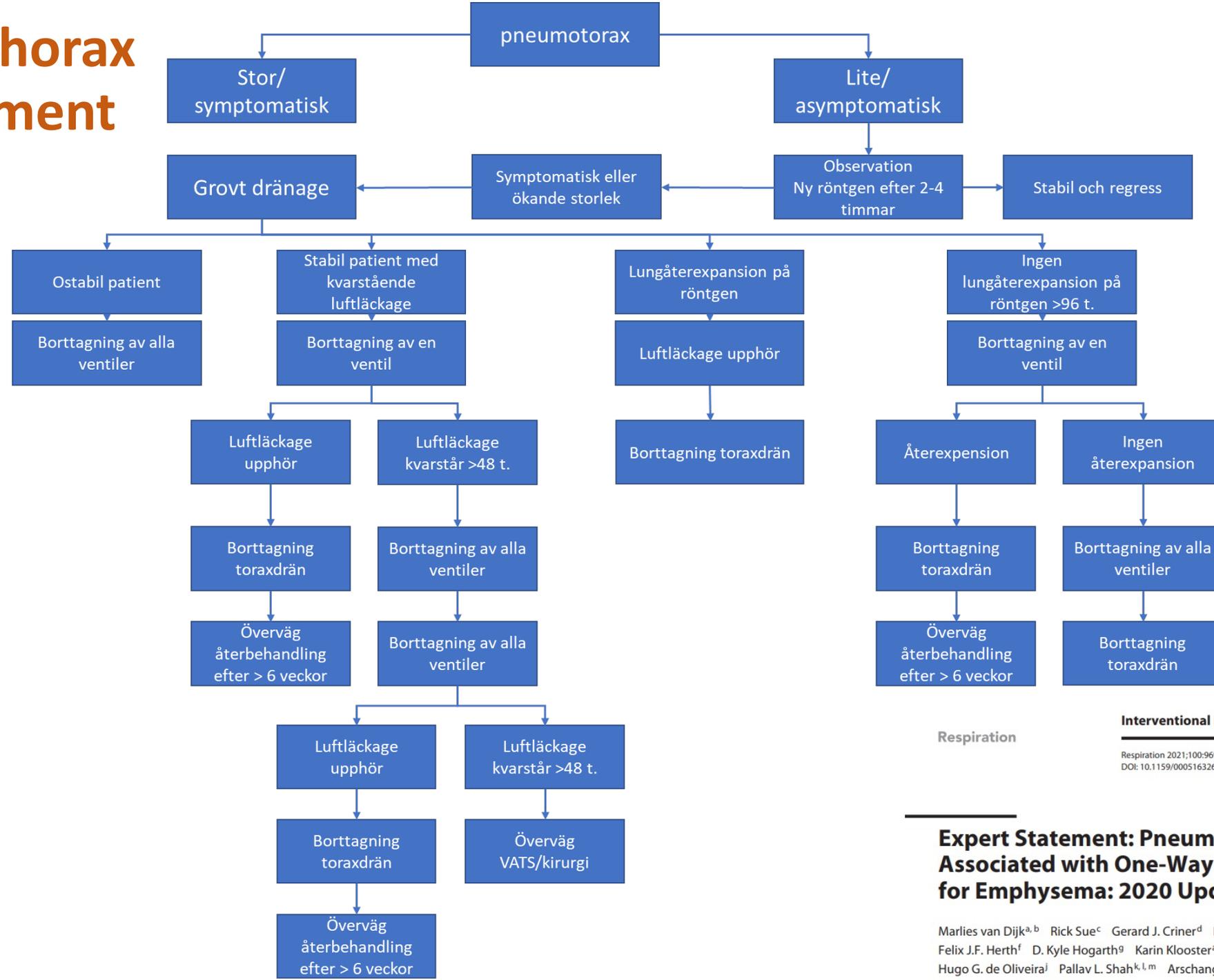


# Zephyr Valve Pneumothorax (PTX) Post-EBV

- PTX can occur in ipsilateral lobe
- Believed to be related to shifts in lobe volume
- 76% of PTX in 3 days
- 83% require chest tube
- Patients with PTX had comparable benefits to patients without



