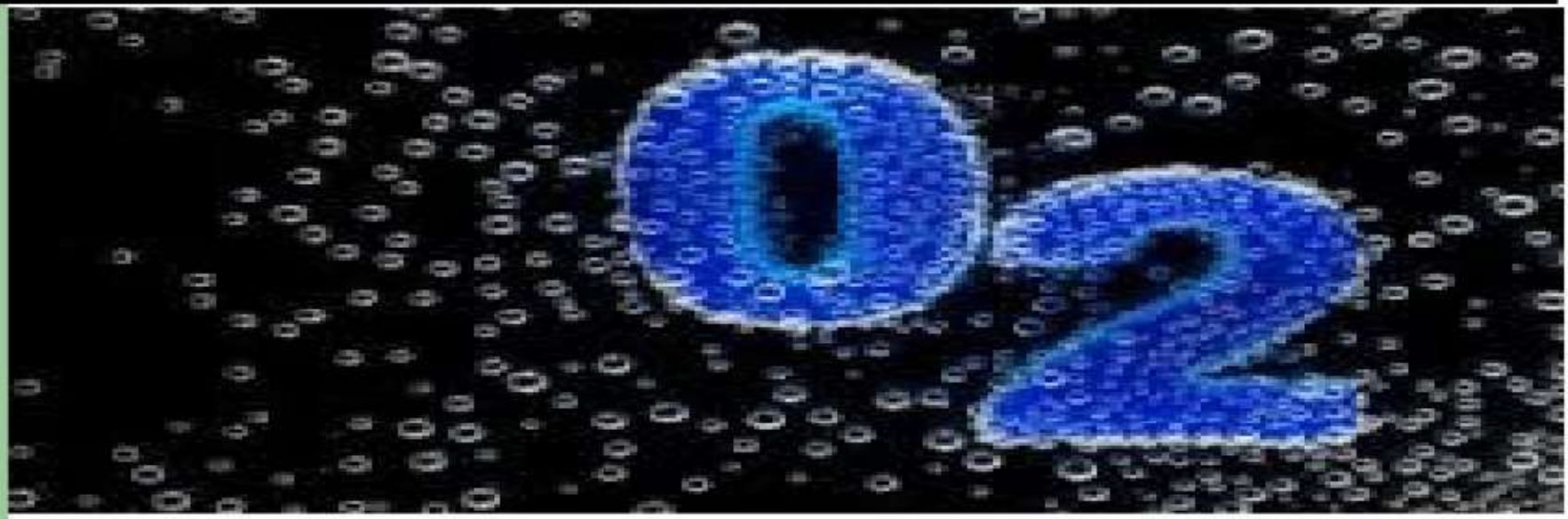
Oxygen Delivery Devices

Common utilized therapy



Associate Professor of Chest Diseases

Dr.Samah Shehata

Oxygen is a drug. (common drug)

- It should written in dose ,rate and method.
- Should be titrated according to response.

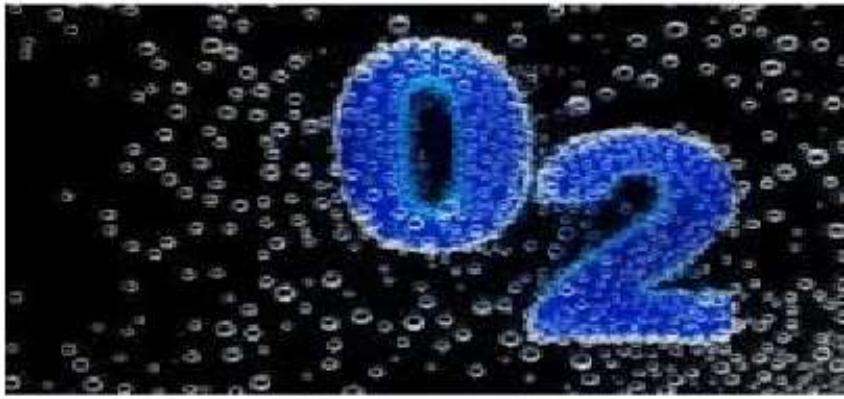
Indications:

- To maintain saturation > 94% or pO2 > 80 mmHg
- Exception is COPD: target saturation 88 – 92 %

Side effects:

