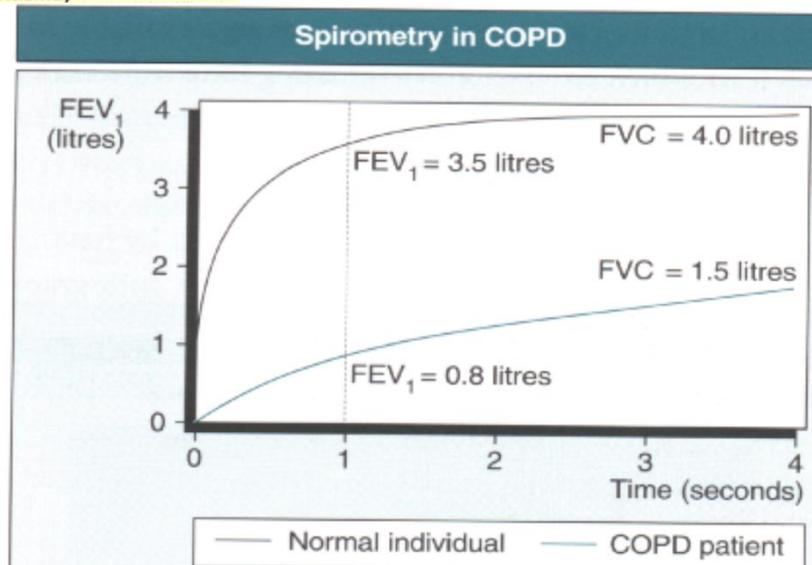
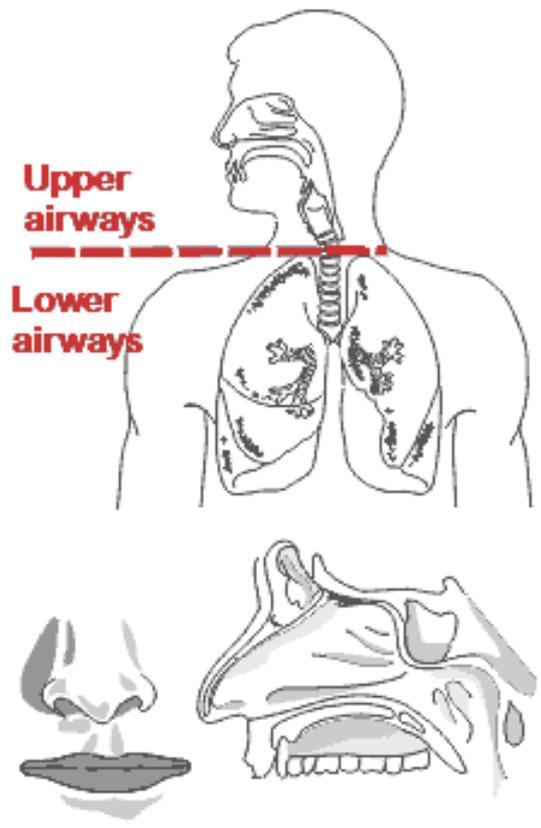


Acute respiratory failure

Arterial blood gas assessment

finn rasmussen 2011

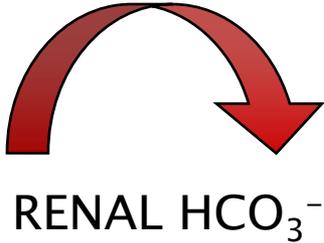
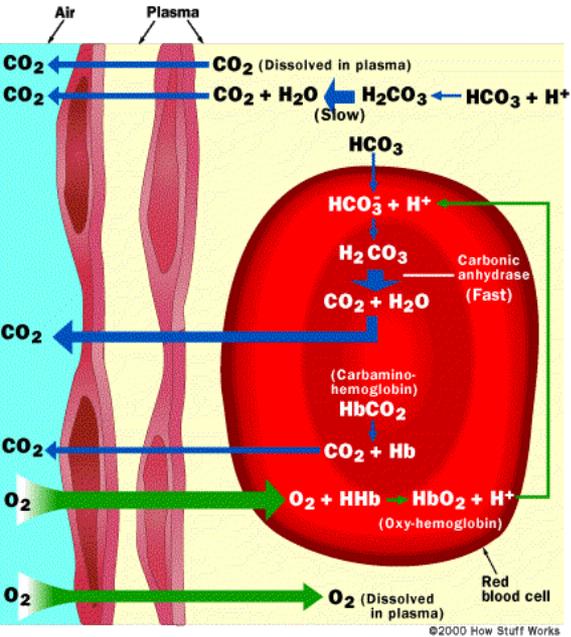
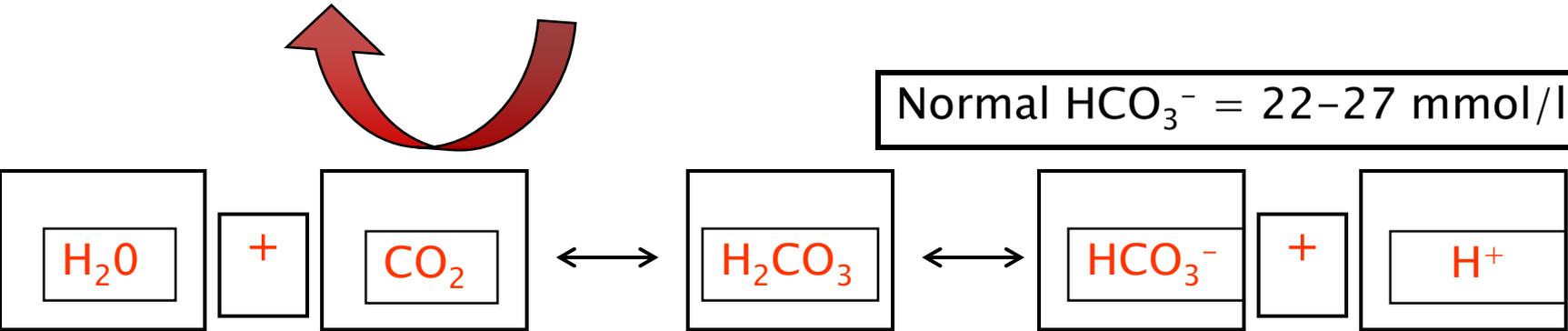


Normal $P_a\text{CO}_2 = 40\text{mmHg}$

Normal $P_a\text{O}_2 = 90-95 \text{ mmHg}$

ALVEOLAR VENTILATION

Normal $\text{HCO}_3^- = 22-27 \text{ mmol/l}$



Normal $[\text{H}^+] = 40 \text{ nmol/l}$

$\text{pH} = -\log [\text{H}^+] = 7.4 (7.35-7.45)$



Normal values

- Question: Does P_aO_2 reduce with age?

