2010b(9)/2003a(14): Describe the factors that affect respiratory system compliance

Compliance = rate of volume change per unit pressure change = ml/cmH₂O

- Related to the interaction between compliance (elasticity) of lung tissue and of chest wall such that:

\[
\frac{1}{\text{Compliance}_{\text{total}}} = \frac{1}{\text{Compliance}_{\text{chest}}} + \frac{1}{\text{Compliance}_{\text{lung}}}
\]

\[
\frac{1}{\text{Compliance}_{\text{total}}} = \frac{1}{200} + \frac{1}{200}
\]

\[
\text{Compliance}_{\text{total}} = 100 \text{ ml/cmH₂O}
\]

Lung compliance can be plotted on a pressure-vol curve

- forms a hysteresis

Factors affecting compliance

Static compliance
- Measures the slope of lung’s pressure-vol curve.
- Pt inspires then expires in series of steps
  - Each step vol is held with glottis open
  - Intra-pleural pressure (as trans-oesophageal P) is measured
- This method allows equilibration of lung vol throughout the lung → measures compliance 2° viscoelastic properties, takes into account slow time-constant alveolar units / ‘stress relaxation’

Dynamic compliance
- Use of spirometer
- Volumes plotted on y-axis as percentage of VC
- Pressure gradient across lung (transpulmonary pressure) on x-axis
- Pressure measured via transoesophageal probe at points of no flow (end inspiration / end expiration) with glottis open.

Normally, static and dynamic compliance correlate well, but in conditions that ↑ ‘slow time constant’ alveoli as equilibration cannot occur with dynamic compliance testing
- ↑ airways resistance
- ↑ compliance
  - Dynamic compliance is always lower than static compliance

Specific compliance
Specific compliance = \( \frac{\text{Static compliance}}{\text{FRC}} \)
- Derives a compliance per unit of lung volume
- Allows comparison to be made across different age groups and different lung sizes
- Normal value 0.05 cmH₂O⁻¹ (children and adults)
Surface Tension
- Attraction b/n molecules of H₂O move together to the smallest shape (sphere) such that the filling pressures would comply with the Law of Laplace

- Law of Laplace
  \[ P = \frac{2\tau}{r} \]
  where \( P \) = pressure, \( \tau \) = surface tension, \( r \) = radius
- Result in:
  o Small alveoli tending to collapse 2° large intra-mural pressures
  o Movement of air down path of least resistance to large alveoli (small will empty into larger)
- Role of Surfactant
  o Produced by Type 2 pneumocytes
  o ↓\( \tau \) to equilibrate pressure b/n small and large alveoli

Lung Size
- ↓size → ↓ compliance
- Occurs with pneumonectomy

Lung Volume
- Compliance curve (sigmoid shape) shows that lung volume will affect lung compliance
  o Intra-pleural pressures range from +3cmH₂O at RV, 0cmH₂O at FRC to -30cmH₂O at TLC
    ▪ ↑compliance around FRC (steep part of curve)
      - Linear 2° minimization of factors below
    ▪ ↓compliance at extremes (flat parts above and below)
      - RV → ↓dynamic compliance 2° airways closure
      - TLC → ↓compliance 2° ↑recoil pressure of chest wall and lung

Blood Volume
- ↑Blood vol → ↓compliance
  o Occurs with ↑RV pressures (supine, fluid overload), LHF

Gravity
- Effect on gravity on erect lung is
- Apex: ↑traction on tissue, larger alveoli, more negative IP
  o Overall result is ↓compliance (towards upper part of compliance curve) i.e large change pressure results in modest ↑vol
- Base: smaller alveoli, less negative IP
  o Result in ↑compliance cf apex

Pathological factors ↓ lung compliance
- Loss of elastic tissue
  o COAD (and pulmonary fibrosis)
- ↑fibrotic tissue
  o Pulmonary fibrosis
- Fluid
  o Pulmonary oedema

By Amanda Diaz
Respiratory

- Empyema
- Pulmonary hemorrhage

By Amanda Diaz