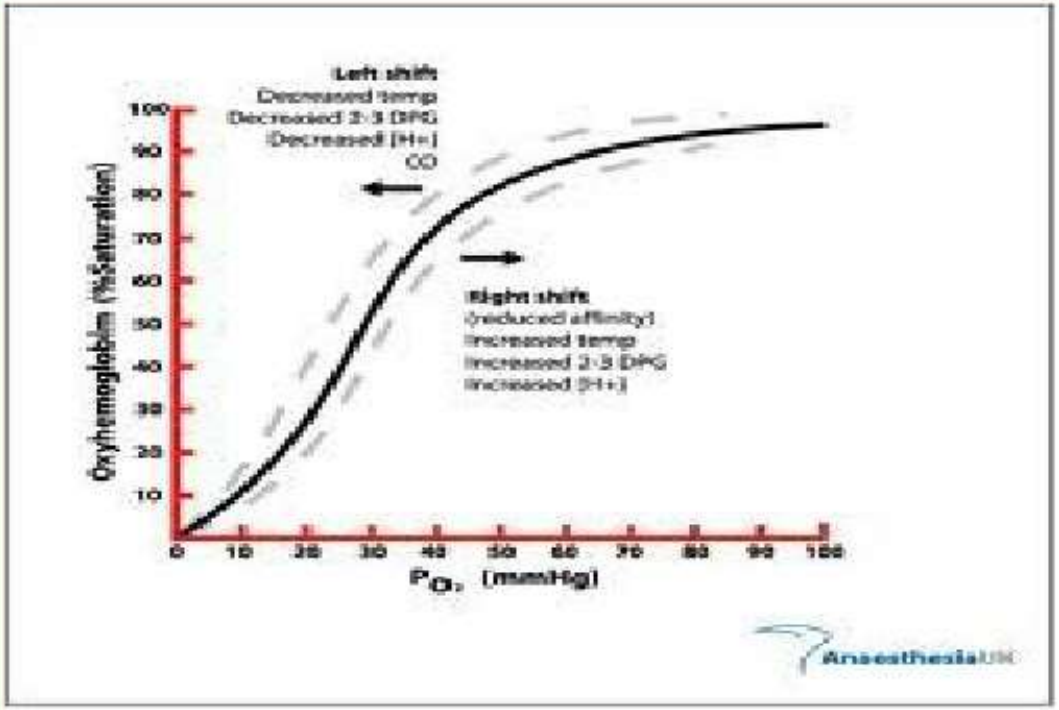
- Saturation of 100% is dangerous even MV.
- Blindness, lung fibrosis, oxygen free radicals.

Types of hypoxia



Types	Definintion	Typical cases
Hypoxic	⇩ oxygen tension	High altitude - hypoventilation - V/Q mismatch.
Anemic	⇩ carrying capacity	Anemia - blood loss - CO poisoning
Stagnant	⇩ perfusion	Heart failure - Shock - ischemia
Histotoxic	Cellular hypoxia	Cyanide - other metabolic poisons - shifting of O2-HB curve.

Oxygen dissociation curve



Decreased Temp.
Decreased 2,3 DPG
Decreased {H+}

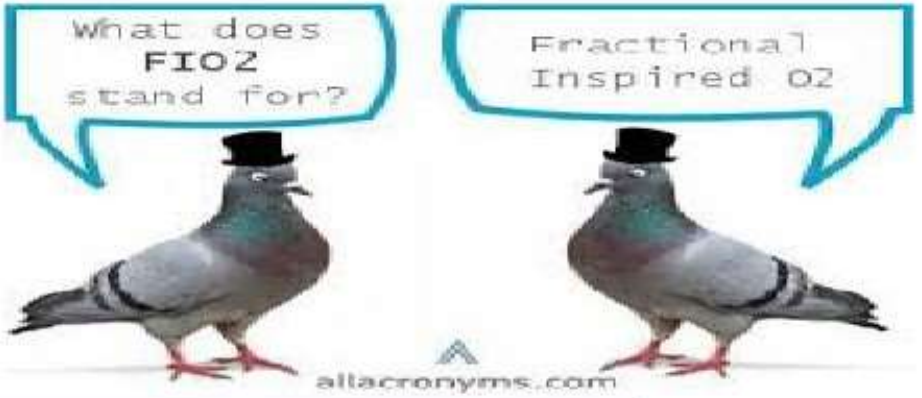
Increased Temp.
Increased 2,3 DPG
Increased {H+}

Grading of hypoxia

Classifications	PaO_2 (rule of thumb)
Normal	80-100 mm Hg
Mild hypoxemia	60-80 mm Hg
Moderate hypoxemia	40-60 mm Hg
Severe hypoxemia	<40 mm Hg

