INDIAN SOCIETY OF ANAESTHESIOLOGISTS (ISA)
MECHANICAL VENTILATION MODULE (BASIC)

Orientation Course for Clinical Specialists &
Refresher Course for Anaesthesiologists

Oxygen Therapy
and
Delivery Systems

Importance of Oxygen

- Body Needs Energy
- Energy production in the body is dependent on O2

  - Aerobic Metabolism; provides 38 mmol of ATP

- Lack of O2 leads to Anaerobic Metabolism; 2 mmol of ATP

  - inadequate energy> inadequate metabolism> Cell death

  - Lactic acid production> metabolic acidosis > Cell death

How do we get Oxygen?

Atmosphere

Oxygen	Inhalation: 21%	Exhalation: 16%
Carbon Dioxide	Inhalation: 0.03%	Exhalation:4%

Gases flow along partial pressure gradients…

- **O2:** Atmosphere > lungs (alveoli) > arterial system > tissues
- **CO2**: Tissues > venous system> lungs (alveoli) > atmosphere

Thus, there is interplay of lung, heart & blood under brain & peripheral control systems

Oxygen Carriage to & from Tissues

Partial	Gas	Atmosphere	Lungs (Alveoli)	Arterial Blood	Venous Blood
Pressure	O2	160	105-110	98-100	35-40
mm Hg	CO2	0.3	35-40	35-40	40-45

- Carried in blood as dissolved O2 & Hb bound O2
- Each 100 ml of arterial blood carries 20 ml of O2

  (Each 100 ml of venous blood carries 15 ml of O2)
- Each minute, O2 consumed by body is appr. 250 ml

  (Each minute, CO2 removed by body is appr. 200 ml)

What is Oxygen Therapy?

- *Use of O2 to prevent or treat HYPOXAEMIA / HYPOXIA*

  - At more than 21% (21% normally inhaled)

  1. At atmospheric PRESSURE - COMMON (Normo/ Orthobaric) or

  2. More than atmospheric PRESSURE (Hyperbaric)

- Hypoxaemia: O2 saturation of <90% or PaO2 of <60 mm Hg

- Hypoxia: Reduction in tissue oxygenation, either reduced delivery or reduced utilization

Classification of Hypoxia

- Have to be identified & simultaneously managed
  1. Hypoxic Hypoxia (low O2 pressure)
  2. Anaemic Hypoxia (low O2 content)
  3. Stagnant Hypoxia (hypotension, vasoconstriction, etc),
  4. Histotoxic Hypoxia (poisoning e.g. cyanide)
- Can be Acute or Chronic Hypoxia

Indications for O2 therapy

Short term O2 therapy	Long term O2 therapy
• Cardiac & respiratory arrest • Respiratory failure (type 1 & 2) • Cardiac failure or MI • Shock from any cause • Increased metabolic demands – burns, poly trauma, severe infections • Carbon monoxide poisoning	• Chronic obstructive lung disease • Interstitial lung disease • Obstructive sleep apnoea • Pulmonary hypertension • Chronic Heart Failure

Goals of O2 therapy

- Increase Saturation
- Improve hypoxia
- Target Levels of O2 Saturation:

  - Acutely ill: >95%

  - At risk of hypercapnic respiratory failure – 88-92%

  - Premature neonates -90%

Oxygen therapy devices

Based on performance	Fixed performance devices Variable performance devices
Based on total flows	Low flow Medium flow and High flow devices
Based on capacity	No capacity Low / Medium /High capacity devices
Based on patient dependency	Low, medium and high dependency devices

No capacity devices: Nasal cannula

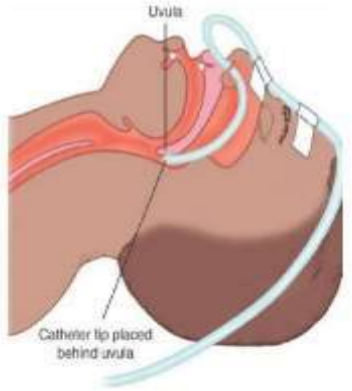
Advantages:

- Inexpensive
- Easy to apply
- Does not interfere with eating or talking
- Comfortable & Well tolerated

Disadvantages:

- Local irritation, drying of nasal mucosa with high flow rates
- Improper size can produce nasal obstruction
- Displacement can produce loss of O2 delivery

No capacity devices: Nasal Catheter



Advantages

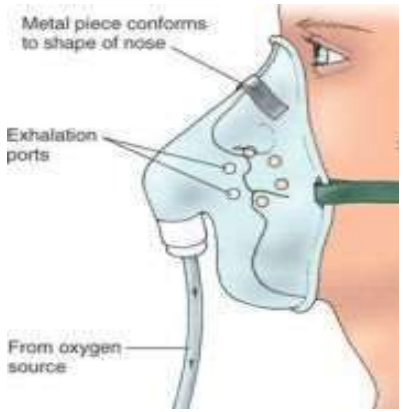
- Good stability
- Disposable
- Low cost

