Non-Invasive Ventilation

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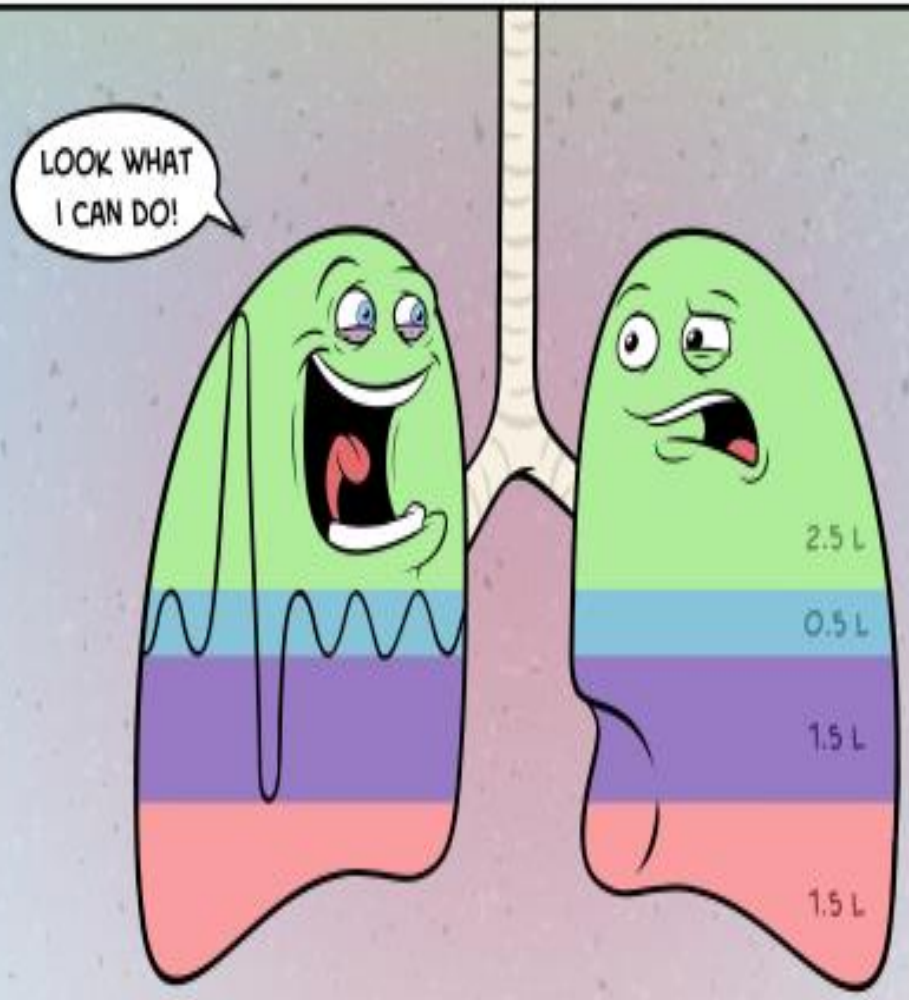
PET

Learning objectives

- What is NIV
- The difference between CPAP and BiPAP
- The indication of the use of NIV
- Complication of NIV application
- Patient monitoring and safety

