DM Seminar 23.01.04

Diffusion Capacity

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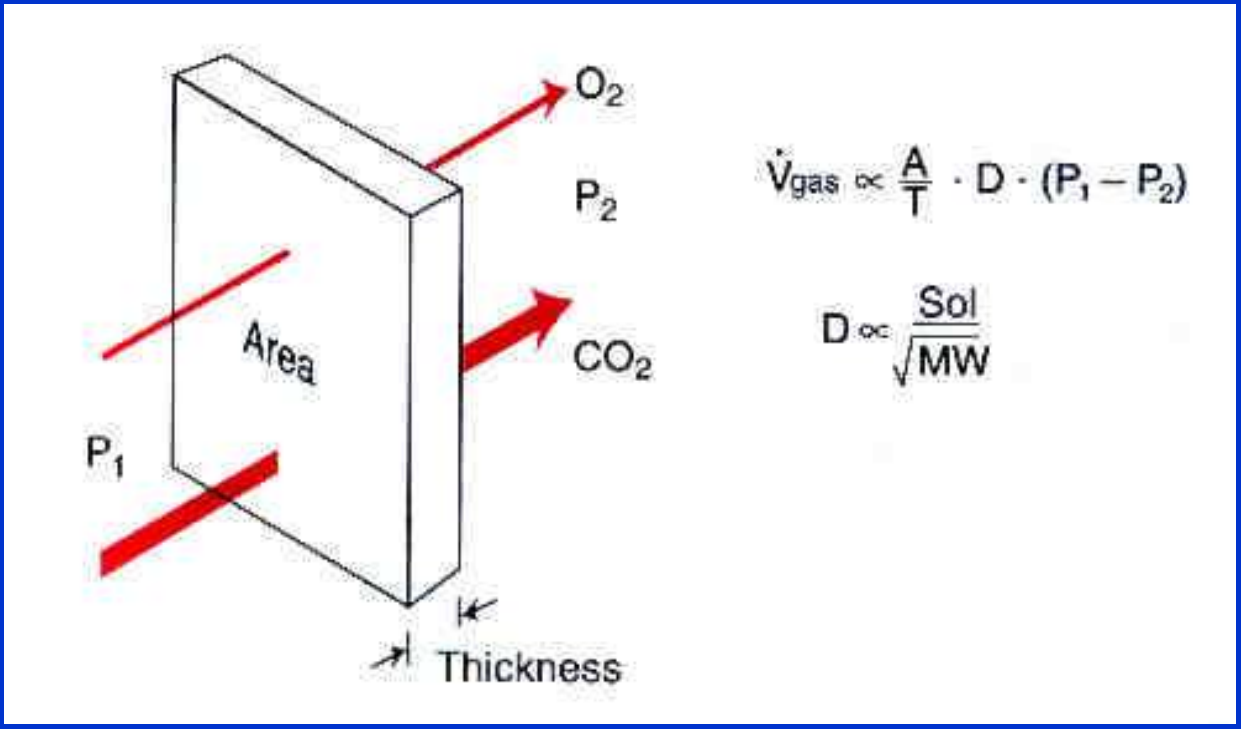