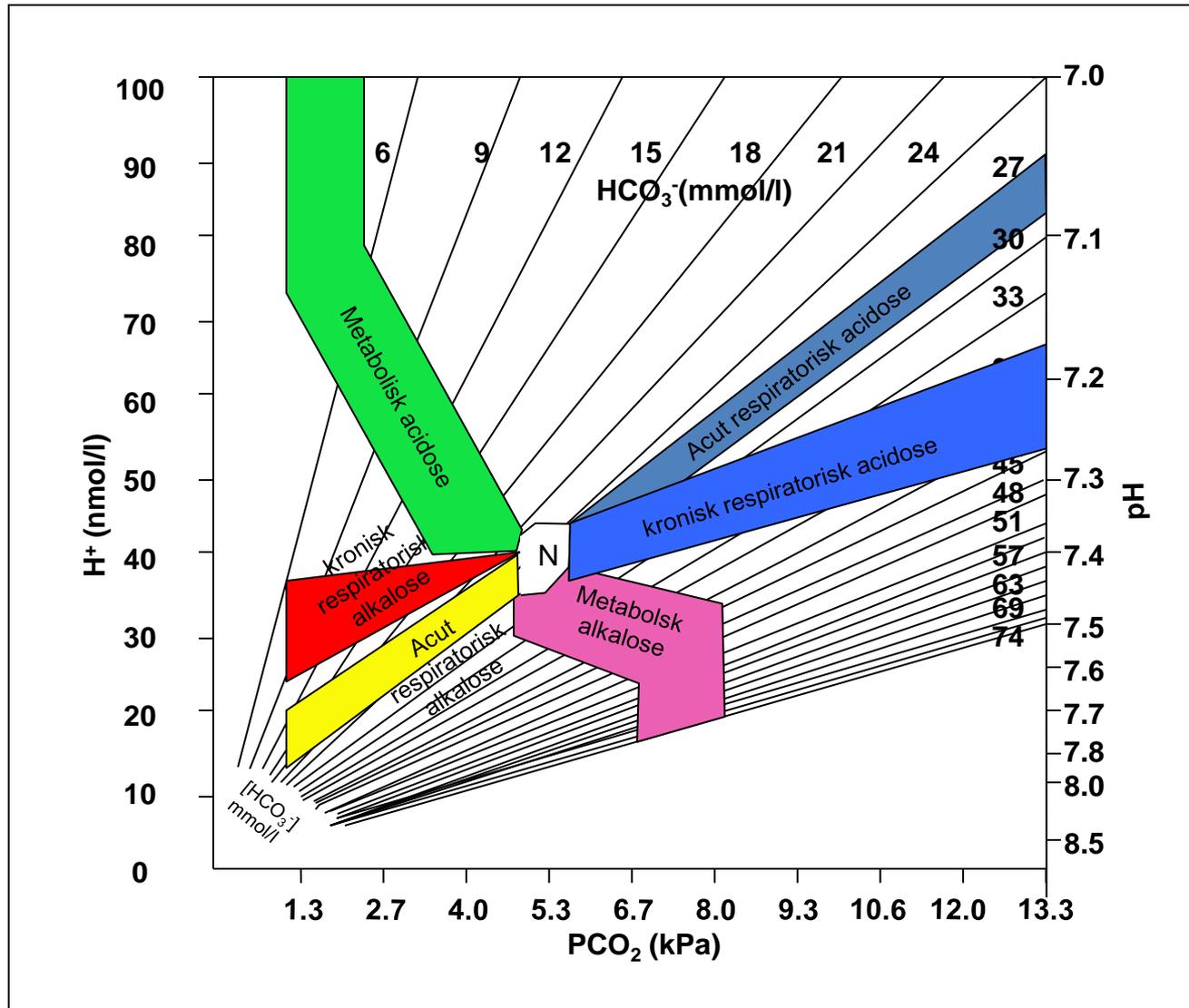
• No, meaningful reductions they are in calculated in the reference interval !!!

	2SD
pH	7,35-7,45
P_aCO_2	35-45
P_aO_2	80-100
HCO_3^-	22-27 mmol/l
Base excess	-3-+3
Saturation	95-100

Interpretation of ABG

	$P_a\text{CO}_2$	HCO_3^-	
Acidosis	high	Normal/high	Respiratory acidosis
Acidosis	Low	Low	Metabolic acidosis
Alkalosis	Low	Normal/low	Respiratory alkalosis
Alkalosis	High	High	Metabolic alkalosis

pH - nomogram



Use 2 parametres to check the result

Case 1

Normal values

- 44 years old male with dyspnoea, and before you arrive the nurse gave him 3lO₂/min
- Is there a problem ?

pH	7,42	(7,35-7,45)
P _a CO ₂	42	(35-45)
P _a O ₂	80	(80-100)
HCO ₃ ⁻	26	(22-27)
Base excess	-2	(-3-+3)
Saturation	97	(95-100)

Interpretation !