LUNG VOLUMES AND CAPACITIES



IRV
INSPIRATORY RESERVE VOLUME

V_T
TIDAL VOLUME

ERV
EXPIRATORY RESERVE VOLUME

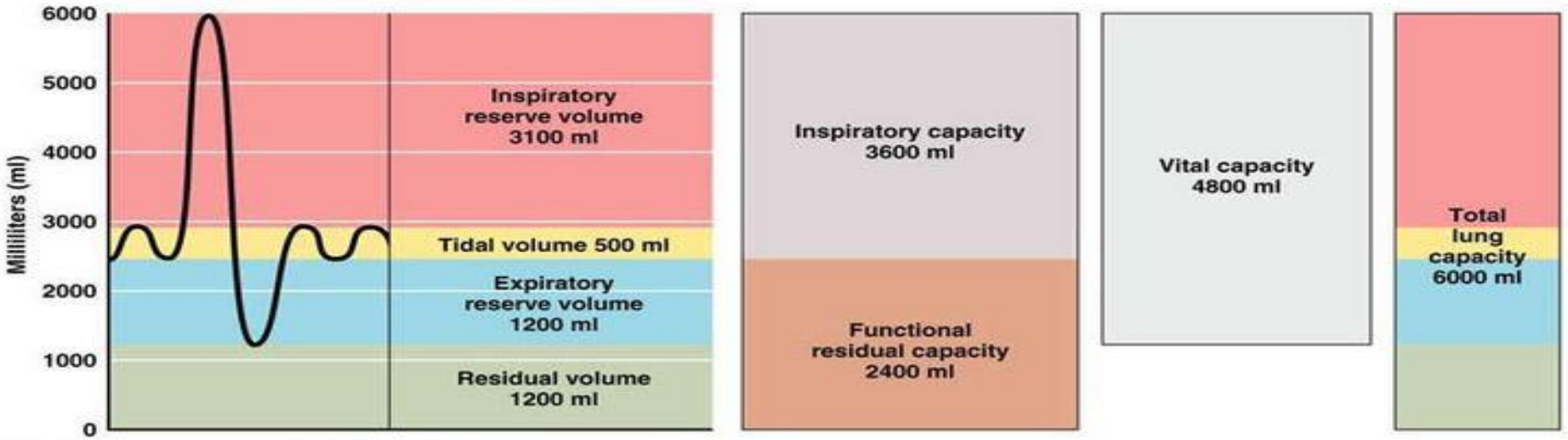
RV
RESIDUAL VOLUME

IC
INSPIRATORY CAPACITY

FRC
FUNCTIONAL RESIDUAL CAPACITY

VC
VITAL CAPACITY

TLC
TOTAL LUNG CAPACITY

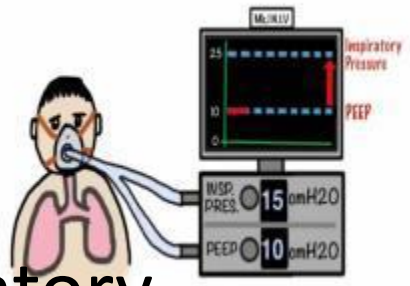


(a) Spirographic record for a male

	Measurement	Adult male average value	Adult female average value	Description
Respiratory volumes	Tidal volume (TV)	500 ml	500 ml	Amount of air inhaled or exhaled with each breath under resting conditions
	Inspiratory reserve volume (IRV)	3100 ml	1900 ml	Amount of air that can be forcefully inhaled after a normal tidal volume inhalation
	Expiratory reserve volume (ERV)	1200 ml	700 ml	Amount of air that can be forcefully exhaled after a normal tidal volume exhalation
	Residual volume (RV)	1200 ml	1100 ml	Amount of air remaining in the lungs after a forced exhalation
Respiratory capacities	Total lung capacity (TLC)	6000 ml	4200 ml	Maximum amount of air contained in lungs after a maximum inspiratory effort: TLC = TV + IRV + ERV + RV
	Vital capacity (VC)	4800 ml	3100 ml	Maximum amount of air that can be expired after a maximum inspiratory effort: VC = TV + IRV + ERV (should be 80% TLC)
	Inspiratory capacity (IC)	3600 ml	2400 ml	Maximum amount of air that can be inspired after a normal expiration: IC = TV + IRV
	Functional residual capacity (FRC)	2400 ml	1800 ml	Volume of air remaining in the lungs after a normal tidal volume expiration: FRC = ERV + RV