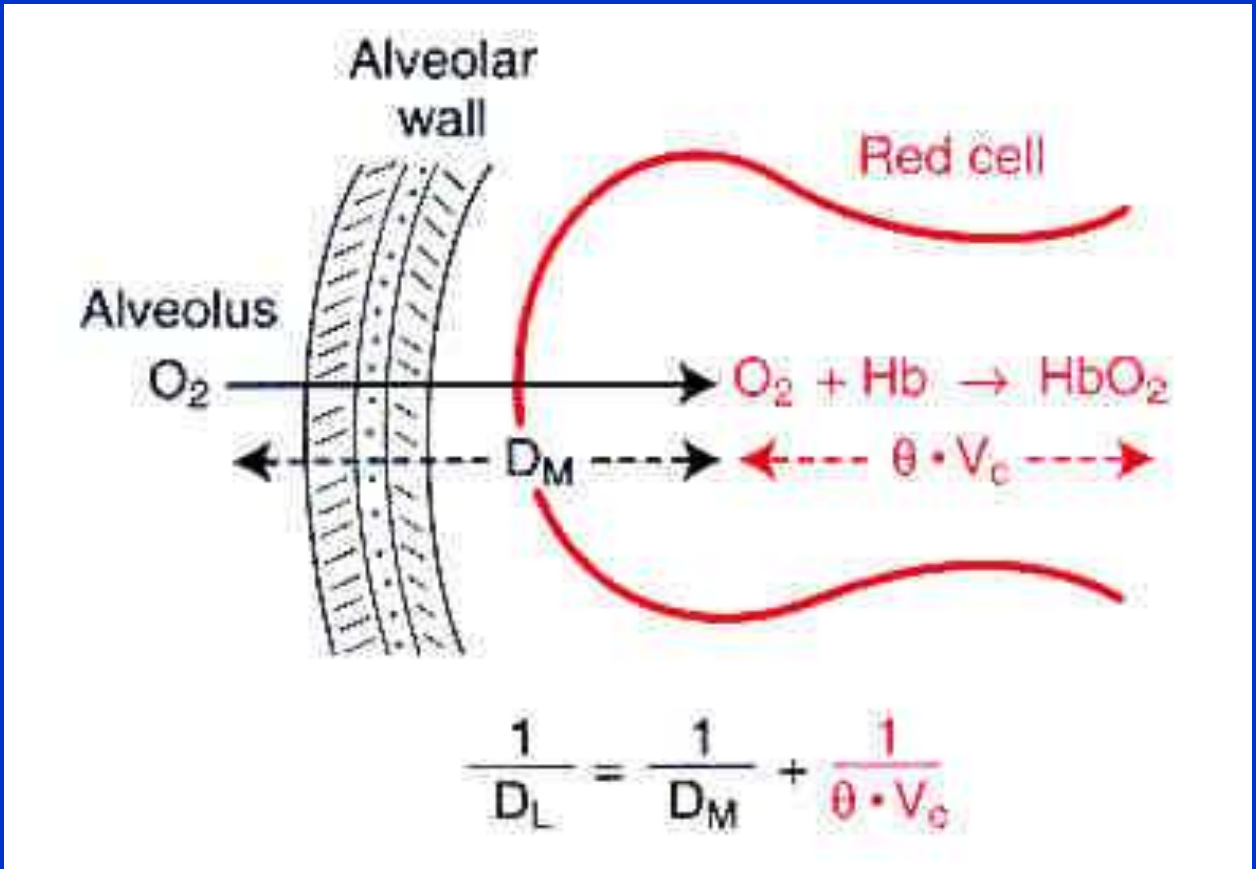
- Physiology of diffusion
- Terminology
- Measurement of diffusion capacity
- Importance in respiratory diseases