# Pneumothorax management



Respiration

**Interventional Pulmonology**

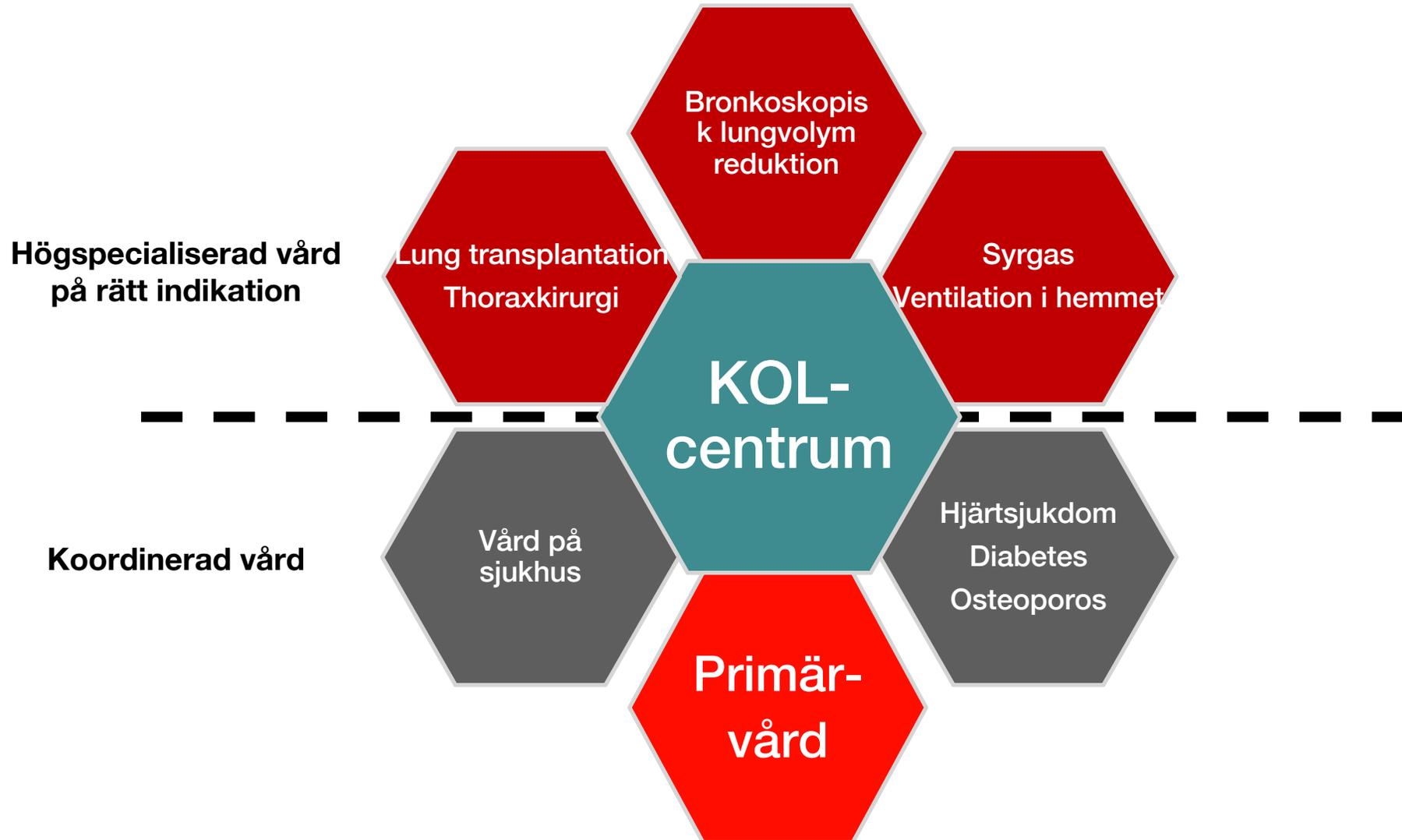
Respiration 2021;100:969-978  
DOI: 10.1159/000516326