(b) Summary of respiratory volumes and capacities for males and females

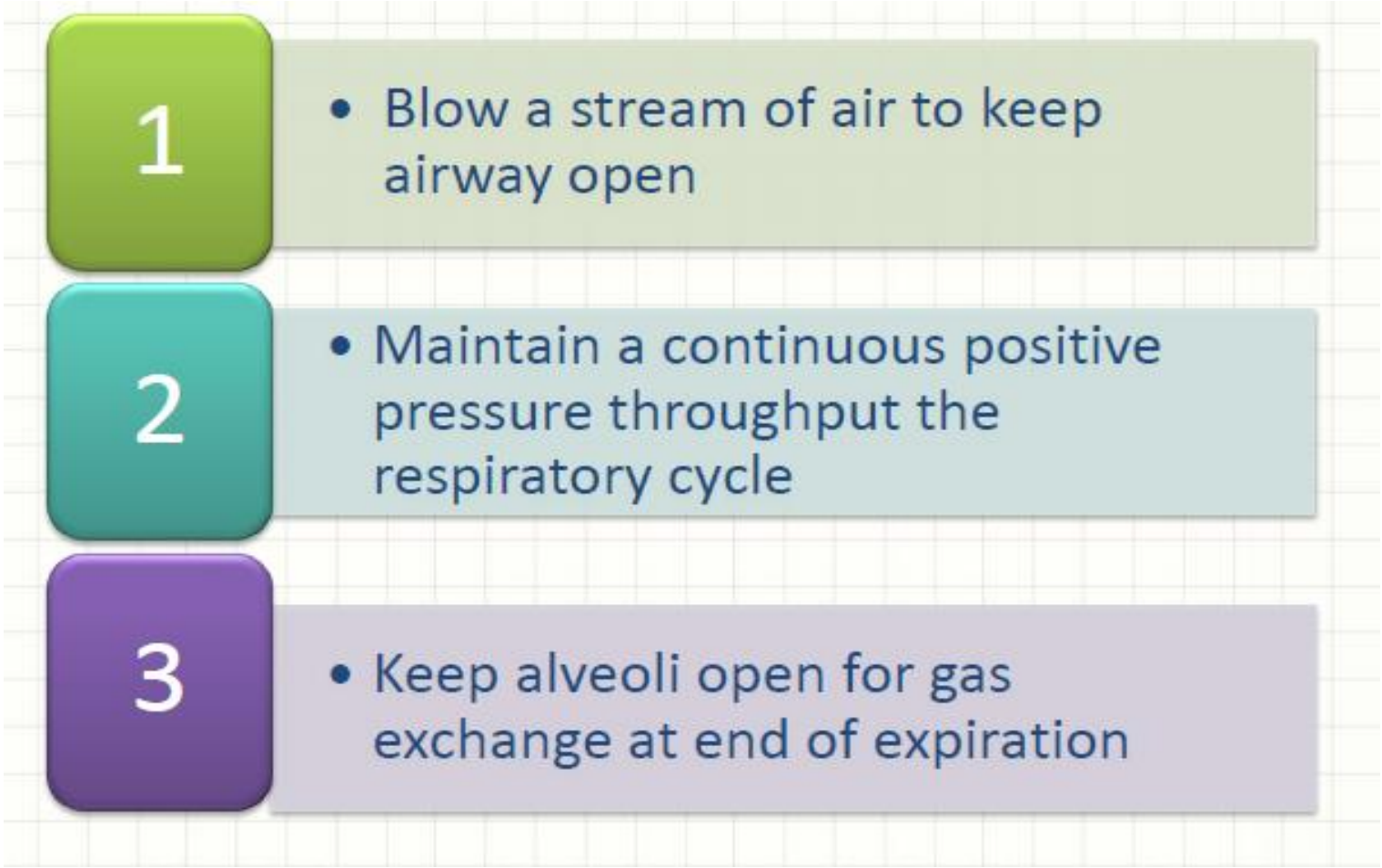
What is NIV?