Physiology

Primary function of lung: gas exchange
Simple passive diffusion
Fick's law of diffusion

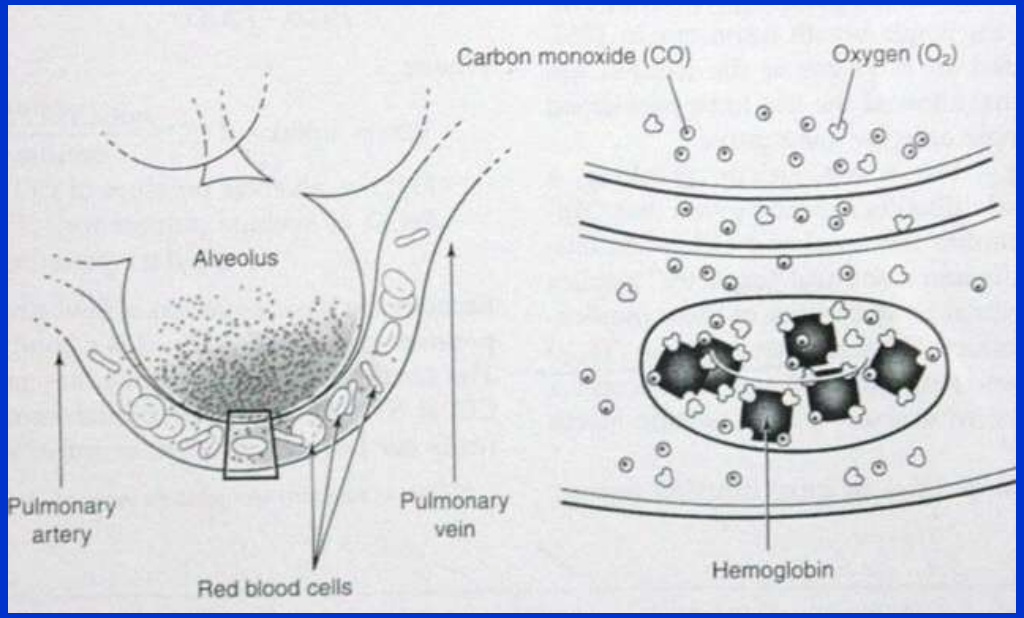


Pathway for diffusion



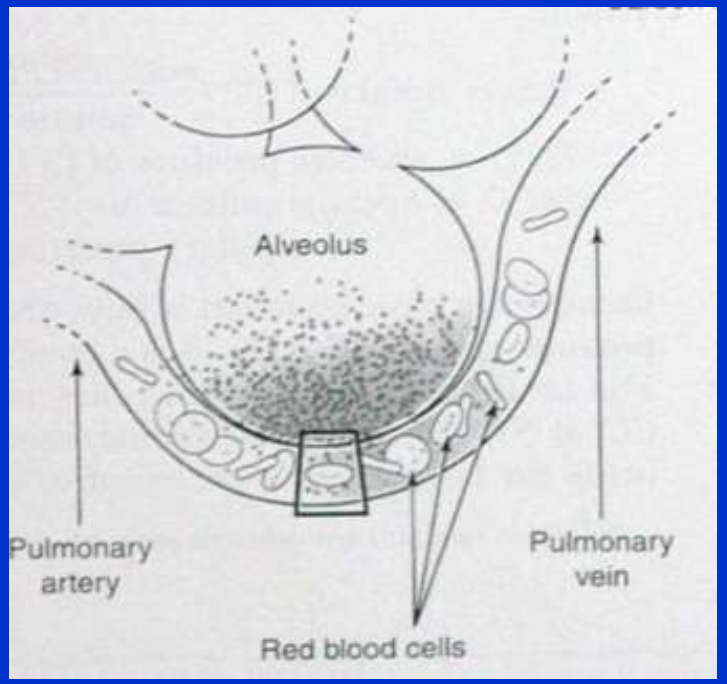
Terminology

North America: “Diffusing capacity”
Europe: “Transfer factor”
Gas exchange involves more than just diffusion
It is also a submaximal index & not a capacity



Why is CO preferred?

- not normally present in alveoli/blood
- transfer is diffusion limited rather than perfusion limited
- Avidly binds to Hb
- CO diffusion is less affected by other factors



Measurement of diffusing capacity

Methods

- Single breath-holding method
- Single expiration method
- Rebreathing method
- Steady state method
- Riley-Lilienthal method