Respiratory failure

Oxygen dose



1. Pt demand

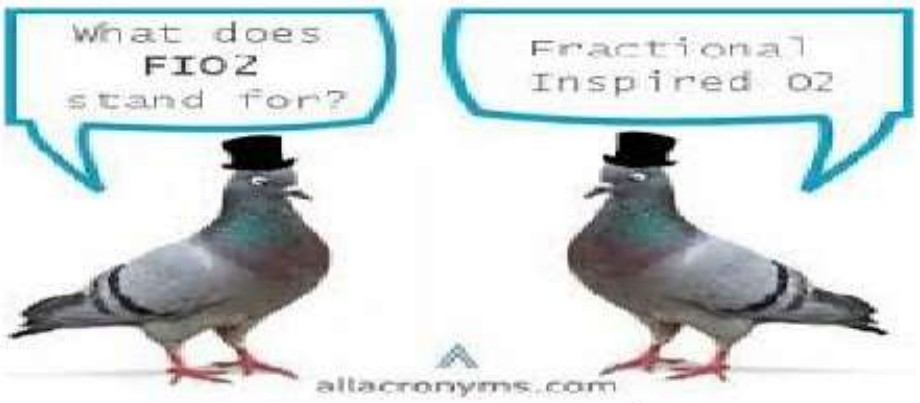
RR × TV = Minute Ventilation

(BV − DS) × RR = Minute Alveolar Ventilation

2. Flowmeter

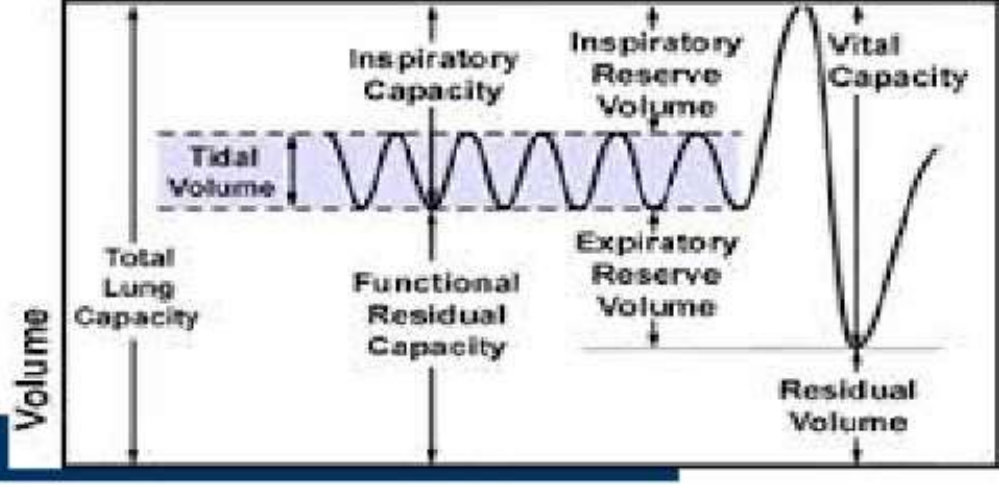
3. O2 device

Oxygen dose


What does FIO2 stand for?
Fractional Inspired O2
allacronyms.com


4
Monitoring

Patient demand



RR × TV = Minute Ventilation

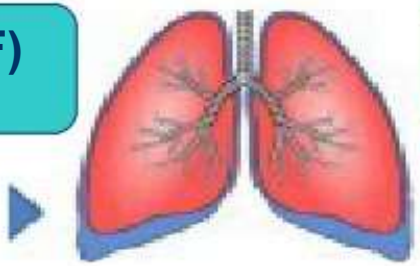
(BV − DS) × RR = Minute Alveolar Ventilation

Hypoxia

- Hypoventilation
  - High pCO2
  - Positive ventilation
- Hyperventilation
  - Low pCO2
  - Negative ventilation

Respiratory Failure

Type 1 (Hypoxemic RF)



Type 2 (Hypercapnic RF)

ABG Not Oximeter

PaO2 < 60 mmHg
PaCO2 (low or normal)

PaO2 < 60 mmHg
PaCO2 > 45 mmHg

COPD patient with PaCO2 of 60 mmHg, PaO2 of 61 mmHg and pH 7.37. Is there any RF? Which type?

