10.7.5 Airway Resistance

Airway resistance (Raw) is a measure of non-elastic resistance to gas flow through the airways as expressed by the following formula:

\[
\text{Raw} = \frac{\text{Peak Inspiratory Pressure} - \text{Plateau Pressure}}{\text{Inspiratory Flow}}
\]

According to Poiseuille's law, where resistance to flow varies directly with airway length and inversely with its radius, airway resistance is influenced by:

- **Airway length** - shorter airways decrease resistance to flow (tracheostomy tubes versus endotracheal tubes), longer airways increase resistance.
- **Radius** - as a parameter of *Poiseuille's law*, doubling the radius results in 16 times less resistance to flow, whereas, decreasing the radius causes increased resistance.
- **Flow rate** - higher flow rates cause increased pressure within the airway, more turbulent flow, and increased airway resistance; lower flow rates decrease pressure.
within the airway, resulting in more laminar or streamlined flow and decreased airway resistance.

Other considerations that may adversely increase airway resistance include:

• **Ventilator circuit factors:**
  - Biting or kinking of the endotracheal tube
  - Cuff herniation
  - Impingement of tube tip against trachea

• **Patient Factors:**
  - Bronchospasm
  - Secretions

Normal values for physiologic airway resistance range from 0.5 to 3 cm H₂O/L/sec. In the intubated patient, normal values for airway resistance range from 5 to 10 cm H₂O/L/sec.
Assessment During Ventilation

A. Expiratory time
B. Pulsus paradoxus
C. autoPEEP
   static-end-expiratory occlusion pressure
dynamic
D. pressure differential
   end-inspiratory occlusion P-P<sub>IP</sub>
   peak-to-plateau gradient -0.5-0.75S inspiratory pause
E. End-expiratory trapped gas volume
F. ECG-RAD, RVH & ‘strain’, acute TR
G. CXR –limited use, see over

Indications for CXR

- Any asthmatic post-itubation
- Signs/symptoms of barotraumas
- Clinical findings suggestive of pneumonia
  localizing signs on chest examination
- When the diagnosis is uncertain = exclusion
Factors to Exclude

- Pneumothorax
- FB
- Upper Airway Obstruction
- LVF & Severe Emphysema - echocardiogram
- Pulmonary Emboli – lower limb Doppler, lung perfusion scan

Investigations

A. FBE, MBA
B. Serial AGA’s
C. CXR
D. ECG
E. Microbiology - tracheal aspirate for MC&S
- blood cultures if febrile
- atypical pneumonia
- serial PEFR
- FEV\textsubscript{1}/FVC

F. Paired Serology - atypical pneumonia

G. PFT’s during recovery – serial PEFR
- FEV\textsubscript{1} / FVC
CVS Effects of Severe Asthma

1. pulmonary hypertension
2. impaired venous return
3. increased LV after load SNS outflow
4. 2 degree effects from hypoxia, hypercarbia & acidosis
5. 2 degree effects from drugs aminophylline, etc.

Mechanical Abnormality

**** increased airways resistance

- All airways involved but to differing degrees.
- Regional variation in time constraints
- Hyperinflation and obstruction
- Rapid shallow respiration
- Increased work of breathing

Pathology

- Smooth muscle contraction
- Inflammatory infiltrate & mucosal edema
- Mucus plugging & inspissations of secretions
- Segmental/lobar obstruction or collapse.
- Barotraumas
Mediators

- Histamine
- Leukotrienes
- Cholinergic nervous system
- Neuropeptides from NANC nervous supply
- PG’s
- IgE
- PAF

Complications

A. Hypoxia, hypotension – myocardial, cerebral hypoxic damage.
B. Respiratory
   - Barotrauma / Volutauam – pneumothorax, pneumomediastinum, pneumopericardium, subcutaneous emphysema.
   - Mucus plugging, airway obstruction, atelectasis.
   - Infection.
   - Respiratory arrest, biochemical disturbances.
C. Biochemical disturbances.