Disadvantages

- Difficult to insert
- High flow increases back pressure
- May provoke gagging, air swallowing, aspiration
- Nasal polyps, deviated septum may block insertion

Medium capacity devices
Simple Face mask

- 100- 300 ml capacity
- **35-55% O_2 at 6-10 L/min**



Advantages

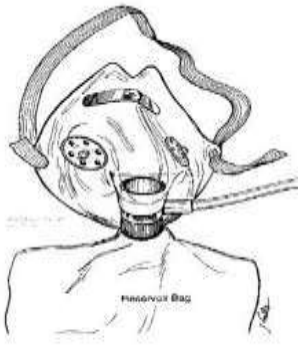
- Quick & easy to set up & apply
- Useful in patients with nasal irritation or epistaxis
- Useful in strictly mouth breathers

Disadvantages

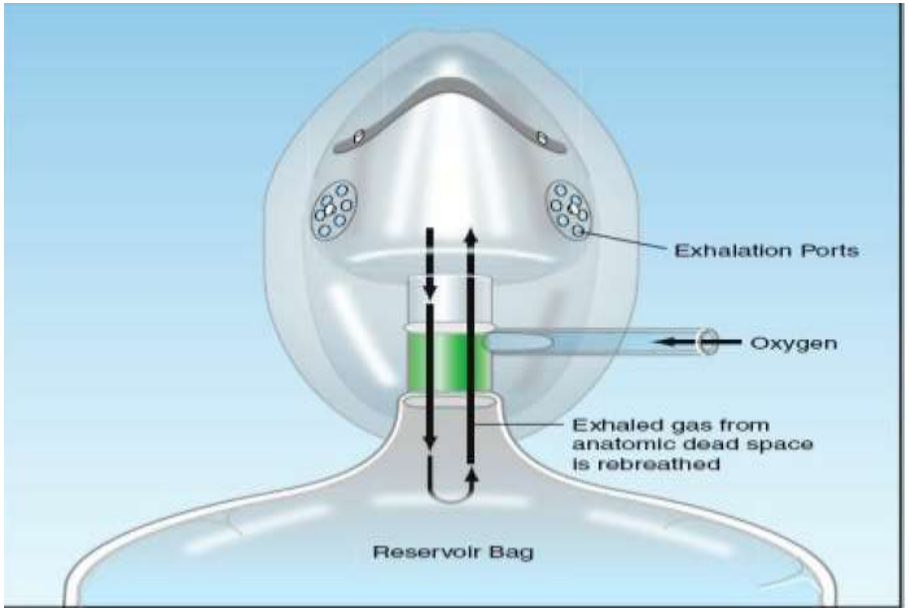
- May be uncomfortable
- Interfere with airway care
- Risk of aspiration in unconscious
- Rebreathing (if flow < 5 L/min)
- Obstructs coughing, impedes eating

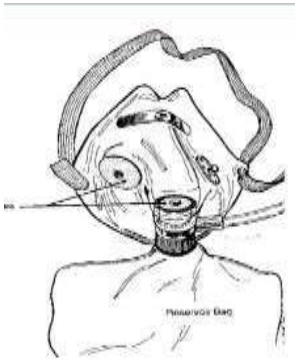
High capacity devices - Masks With Reservoir

- 1-2 litres capacity Reservoir
- Min 6-8 L/ min flow: Can provide 40-70% O2



Partial rebreathing mask





Nonrebreathing mask

Oxygen therapy (Marino PL, Marino's The ICU Book, 4th ed 2014

Fixed Performance Devices

1. Venturi mask
2. High flow nasal catheters (HFNC)
3. Anaesthesia work station
4. ICU ventilator

Venturi Devices

- Based on Venturi Principle
- O2 delivered (FiO2) depends on O2 flow rate
- Connected to Mask