Technique

- patient conditions
- inspiratory maneuver
- breath-hold
- expiratory maneuver

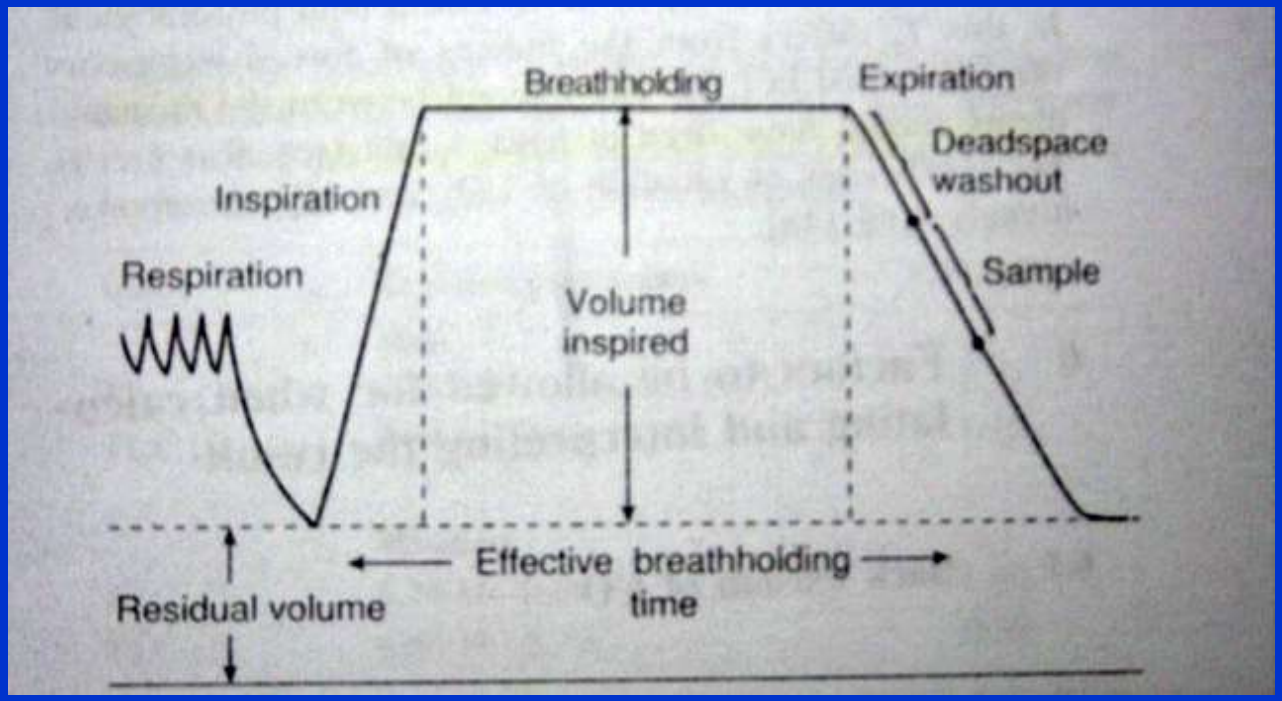
Single breath vs. Steady state

Easy for the lab
Well standardized
Less affected by nonuniformity of ventilation
Difficult to perform by dyspneic patients, during exercise

Requires no respiratory maneuvers
Technically difficult
Gives lower values than single breath method

Summary of the procedure

Spirometry, lung volumes



Patient conditions

Avoid conditions that affect PC blood volume (exercise, meals)

DLCO least in standing, max in supine position

Inspiratory maneuver

14%He, 18%O2, 0.27%CO)