Received: November 23, 2020  
Accepted: February 14, 2021  
Published online: June 1, 2021

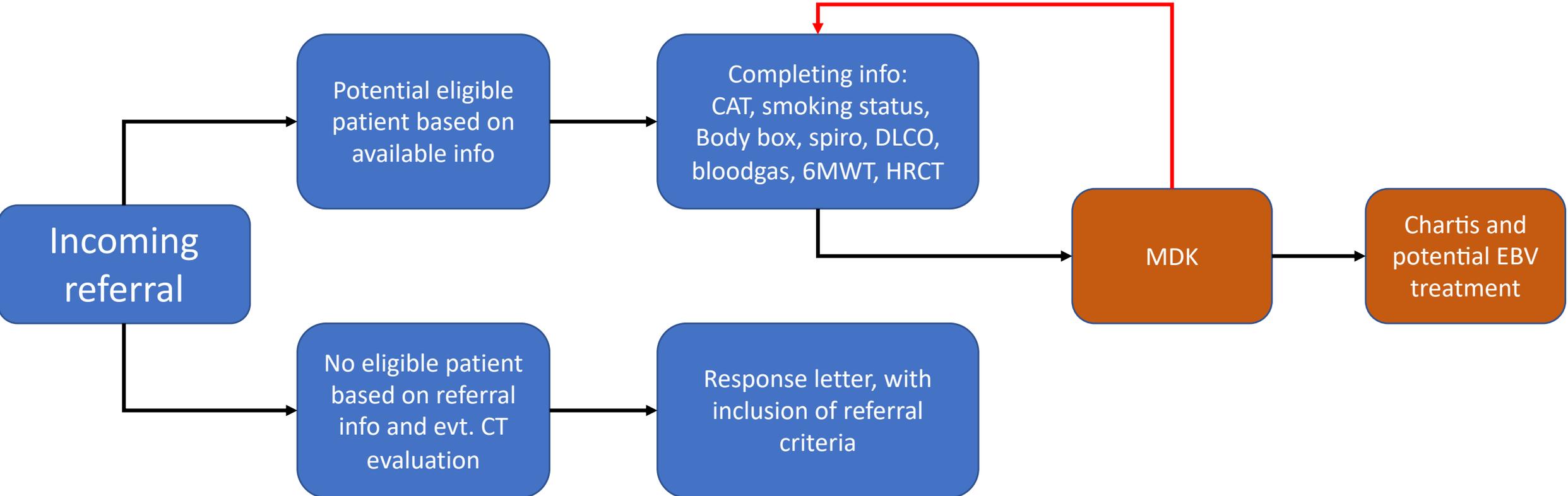
**Expert Statement: Pneumothorax Associated with One-Way Valve Therapy for Emphysema: 2020 Update**

Marlies van Dijk<sup>a,b</sup> Rick Sue<sup>c</sup> Gerard J. Criner<sup>d</sup> Daniela Gompelmann<sup>e</sup>  
Felix J.F. Herth<sup>f</sup> D. Kyle Hogarth<sup>g</sup> Karin Klooster<sup>a,b</sup> Janwillem W.H. Kocks<sup>b,h,i</sup>  
Hugo G. de Oliveira<sup>j</sup> Pallav L. Shah<sup>k,l,m</sup> Arschang Valipour<sup>n</sup> Dirk-Jan Slebos<sup>a,b</sup>