- ABG must be evaluated in the context of the oxygen fraction in the air delivered
- Normal :($FiO_2=21\%$)

The patient is therefore hypoxemic !?

pH	7,42	(7,35-7,45)
P_aCO_2	42	(35-45)
P_aO_2	80	(80-100)
HCO_3^-	26	(22-26)
Base excess	-2	(-2-+2)
Saturation	97	(95-100)

Remember

- P_aO_2 values lower than 80mmHg are considered arterial hypoxaemia
- P_aO_2 values lower than 60mmHg indicates hypoxaemic respiratory failure
- The FiO_2 must be known for interpretation of the ABG

Values for PaO₂ and saturation

	<u>PaO₂ (mmHg)</u>	<u>SaO₂ (%)</u>
Normal	98	97 (95-100)
Hypoxaemia	<80	<95
Mild hypoxemia	60-80	90-94
Moderate hypoxemia	40-60	75-89
Severe hypoxemia	<40	<75

Case 2

15 years old girl, seems nerveous tells she has a prickly sensation in both hands and lips ?

ABG , interpretation ?

Likely diagnosis ?

pH	7,46	(7,35-7,45)
P _a CO ₂	23	(35-45)
P _a O ₂	100	(80-100)
HCO ₃ ⁻	21	(22-27)
Base excess	3	(-3-+3)
Saturation	99	(95-100)

Case 2

Respiratory alkalosis

Hyperventilation

Treatment: breathing for a while in a plastic bag

pH	7,46	(7,35-7,45)
P _a CO ₂	23	(35-45)
P _a O ₂	100	(80-100)
HCO ₃ ⁻	21	(22-27)
Base excess	3	(-3-+3)
Saturation	100	(95-100)

Case 3

30 years old man with sudden dyspnoea
and abdominal pain

Surgent evaluates first and says there is not
a intra abdominal catastrophe

ABG problem ?

Diagnosis ?

pH	7,33	(7,35-7,45)
P _a CO ₂	24	(35-45)
P _a O ₂	99	(80-100)
HCO ₃ ⁻	12	(22-27)
Base excess	-12	(-2-+2)
Saturation	99	(95-100)

Case 3

The patient is acidotic, with a low $P_a\text{CO}_2$ pointing towards metabolic acidosis with a certain respiratory compensation

With a $P_a\text{O}_2=99$ mmHg its unlikely that the patient has a respiratory problem

Remember: dyspnoea is unspecific and can not be separated without a ABG

Most likely diagnosis??

pH	7,33	(7,35-7,45)
$P_a\text{CO}_2$	24	(35-45)
$P_a\text{O}_2$	99	(80-100)
HCO_3^-	12	(22-27)
Base excess	-12	(-3-+3)
Saturation	99	(95-100)

Case 3

If you find a B-glucose: 250g/l
with glucose and ketons in
the urine

Diabetic ketoacidosis

pH	7,33	(7,35-7,45)
P _a CO ₂	24	(35-45)
P _a O ₂	99	(80-100)
HCO ₃ ⁻	12	(22-27)
Base excess	-12	(-3-+3)
Saturation	99	(95-100)

Case 4

- 23 year old male with cyanosis, drowsy, pinpoint pupils and superficial respiration
- ABG, interpretation ?
- Most likely diagnosis and treatment ??

pH	7,08	(7,35-7,45)
P _a CO ₂	75	(35-45)
P _a O ₂	40	(80-100)
HCO ₃ ⁻	26	(22-27)
Base excess	-2	(-3-+3)
Saturation	86	(92-99)

Case 4

- Respiratory acidosis
- Clinical problem: JUST hypoventilation or a potential dangerous underlying disease?

pH	7,08	(7,35-7,45)
P _a CO ₂	75	(35-45)
P _a O ₂	40	(80-100)
HCO ₃ ⁻	26	(22-27)
Base excess	+2	(-3-+3)
Saturation	86	(92-99)

Causes of hypoventilation

- Severe airwayobstruktion
 - Asthma
 - COPD
- Severe restrictive lungedisease
- Loss of central respiratory drive
 - narkotics
- Respiratory "pumpfailure"
 - Kyphoscoliose
 - Neuromuskular disease

Case 4

- "Easy" to evaluate P_aO_2 when P_aCO_2 is normal
 - V/Q mismatch emphysema, pneumonia, embolia, right-left shunt
 - Loss of alveoli area: emphysema, fibrosis
- However when P_aCO_2 is abnormal is it hypoventilation or which disease ???

Case 4

23 year cyanotic, drawsy, pinpoint pupils and superficial respiration

- Hypoventilation =>

Treatm. Narcanti !?

- ILT supplement !
- Effect of narcanti....

pH	7,08	(7,35-7,45)
P _a CO ₂	75	(35-45)
P _a O ₂	40	(80-100)
HCO ₃ ⁻	26	(22-27)
Base excess	+2	(-3-+3)
Saturation	86	(95-100)

Some practical advise

- Be worried if
 - RF > 24-30/min (or < 8/min)
 - Not able to talk half a sentence without a break
 - Agitated, confused or in coma
 - Cyanosis or SpO₂ < 90%
 - Worsening in spite of treatment
- Remember
 - A normal SpO₂ does not necessary means that there is not serious ventilatory problem

Case 5

- 41 year old male, developed over some years increasing dyspnoe. Smoked 20 cig/day in 20 years.
- examination and tests ?

Case 5

- ABG normal ??
- Other tests ?

pH	7,40	(7,35-7,45)
P _a CO ₂	5,6	(35-45)
P _a O ₂	90	(80-100)
HCO ₃ ⁻	24	(22-27)
Base excess	+1	(-3-+3)
Saturation	98	(92-99)

AGE 47 SEX M HT 1.85 WT

ROOM TEMP. PRESSURE.