Oxygen Devices Classification

Passive

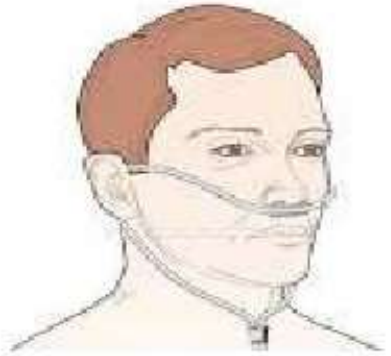
Positive Ventilation

Active

Negative Ventilation

Oxygen Devices Classification

Low flow device



Oxygen Devices Classification

High flow device

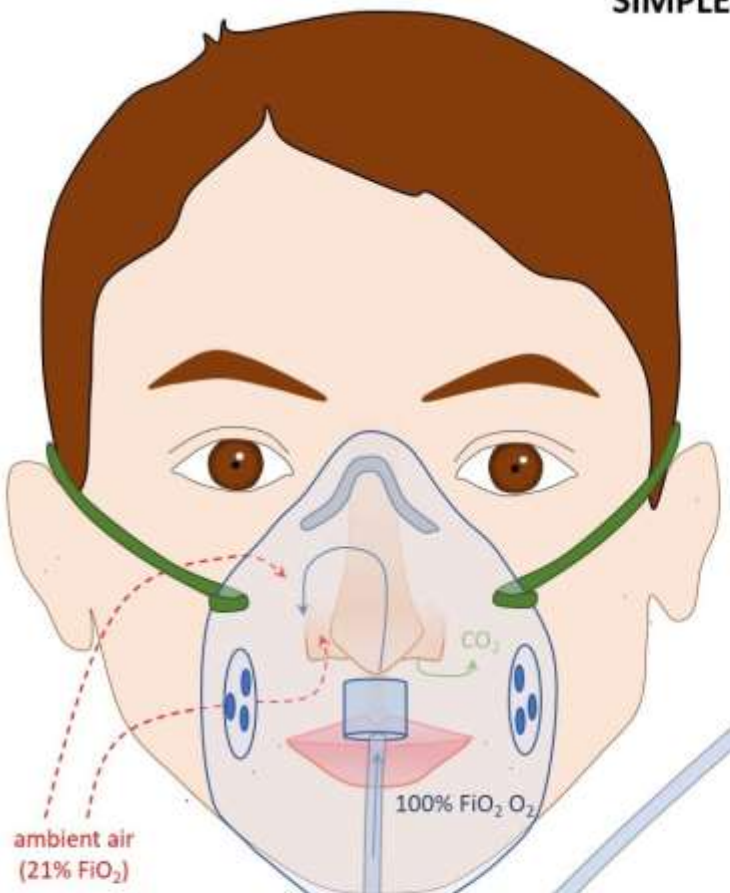
Nasal Prongs

Flow	FiO2
• 1 L/min	• 24 % (0.24)
• 2 L/min	• 28 % (0.28)
• 3 L/ min	• 32 % (0.32)
• 4 L/ min	• 36 % (0.36)
• 5 L/ min	• 40 % (0.40)
• 6 L/ min	• 44 % (0.44)

Nasal Prongs

Advantages	Disadvantages
Tolerable (satisfaction + compliance)	Flow limitation.
Can use the mouth (eat, speak, treat)	FiO2 limitation.
Avoid high FiO2 in COPD.	Nasal drying and irritation with high flow rate?

SIMPLE FACE MASK



1. 100% FiO_2 oxygen is delivered at various flow rates, which collects in the face mask, creating a reservoir of 100% O_2 of ~ 100 – 250 mL

2.Because of venting holes and imperfect fits of face masks, ambient air is entrained during inspiration, diluting 100% O_2 delivered to the mask

5. Maximal FiO_2 delivered ~ 60-70% (with normal breathing)

6. Effective FiO_2 affected by breathing pattern (↑ V_E or ↑ inspiratory flow rate → ↑ ambient air entrained → ↓ effective FiO_2)

Mask plus reservoir

What is show in this picture?