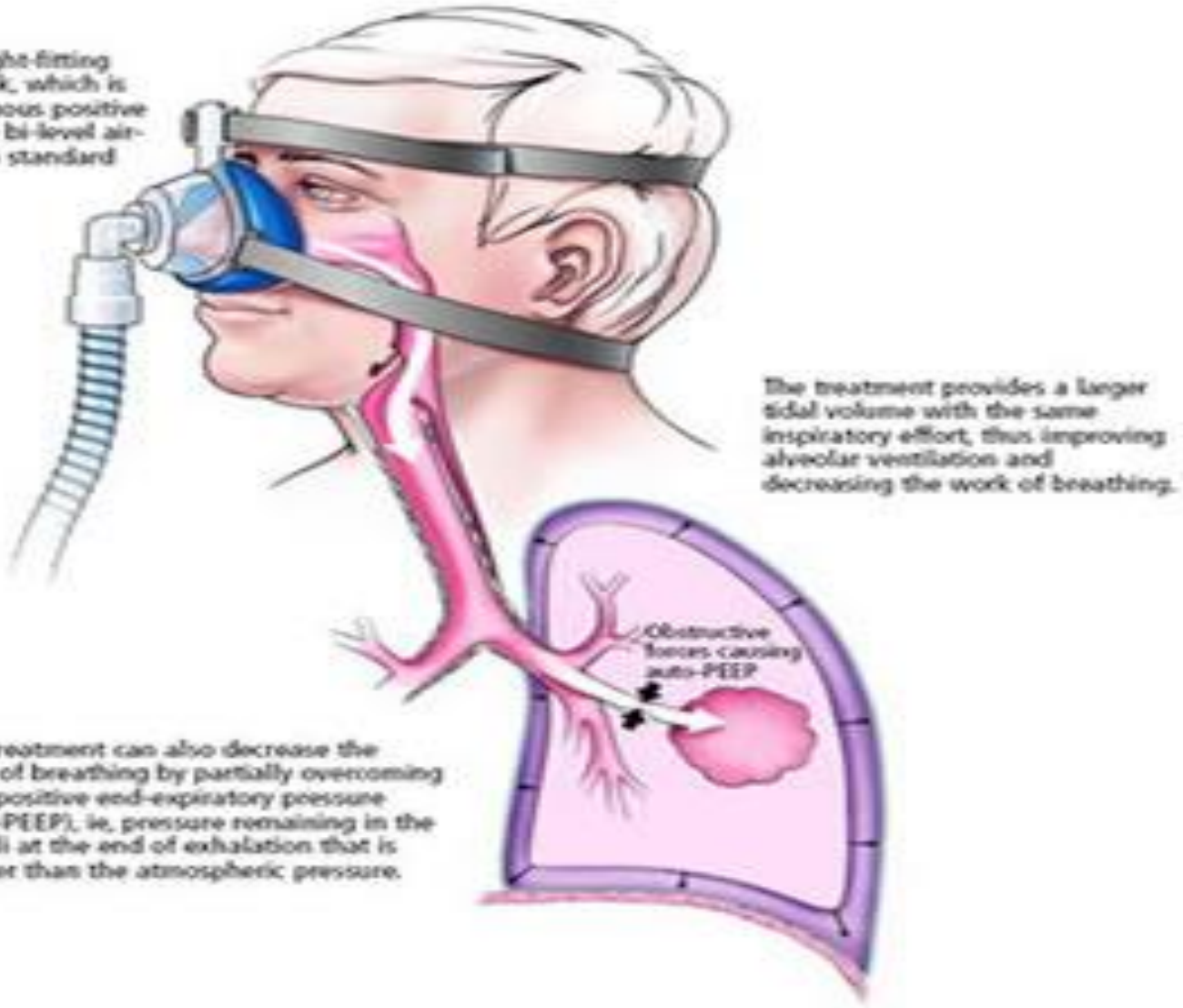
- ‘NIV refers to the provision of ventilatory support through the patient’s upper airway using a mask or a similar device.
- This technique is distinguished from those which bypass the upper airway with a tracheal tube, laryngeal mask, or tracheostomy and therefore are considered as invasive.’
- **Continuous positive airway pressure (CPAP)**
- **Bilevel positive airways pressure (BiPAP)**

Non-invasive ventilation

CPAP mechanism



In selected patients with hypercapnic respiratory failure due to an acute exacerbation of chronic obstructive pulmonary disease (COPD), noninvasive positive pressure ventilation, added to usual medical therapy, reduces the need for endotracheal intubation, the length of hospital stay, and the risk of death.