RESU TO	PRED.	MEAS.	POST BD	% PFE / POS
VC / FVC	5,68	3,55		
FEV1	4,54	0,95		

Case 5

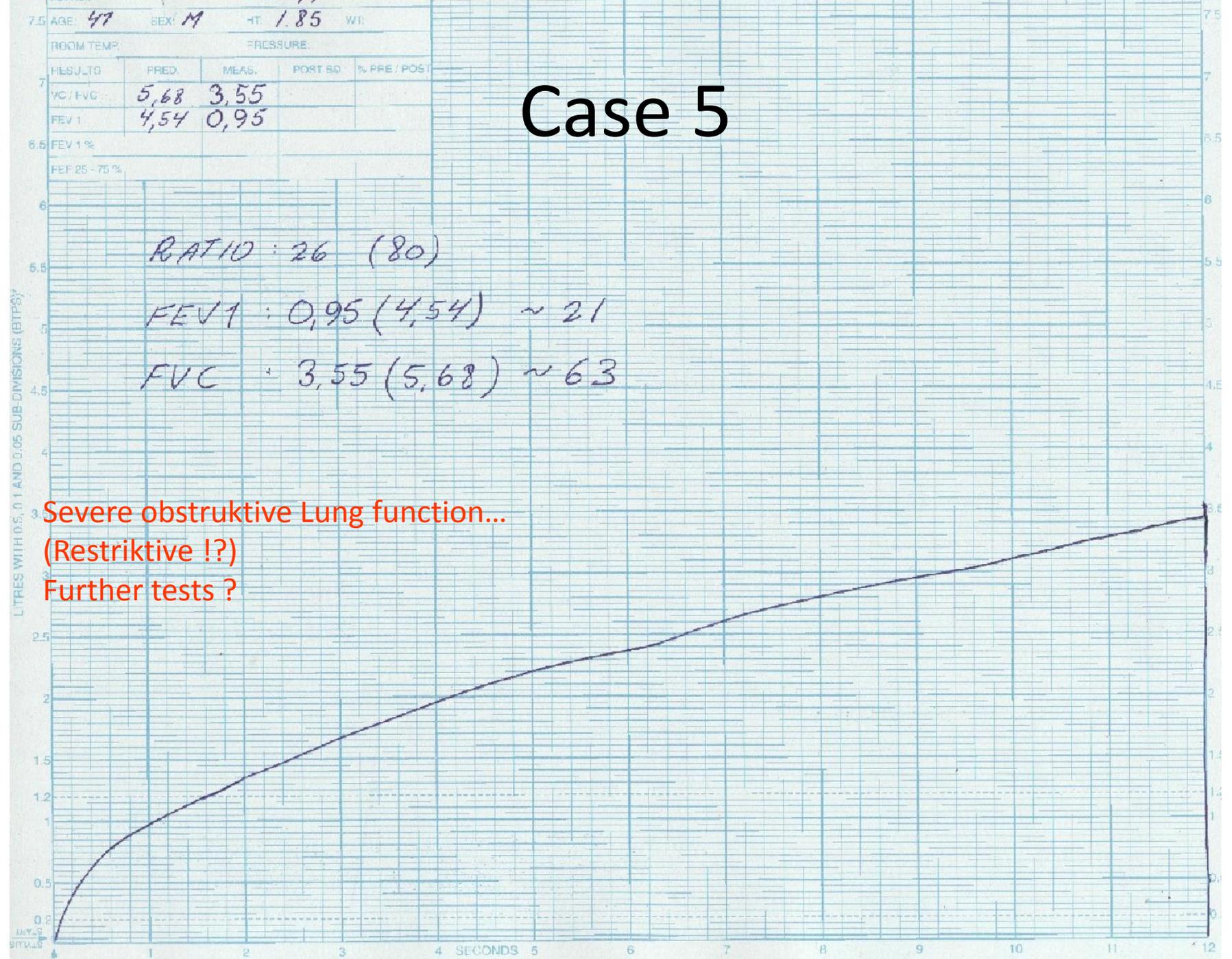
RATIO : 26 (80)

FEV1 : 0,95 (4,54) ~ 21

FVC : 3,55 (5,68) ~ 63

Severe obstructive Lung function...
(Restriktive !?)
Further tests ?

LITRES WITH 0.5, 0.1 AND 0.05 SUB-DIVISIONS (BTFS)