Partial rebreathing mask

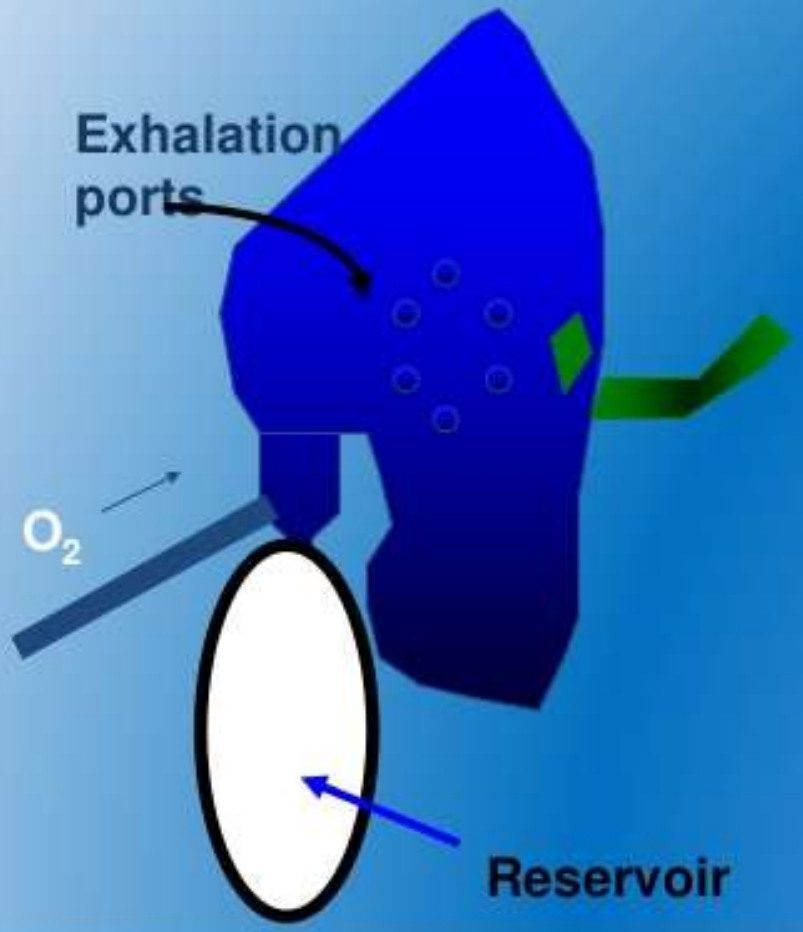
Non rebreathing mask

Why?

Partial Rebreathing Mask

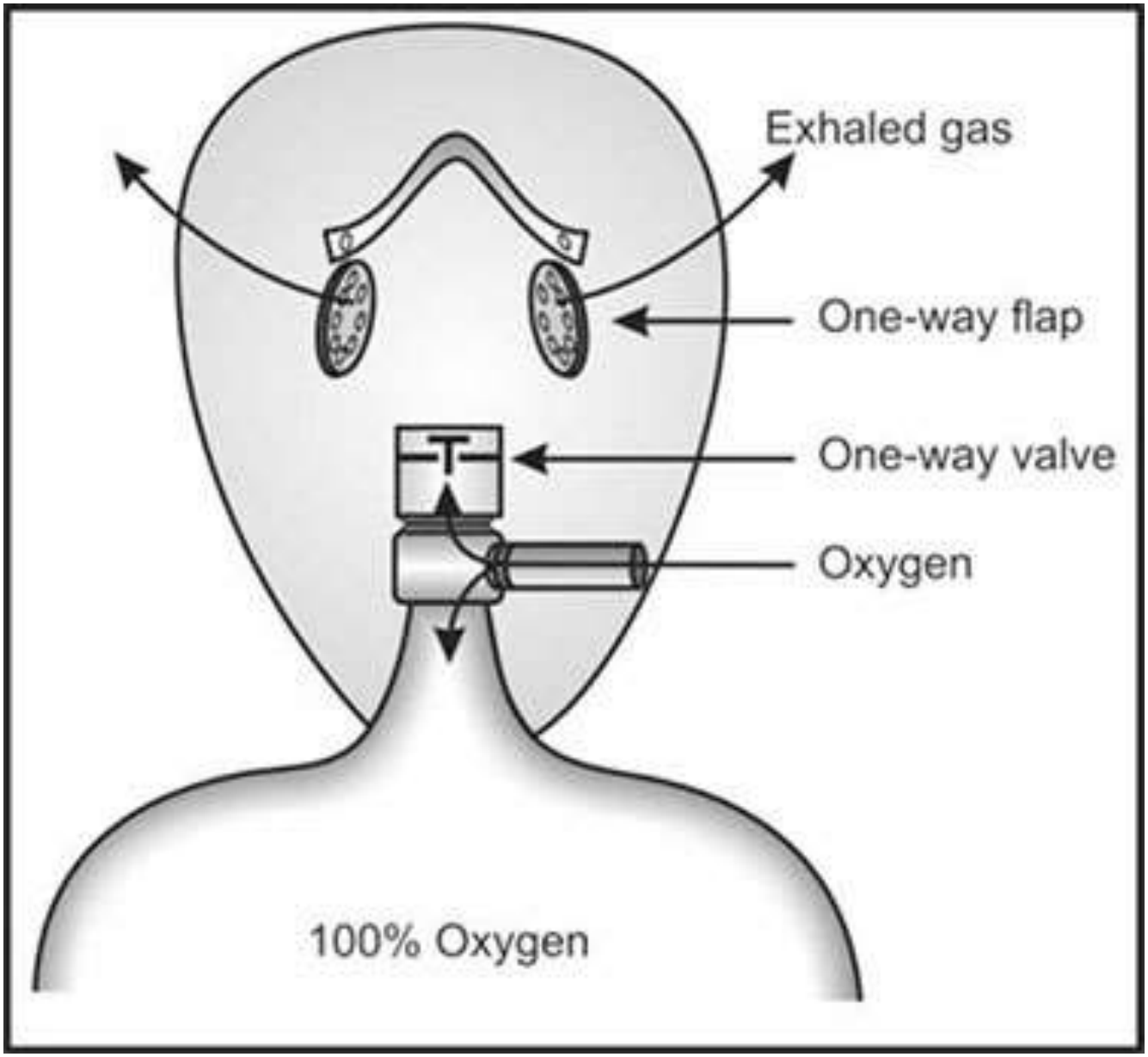
- A combination of face mask and a collapsible O 2 reservoir bag.
- Oxygen flows continuously to the bag