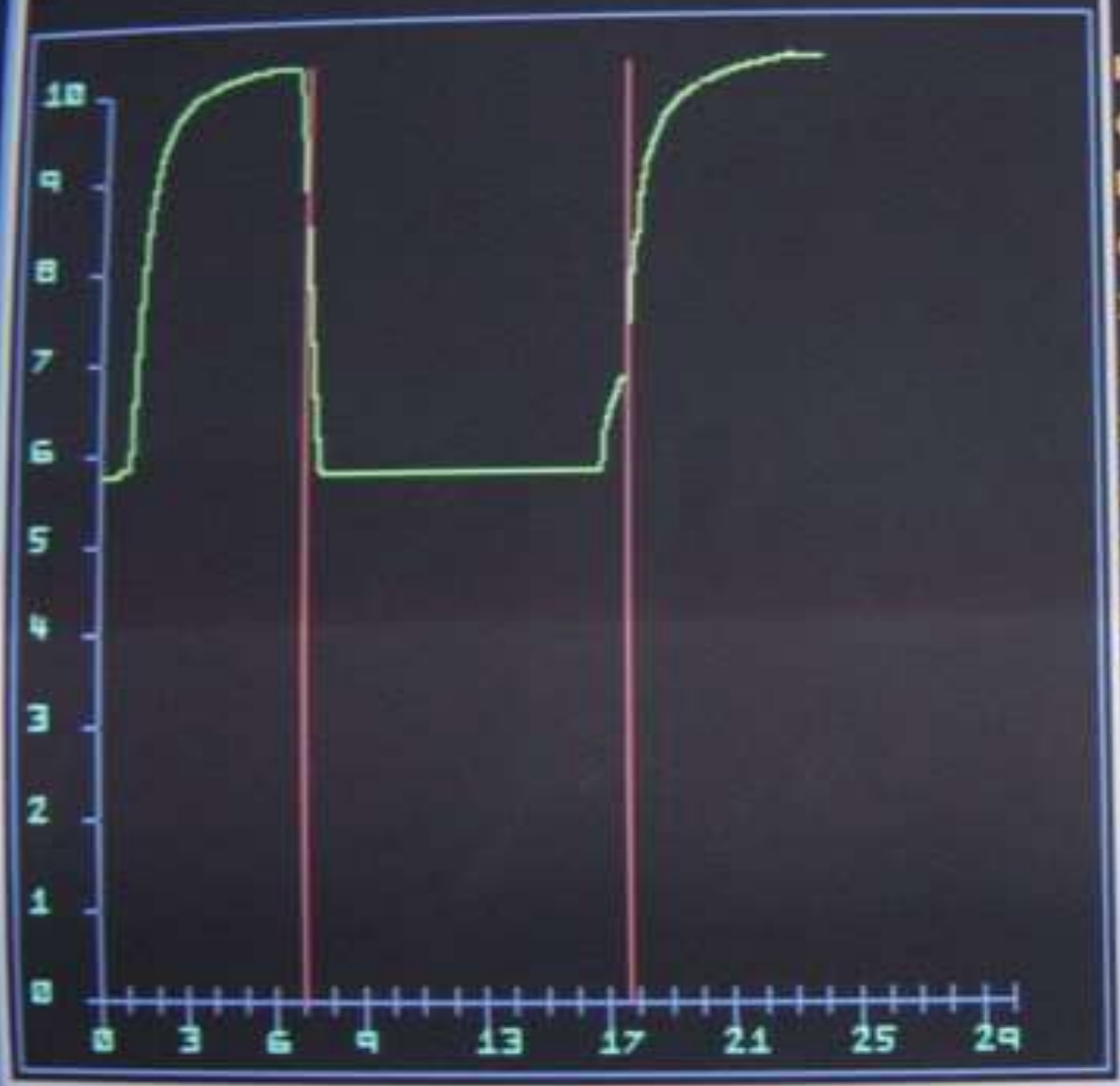
Sample collection volume

0.5-1LIf VC<2L, reduce to 0.5L

Deadspace washout(0.75 L)

If VC<2L, reduce to 0.5L

breathhold



Diffusion Data

Helium Inspired	13.94
Co Inspired	.259
Helium Expired	11.23
Co Expired	.092
Diffusion Time	10.66
Inspired Volume	4.02
DLCO Result:	28.90
O2 Expired	15.70
1/Theta	0.934
Hgb :	15.00
V Insp BTPS:	4.41

Hit any key
when ready

QUICK REFERENCE SHORT FORM REPORT

Name :SINGH,AKASH B. ID: 145366 Dat
Age :29 Race: I Height : 172in Weight :7

SPIROMETRY		Normal Range	Measured Pre	%Norm
FVC	L	4.15 - 3.09	5.21	125
FEV1	L	3.48 - 2.61	4.32	124
FEV1/FVC	%	84 - 76	83	98
FEF25-75	L/S	3.74 - 1.95	4.23	113
PEFR	L/S	7.79 - 3.9	11.28	144

LUNG VOLUMES		Normal Range	Measured Pre	%Norm
SVC	L	4.88 - 3.83	10.51	215
FRC	L	3.1 - 1.64	5.21	168
RV	L	1.48 - .72	9.5	641
TLC	L	6.36 - 4.9	20.01	314
RV/TLC	%	23 - 14	47	204

DIFFUSION	Normal Range	Measured Pre	%Norm
DLCO CORR	32.68 - 29.81	28.59	87
VA @BTPS	7.21 - 5.6	5.39	74
DL/VA	5.45 - 4.11	5.31	97

The Report

Calculation of DLCO

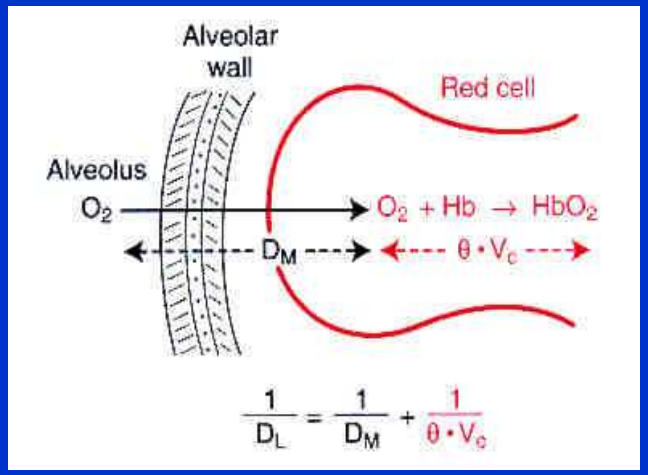
$$DLCO = \frac{VA}{T \times (PB-47)} \times \ln \frac{FACO_i}{FACO_F}$$