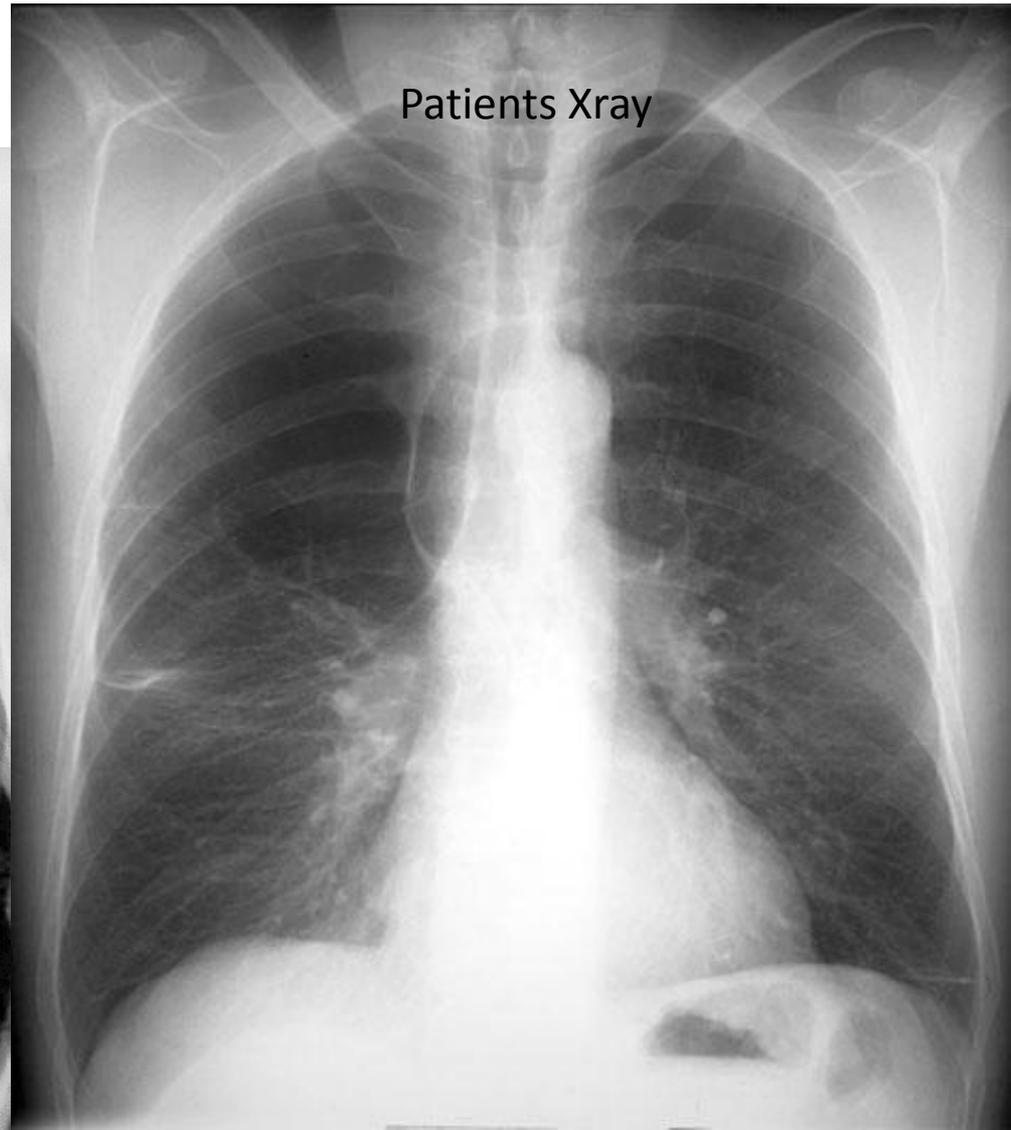
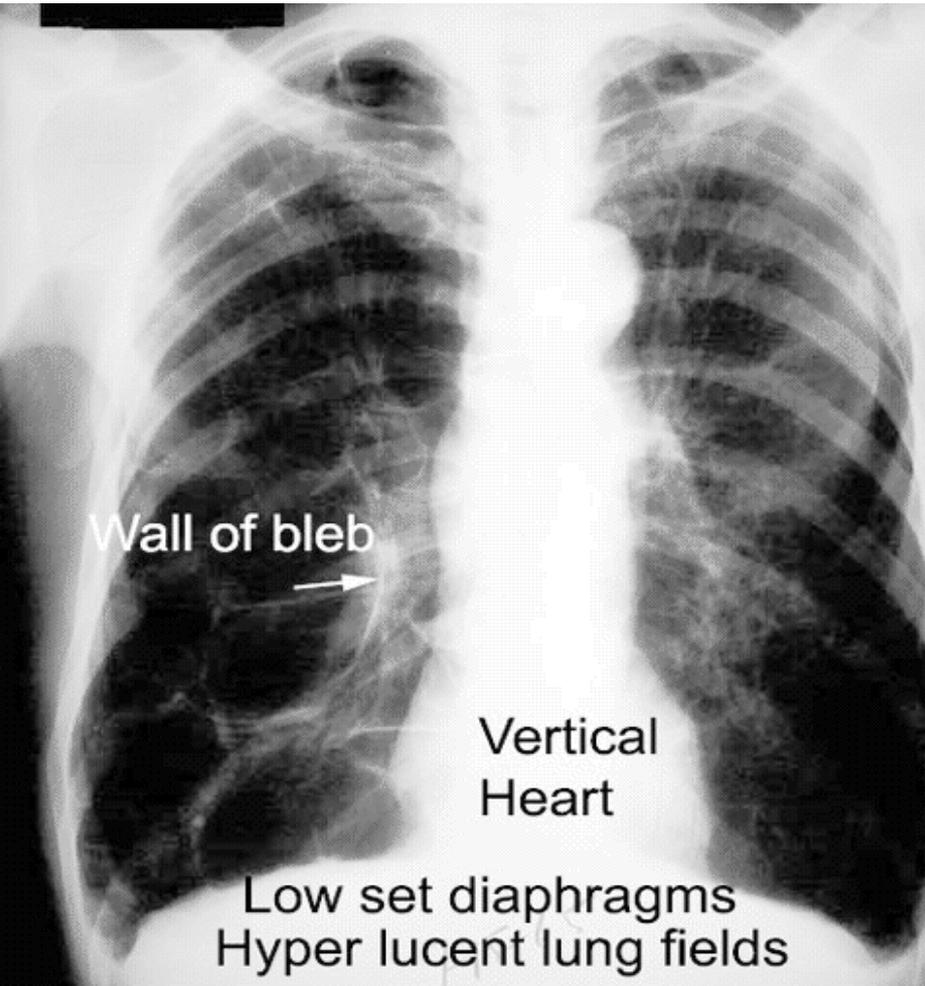


Rtg Thorax



Reversibility ??