Medical Illustrator: Joseph Pangrace

Type I Resp Failure

- Hypoxaemic resp failure
- Oxygenation failure
- Resp insufficiency
- Failure of lung and heart to provide adequate O_2 to meet metabolic needs.

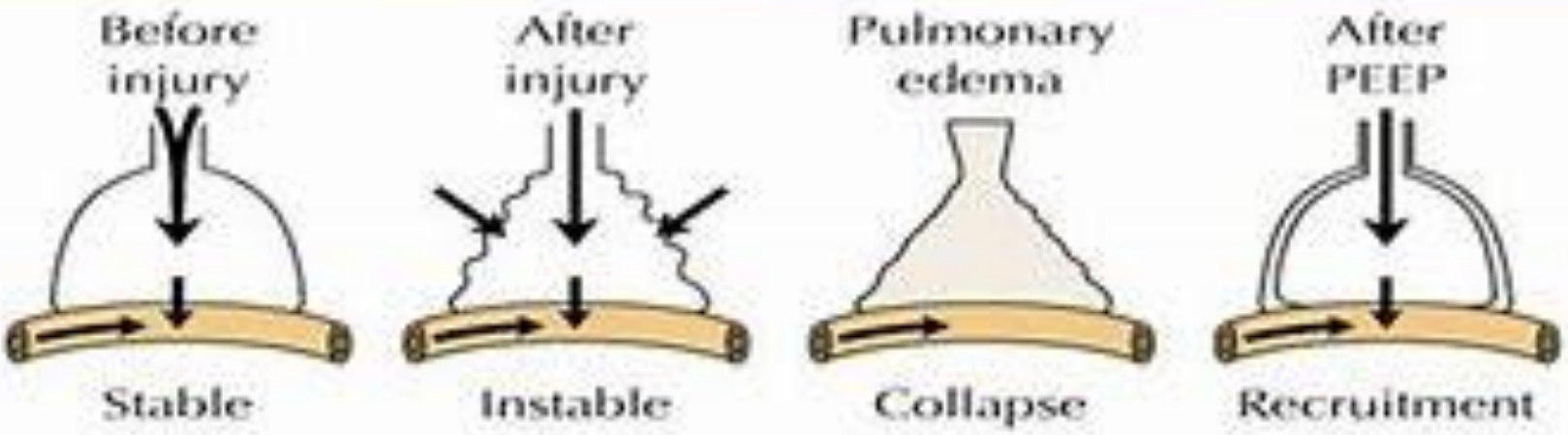
- Causes
  - R-L shunt
  - V/Q mismatch
  - Alveolar hypoventilation
  - Diffusion defect
  - Inadequate FiO2
- Examples
  - Pneumonia
  - Pulmonary embolism
  - Pulmonary oedema
  - Emphysema
  - ARDS
  - Pulmonary fibrosis

Effectiveness of CPAP

- Increase functional residual capacity (FRC)
- reduce the WOB.
- Alveoli recruitment, increase gas exchange, improve V/Q match and oxygenation
- Re-expand fluid filled alveoli
- Does not affect tidal volume

Positive End Expiratory Pressure (PEEP)