Partial Rebreather mask



- O_2 directed into reservoir
- Insp: draw gas from bag & ? room air
- Exp: first 1/3 of exhaled gas goes into bag (dead space)
- Dead space gas mixes with 'new' O_2 going into bag
- Deliver ~60% O_2

Non-rebreathing face mask



Non-rebreathing face masks

- Face mask + oxygen reservoir + a valve at exhalation port + a valve between reservoir and mask
- Patient inhales oxygen from the bag and exhaled air escapes through flutter valves on the side of the mask
- Oxygen flow into the mask is adjusted to prevent the collapse of the reservoir (12 L/min)
- It prevent the room air from being entrained
- 10-15 L/min, FiO2 90-100%

6: 55-60%
8: 60-80%
10: 80-90%
12: 90%
15: 90-100%

Simple face mask/Partial rebreathing/ non rebreathing

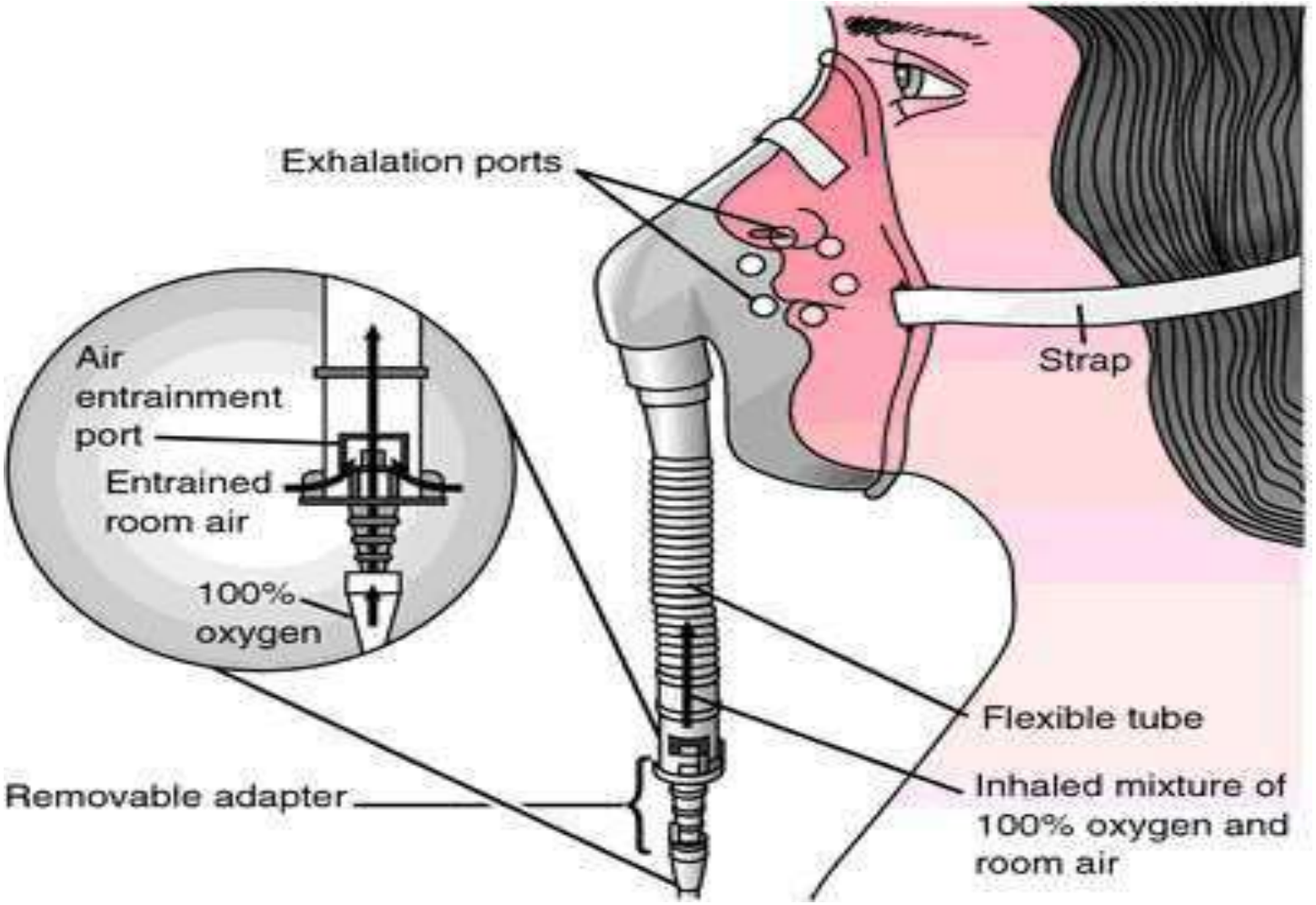
The device	Characteristics	Advantages	Disadvantages
Simple mask 5 - 10 L/min FiO2 (40 - 60%)	**Mask** - no reservoir	Nebulizer or venture port **Accepted FiO2**	**Considerable air mixing** - No use of mouth
Partial mask 5 to max to Keep bag inflated	Simple mask + **reservoir**	**Higher FiO2** FiO2 (up to 60 %)	**Less room air mixing** - no use of nebulizer or venturi
Non rebreathing 5 to max to keep bag inflated	Simple mask + reservoir + one way **valve**	**Highest FiO2** **Negligible room air mixing** FiO2 (up to 95%)	No use of mouth, venture or nebulizer