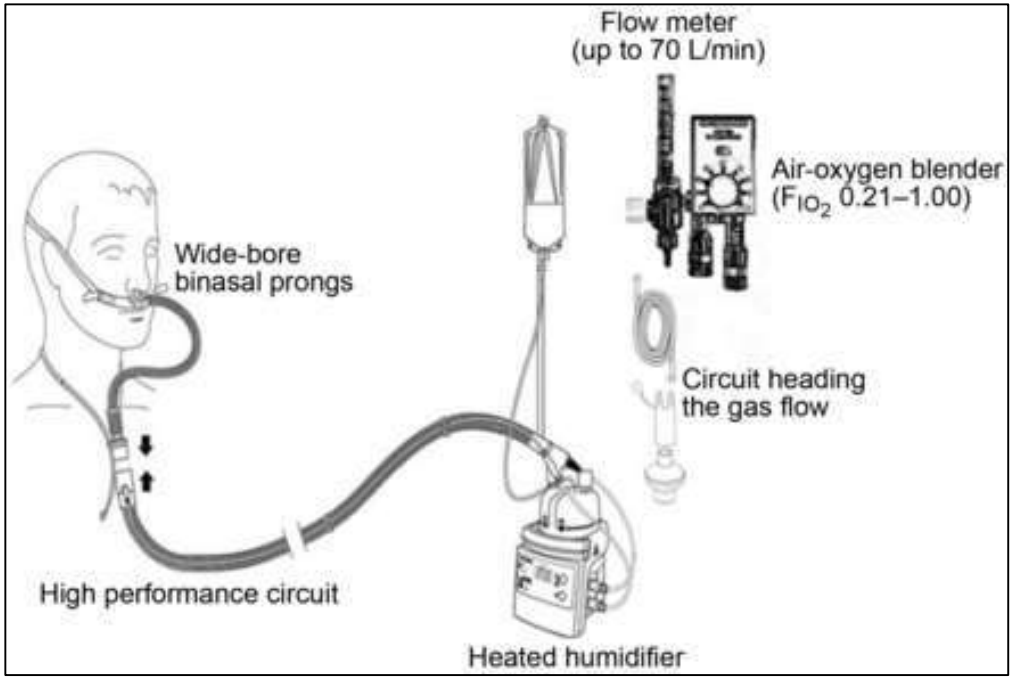
Venturi Devices: Connectors

- Devices for different O2 Concentrations
- Colour Coded

Colour	FiO2	O2 flow l/min
Blue	24%	2
White	28%	4
Orange	31%	6
Yellow	35%	8
Red	40%	10
Green	60%	15

Adjustable venturi device

High Flow Nasal O2 (HFNO)



Respiratory Care November 2012, 57 (11) 1873-1878

- Provides humidified,

  constant high-flow nasal O2

  1. Up to 100 l/min

  2. Up to 100% FiO2

  3. CPAP 5-7 cm H2O

Advantages: Decreases work of breathing

Avoids intubation

Continuous Positive Airway Pressure (CPAP) Devices

- Provide Air-O2 with Humidification
- *Provide positive pressure during inspiration & expiration*
- Adult / Paediatric
- Interphase: Face mask / Nasal mask / Helmet
- Useful for COPD: Opens up collapsed airways
- Home use for COPD & Obstructive Sleep Apnoea

Typical settings for CPAP

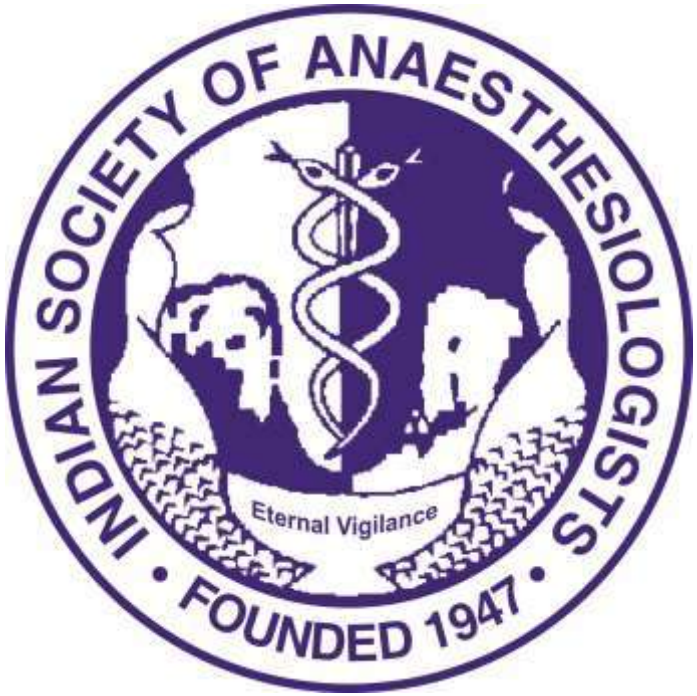
- Spontaneous mode
- CPAP or positive end-expiratory pressure (PEEP) range from 5-15
- Peak airway pressure range from 8 to 20 cm H_2O

Contra Indications:

- Uncooperative patient, trauma (face, airway), copious secretions, unstable Cardiac/ respiratory status, etc

Conclusion

- O2 at >21% is indicated to manage hypoxia from different causes
- Various techniques & devices are available
- Inspired O2 delivered to patients can be varied or fixed
- Best Option should be tried based on patient status
- HFNO provides high flow of humidified O2 & has high potential to avoid intubation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