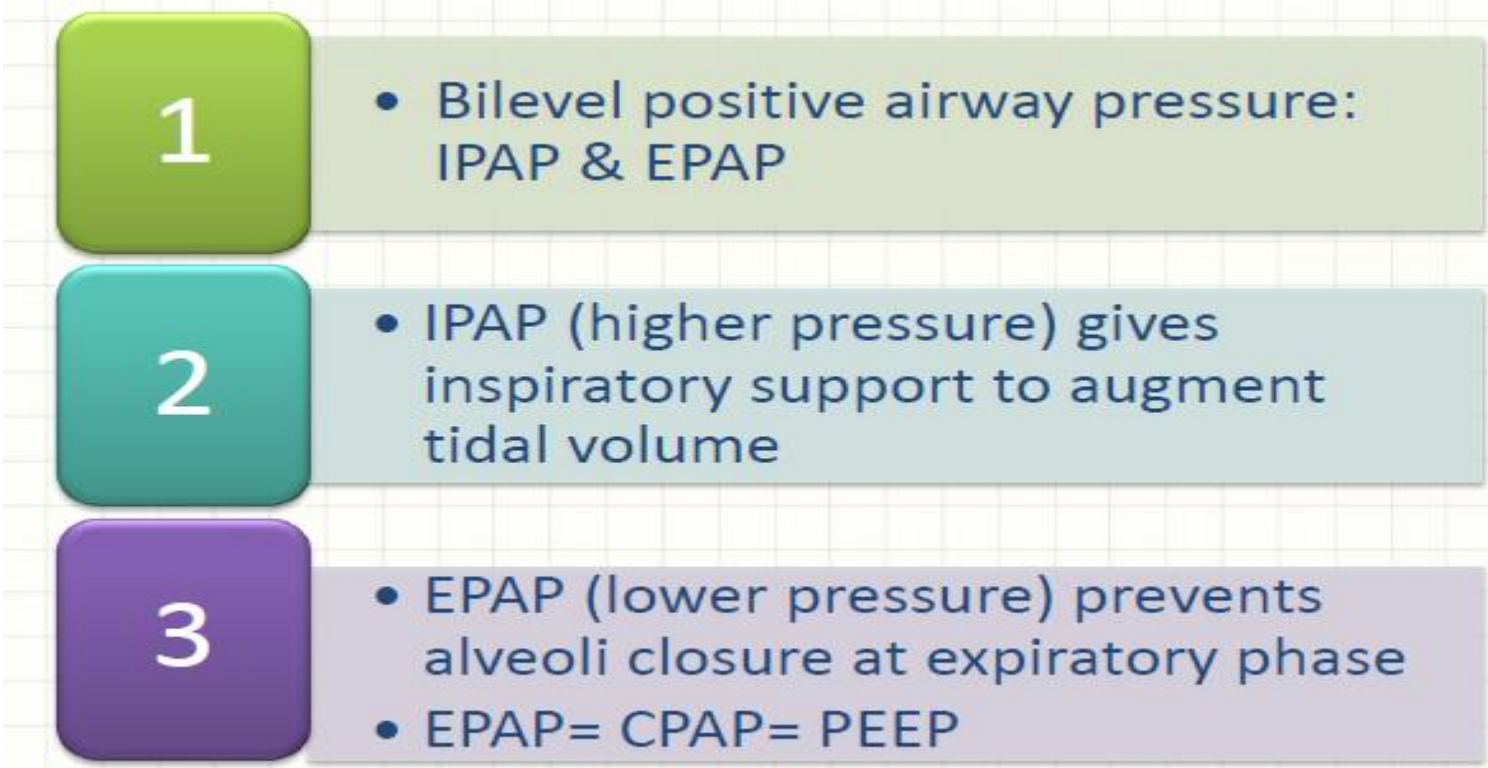
- ↑ Functional residual capacity
- Move fluid from alveoli into interstitial space
- Improve oxygenation



Indication for CPAP

- Type 1 respiratory failure (PaO 2 <8 KPa)
- Acute cardiogenic pulmonary oedema
- Atelectasis (collapsed lungs)
- Obstructive sleep apnoea