T = time of breath hold
PB = barometric pressure
47 = water vapour pressure at 37^{o}C

$$KCO = \frac{DLCO}{VA}$$

Factors influencing DLCO

- Physiological
- Technical



- Physiological

Hb level

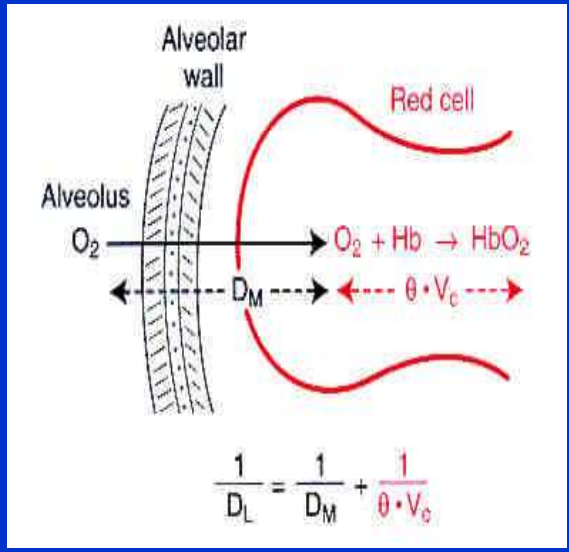
DLCO directly correlates with Hb

1g/Dl decrease Hb – 4% decrease DLCO

1g/Dl increase Hb – 2% increase DLCO

COHb level

- increase in COHb reduces DLCO in two ways
  - decreases available binding sites on Hb
  - reduces differential driving P across ACM
- 1% Increase in COHb decreases DLCO by 1%



Alveolar volume (VA)

- increase in LV - increase in DLCO
- expansion of lung - thinning of ACM, increase in d of corner vessels
- therefore correct DLCO for volume
- KCO=DLCO/VA

e.g. i. Asbestosis – ILD + Pleural thickening

ILD (reduced KCO)

Pleural thickening (normal/ increased)

ii. COPD, Asthma (“increased” DLCO)

Circadian rhythm

DLCO drops 1-2%/hr between 9.30am-9.30pm

Gender & Ethnicity

lower in women for a given height

lower in African-Americans, Asians

Age, stature, muscle mass

Smoking and alcohol consumption

no smoking for 24 hrs

no alcohol for 4 hrs

Exercise

30-40% increase

recovery after high-intensity ex - 24 hrs

Body position

remain seated for 5 min before procedure

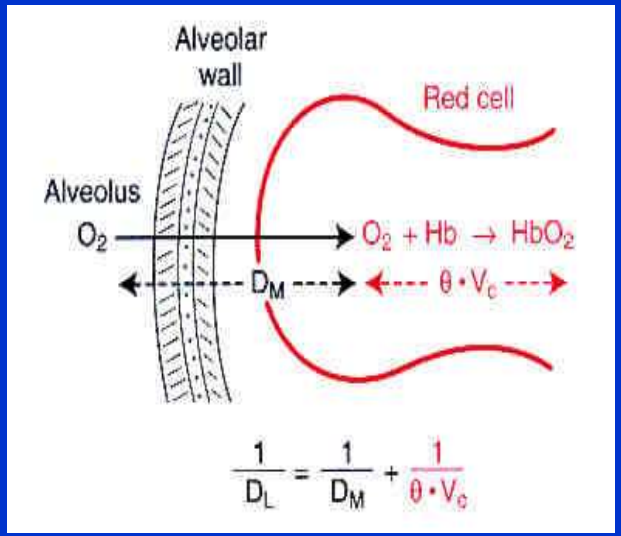
Menstrual cycle

highest just before, least 5-10 days after

Technical factors influencing DLCO

PIO2

- Inversely related
- DLCO increases by 0.31% per mm Hg decrease in PIO2
- USA:FiO2 0.21
- Europe: FiO2 0.17
- PGI: FiO2 0.18
- Discontinue suppl. O2 > 5 min before procedure