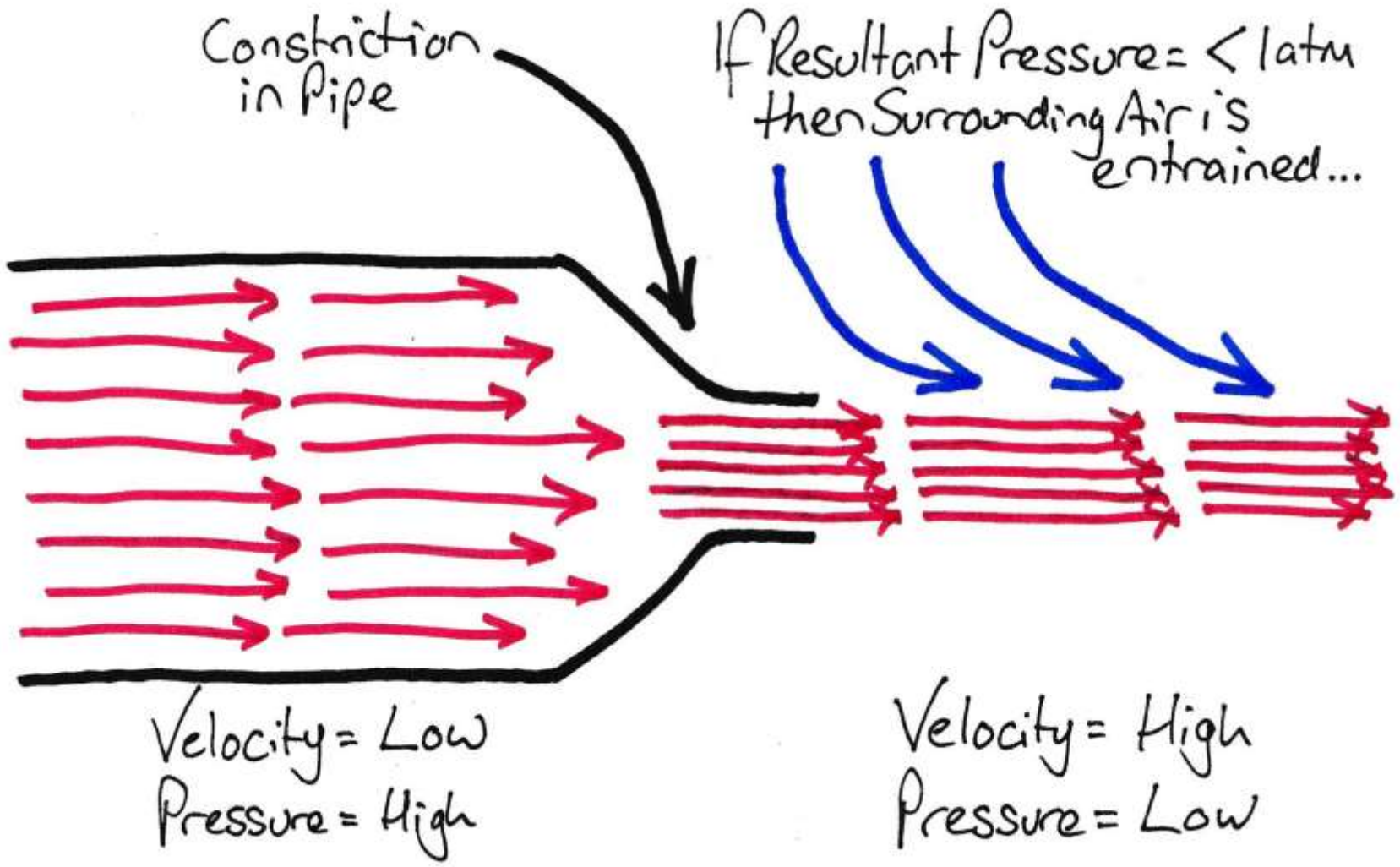
Venturi mask

Characteristics	Advantages	Disadvantages
High flow device	Controlled FiO2	Limited low FiO2
Room air mixing	Suitable for chronic CO2 retention	Ignores patient O2 demand
Adjustable valve	Can use nebulizer	
Use simple mask or CPAP		

Venturi mask

Venturi Mask Principle




Constriction in Pipe
If Resultant Pressure = < 1atm then Surrounding Air is entrained...
Velocity = Low
Pressure = High
Velocity = High
Pressure = Low

Venturi mask flow rates

Venturi valve colour	Inspired oxygen concentration (%)	Oxygen flow (l/min)	Total gas flow (l/min)
Blue	24	2–4	51–102
White	28	4–6	44–67
Yellow	35	8–10	45–65
Red	40	10–12	41–50
Green	60	12–15	24–30

LONG-TERM OXYGEN THERAPY

LTOT can be defined as oxygen used for at least 15 h per day in chronically hypoxaemic patients.

Table 1. Indications for Long-Term Oxygen Therapy.