BiPAP mechanism



Effectiveness of BiPAP

- IPAP
  - Increase in tidal volume assists CO2 clearance
  - Inspiratory support reduce WOB
- EPAP
  - Keeps alveoli open on expiration
  - Increases lung volume, functional residual capacity (FRC)
  - Improves alveolar gas exchange
  - Improves oxygenation

Type II Resp Failure

- Hypercapneic resp failure
- Pump failure
- Ventilaion failure
- Failure of lung to eliminate adequate CO2

- Causes
  - Pump failure (drive, muscle and WOB)
  - Increase CO2 production
  - R-L shunt
  - Increase deadspace

Indication for BiPAP

Type 2 respiratory failure (Hypercapnia PaCO 2 >6.1KPa even SpO 2 is normal)

- Pulm cause
  - Exacerbation of COPD
  - Chronic Asthma
  - Advanced Pulm fibrosis
  - OSA syndrome
- Reduce Resp drive
  - Sedative drugs (e.g.post extubation)
  - Brain tumour or trauma
- Weaning from mechanical ventilation
- Chest wall rib cage problem
  - Flail chest
  - Kyphoscoliosis

Setting

IPAP

- 10 -12 cmH2O, increase to target pressure as tolerated by the patient

EPAP

- 4 – 5 cmH2O, can be increased to 12-15 cmH2O

The pressure between IPAP and EPAP is pressure support . Be aware when adjusting ventilation setting to maintain tidal volume

Contraindications

- Respiratory arrest , Apnoea
- Vomiting, bowel obstruction
- Cardio-respiratory instability, SBP <90mmHg, severe hypoxaemia, respiratory acidosis
- Uncooperative patient (claustrophobia , anxious, agitation)
- Recent facial, oesophageal or gastric surgery
- Craniofacial trauma or burns
- Inability to protect airway (High aspiration risk)
- Excessive secretion and unable to manage secretion
- Reduced level of consciousness

Complications

- Pressure sore
- Air leak
- Dry eyes
- Gastro distension, vomiting and aspiration
- Hypotension
- Increased ICP
- Secretion drying / retention
- Difficulty in communication
- Reduce in oral intake
- Anxiety

Patient monitoring

- Keep reassessing A and B, repeat ABG 30-60 minutes after application
- Alarms setting
- Looking for improvement after 1-2 hrs (no more than 4 hrs)
- Always be prepared for intubation (NIV may fail, need management plan)
- Need to recognise sings of failing (escalation when required)

Signs of failure

- Unable to tolerate mask or failure of coordination with the ventilator
- Development of new symptoms or complications such as pneumothorax, excessive sputum retention, nasal bridge erosion
- Failure to improve in arterial blood gas
- Respiratory acidosis worsening
- Deterioration in patient's condition
- CVS instability
- Reduced mental status

Patient care

- Appropriate masks
- Avoid high airway pressures
- Gastric distension/aspiration
- PUP
- Sinus pain
- Communication issues (psychological support)
- Humidification/NEBS
- Hydration and nutrition

Optiflow- Airvoflo

- Optiflow is a non-invasive device which warms and humidifies high flow nasal cannula air/oxygen blends which are delivered to the patient.
- The warmth and high humidity mean that the very high nasal flows can be tolerated.
- Heat and humidity prevents airway water-loss, airway cooling, thickened secretions, nasal irritation and bleeding.
- The Optiflow allows delivery of breathing gases heated to body temperature at 100% relative humidity through nasal cannula from 0.3lpm-8lpm without airway drying or cooling.
- By contrast, flow from a bubble humidification system is well below bodytemperature and has a significant water deficit (Powell 2005).

Benefits

- The effects of heat and molecular humidity optimize the use of nasal cannula allowing higher flows to be used.
- Provides the ability to deliver high flows without adverse side effects and patient discomfort including:
  - nasal drying,
  - bleeding, and
  - septal breakdown
- • In the ICU environment, use of Optiflow allows practitioners and family members to easily feed, and care for patients.

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