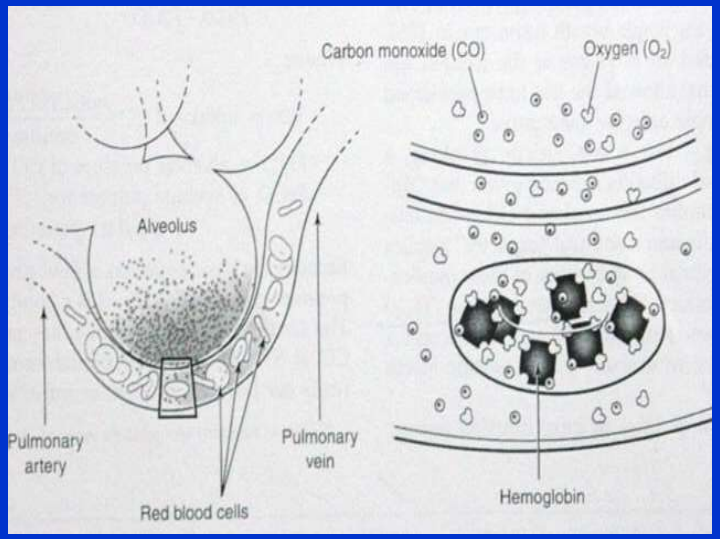
Other Technical variables

- Inspired volume
- Duration and condition of breath hold
- Deadspace washout volume
- Method of gas analysis
- Method of measuring VA

Diseases causing alterations in DLCO

Increased DLCO

- True increase
  - Polycythemia
  - Alveolar haemorrhage
  - L-R shunts
  - Exercise
- Pseudo-increase
  - Bronchial asthma



Decreased DLCO

ILD

early though nonspecific manifestation

monitoring progress & Rx

monitoring people at risk

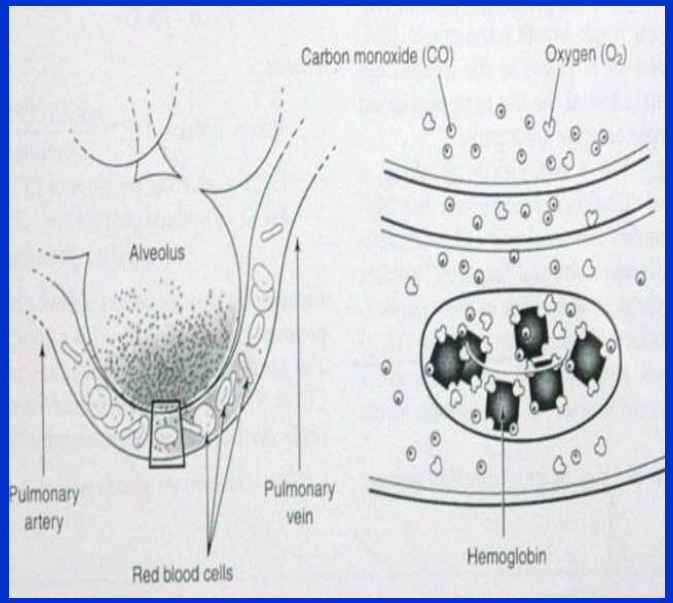
COPD

Δ of emphysema

correlates with severity

predicts exercise limitation

predicts mortality



Pulmonary embolism

unexplained dyspnoea + reduced DLCO
correlates with d^o of obstruction
reductions persist for 3 yrs

CCF

Increased in early CCF
Decreased in advanced & chronic cases
correlates with NYHA class

Misc

Anemia, CRF
Alcoholism, smoking
RHD, PPH etc.

Example1

57 M, Ex-smoker, Gradually progressive dyspnoea x 6 mo

	Measured	%predicted
FEV1	2.08	92
FVC	3.45	74
FEV1%	81	
TLC	3.81	73
RV	1.26	54
RV/TLC%	33	
DLCO	5.9	36
DLCO/VA	1.83	53
VA	3.23	

Example 2

65 M, Smoker, prog dyspnoea X 6 yrs

	Measured	%predicted
FEV1	1.12	31
FVC	2.14	43
FEV1%	52	
TLC	9.67	134
RV	6.35	260
RV/TLC%	66	
DLCO	14.5	57
DLCO/VA	4.04	103
VA	3.59	