# Patientstöd genom vårdssamverkan

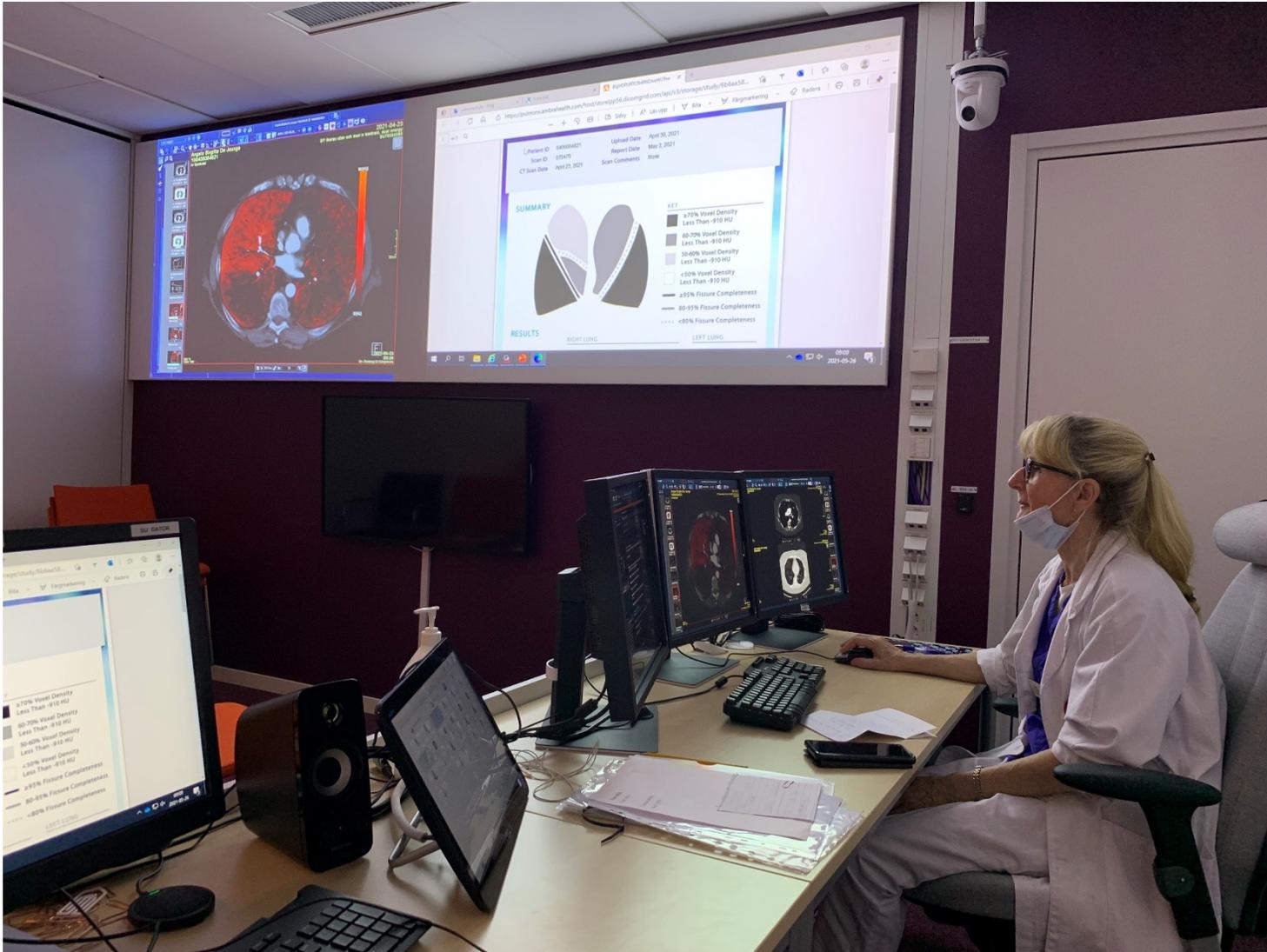


# From referral to treatment



# Multidisciplinary board

MDK



- Lung physician COPD-center
- Coordinator COPD-center
- Interventional pulmonologist
- Thorax radiologist