X-Ray thorax

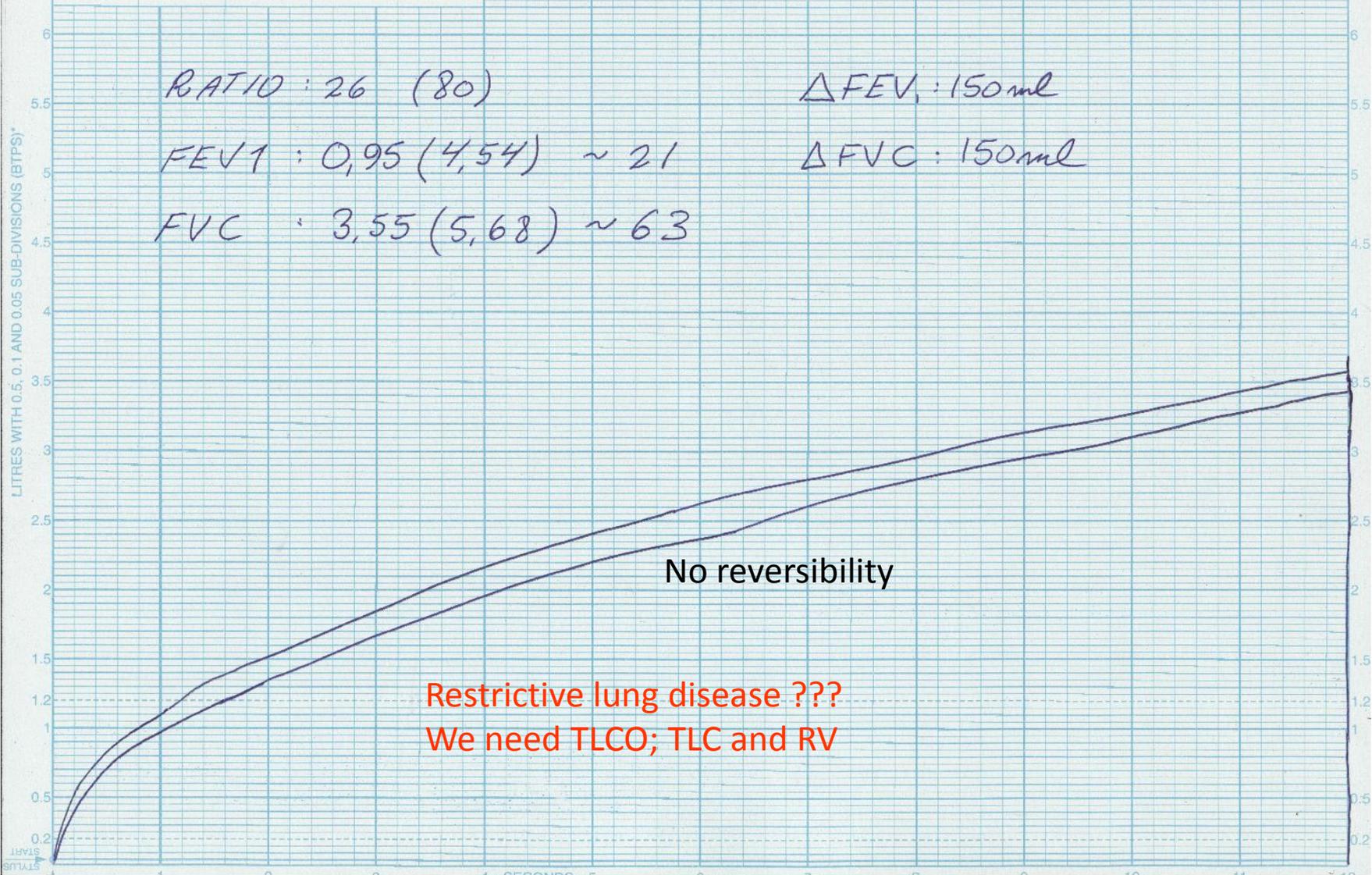


SUBJECT NAME:		DATE: 20/7		TIME:	
7.5	AGE: 47	SEX: M	HT: 1.85	WT:	
ROOM TEMP:			PRESSURE:		
7	RESULTS	PRED.	MEAS.	POST BD	% PRE / POST
	VC / FVC	5,68	3,55	3,70	
	FEV 1	4,54	0,95	1,1	
6.5	FEV 1 %				
	FEF 25 - 75 %				