# Pyttesmå ventiler fixar uppblåsta lungor

Publicerad: 25 november 2021, 06:00

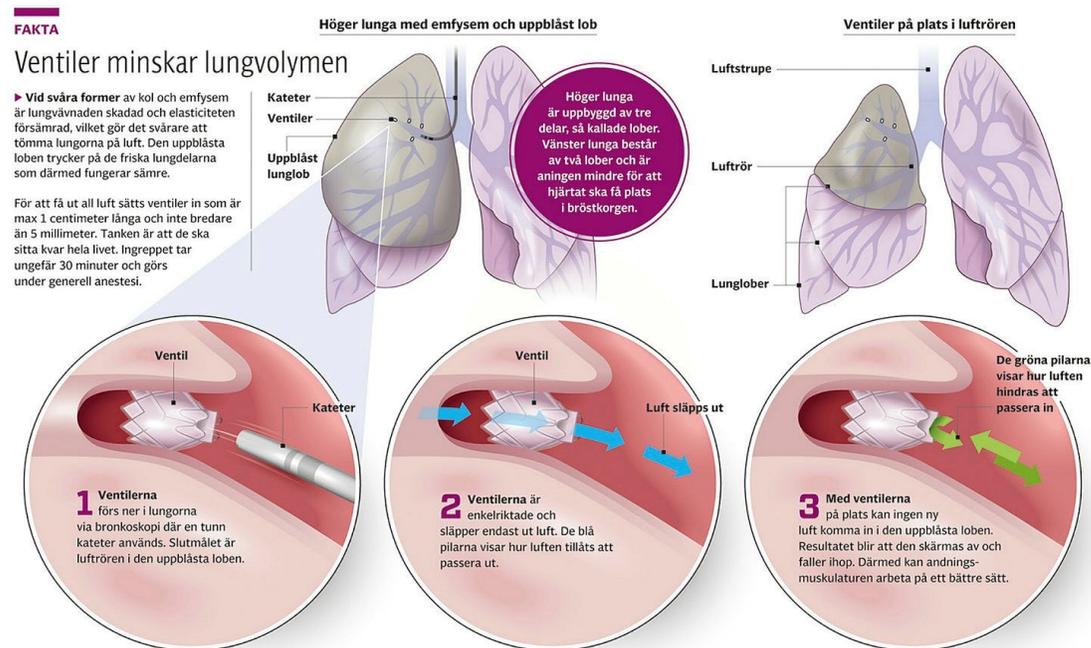


Lowie Vanfleteren som är överläkare på kol-centrum vid Sahlgrenska universitetssjukhuset i Göteborg och Georg Schramm som är biträdande överläkare på lungkliniken vid Skånes universitetssjukhus i Malmö är båda positiva till den nya metoden med ventiler som skärmar av skadade delar av lungan.

Foto: Johanna Svensson, Getty Images

**Enkelriktade ventiler som skärmar av lungans sjuka delar införs i klinisk rutin vid svår kol. Två sjukhus ligger i startgroparna.**

# DAGENS Medicin



24 augusti, 2022

## Bättre lungfunktion tack vare ventiler

Personer med KOL kan förbättra sin lungfunktion genom att få ventiler i en sjuk lunglob. Lungläkaren Lowie Vanfleteren har sett patienter "färdas tio år tillbaka i tiden" när de får sina ventiler. Så blev det för 71-årige Gunnar Thunell, som i maj blev den första patienten i VGR som fick behandlingen.

2003 fick **Gunnar Thunell**, då 52 år, diagnosen KOL. Han slutade omedelbart att röka, och

fick läkemedel

– Det har varit

dörren har varit

sämre kondition

sedan. Jag orkar

Innan ventilbehandlingen gjorde Gunnar Thunell ett gångtest. Då klarade han att gå 210 meter, med tre pauser. Några veckor efter ingreppet gick han 320 meter utan att stanna – trots att han just haft lunginflammation. Lungfunktionen ökade från 25 till 37 procent under samma period.

– För mig är det en markant skillnad, och det har gett en nytändning vad gäller träningen. Nu ska jag försöka bli så bra det bara går. Ingreppet var en del, nu är resten upp till mig. Jag skulle väldigt gärna vilja ha båt igen, men vi får se hur allt går.



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VÄSTRA GÖTALAND  
SAHLGRENKA UNIVERSITY HOSPITAL

# Thank you!

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