Case 5

RATIO : 26 (80)
 FEV1 : 0,95 (4,54) ~ 21
 FVC : 3,55 (5,68) ~ 63

Δ FEV: 150ml
 Δ FVC : 150ml



No reversibility

Restrictive lung disease ???
 We need TLCO; TLC and RV

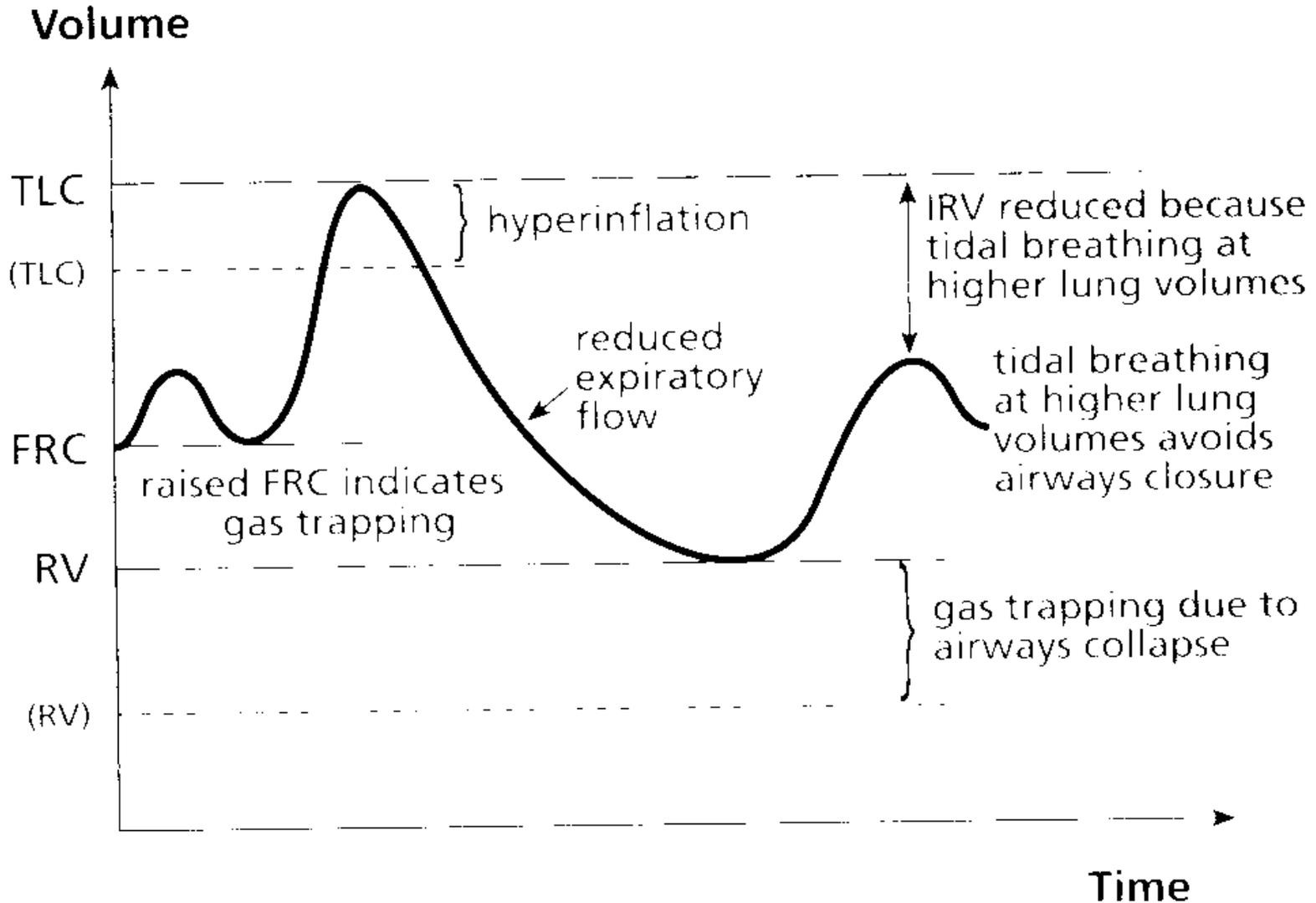
Case 5

Obstruktive/restrictive ????

	Measured	Predicted	%predicted
FEV ₁ : 1,05	4,54	23	
VC:	3,70	5,78	64
Ratio:	28	79	---
RV:	2,9	2,2	132
TLC:	7,9	6.8	116
TLCO 25,3	35,3	72	

Obstruktive, With hyperinflation likely due to emphysema

Values when Obstruktive disease



Lungfunktion

- correct teknik by performing spirometry ?? Possible wrong
interpretation, diagnosis, treatment.
- All measurements: FEV1, FVC, FEV1/FVC ratio are necessary for interpretation
 - Obstruktive: FEV1 low, FEV1/FVC low
 - Restriktive: FVC low, FEV1/FVC high to normal
- Reversibility: defines as a change of lungfunktion > 10%
or/and 500 ml
 - Less can still be clinical meaningful !!!!

Case 5

- 41 year old man with COPD
Normal what is missing ??

s- α_1 antitrypsine: 15 μmol (1,50-2,68)

Genotyping showed Pi Z a known variant whom dyspnoe develops median 40 years if smoking heavily

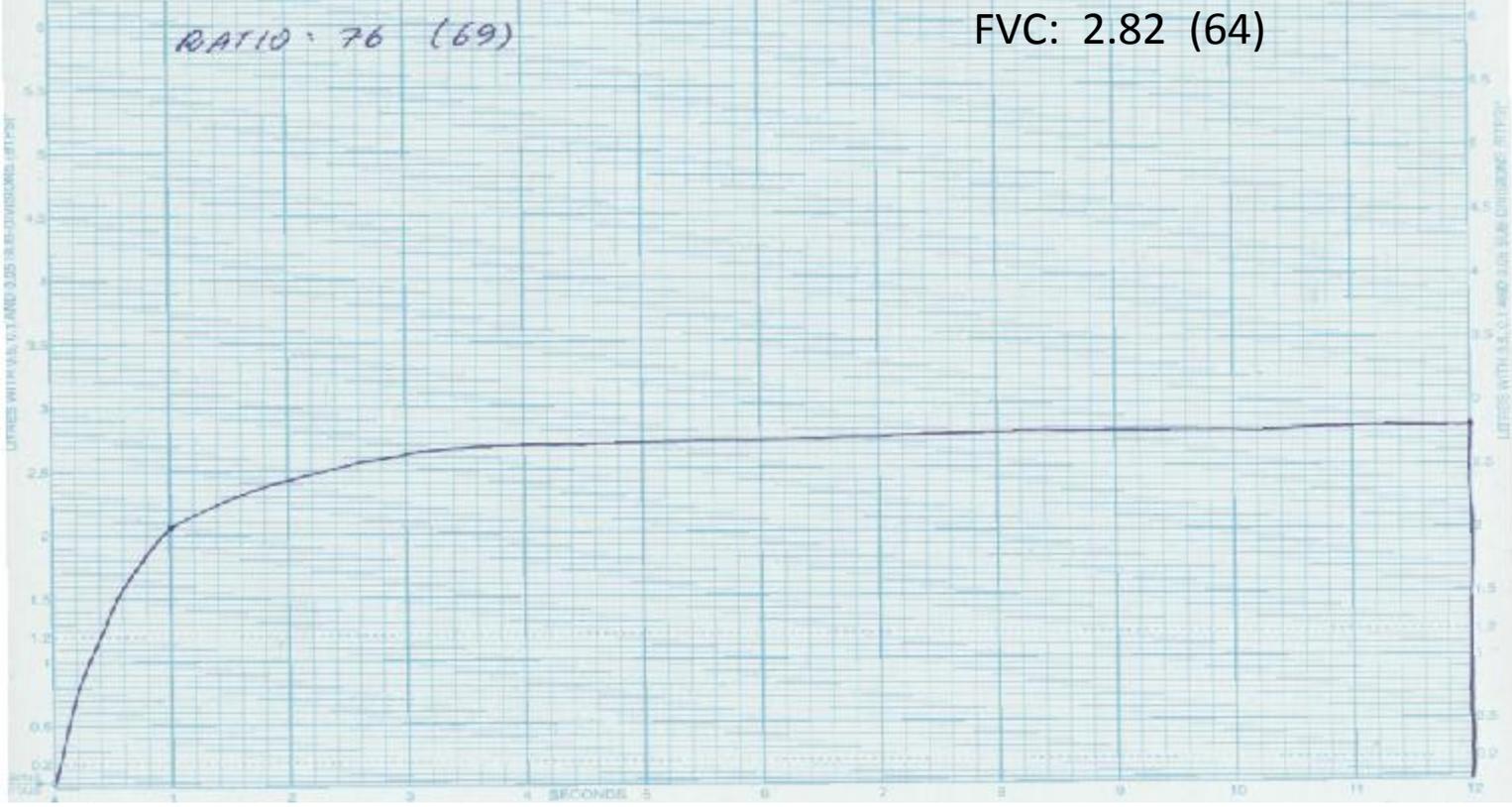
Case 6

- 68 years old male slowly progressing breathlessness, dyspnoea and cough, 10 packyears, work as a nurse.

AGE 68 SEX M HT 1.78 WT 83
 ROOM TEMP: PRESSURE:
 RESISTS: PIPED MEAS POSTED ~~1000000~~
 VOL/FVC 3.00 2.14 71
 FEV1 4.42 2.82 64
 FEV1 %
 FEV25-75%

RATIO: 76 (69)

FEV1: 2.14 (71)
 FVC: 2.82 (64)



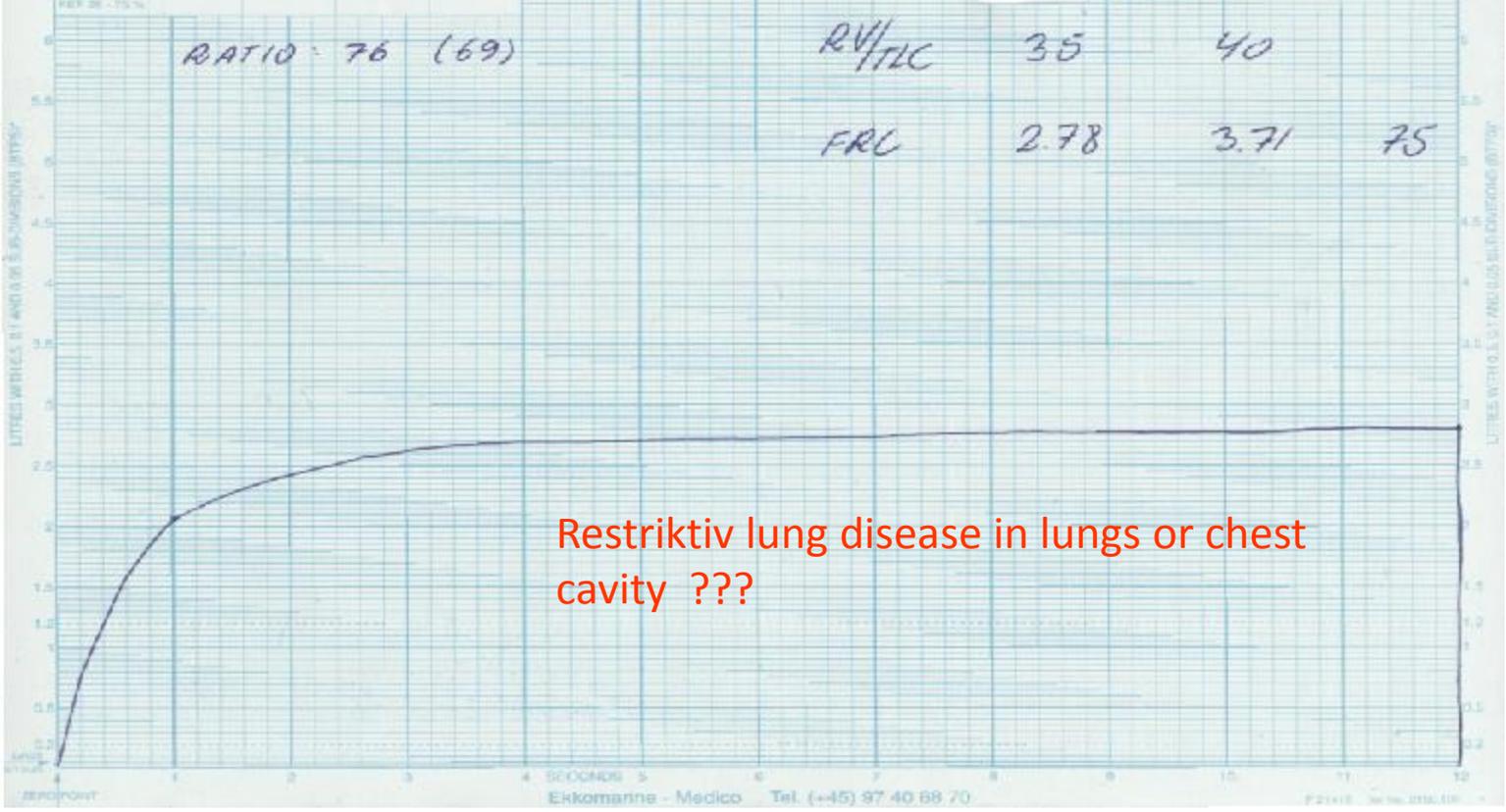
FEV1 og FVC low but FVC relatively more
 Kurve seems normal
 Next tests ??

Bodybox

AGE 68 SEX M HT 1.78 WT 83
 ROOM TEMP. PRESSURE
 RESULTS PRED. MEAS. FOOT NO. *mmHg*
 VC / PVC 3.00 2.14 71
 RV 4.42 2.82 64

	MAKT	PRED	% PRED
TLC	4.70	6.54	72
RV	1.64	2.51	65
RV/TLC	35	40	
FRC	2.78	3.71	75

RATIO: 76 (69)



Restriktiv lung disease in lungs or chest cavity ???

	Measured	%
TLC	4.70	(72)
RV	1,64	(65)
TICO	2,00	(65)

RV low: lungs

Volume Restriktive lungelidelsler