Continuous oxygen

Resting PaO_2 ≤55 mm Hg or oxygen saturation ≤88 percent

Resting PaO_2 of 56–59 mm Hg or oxygen saturation of 89 percent in the presence of any of the following:

- Dependent edema suggesting congestive heart failure
- P pulmonale on the electrocardiogram (P wave greater than 3 mm in standard leads II, III, or aVF)
- Erythrocythemia (hematocrit >56 percent)

Noncontinuous oxygen

Oxygen flow rate and number of hours per day must be specified

- During exercise: PaO_2 ≤55 mm Hg or oxygen saturation ≤88 percent with a low level of exertion
- During sleep: PaO_2 ≤55 mm Hg or oxygen saturation ≤88 percent with associated complications, such as pulmonary hypertension, daytime somnolence, and cardiac arrhythmias

Non-invasive ventilation masks

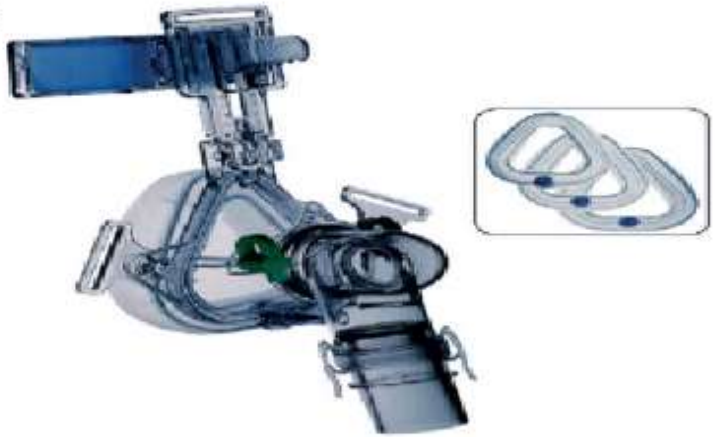
A

Full face mask

B

Total face mask

C



Nasal mask

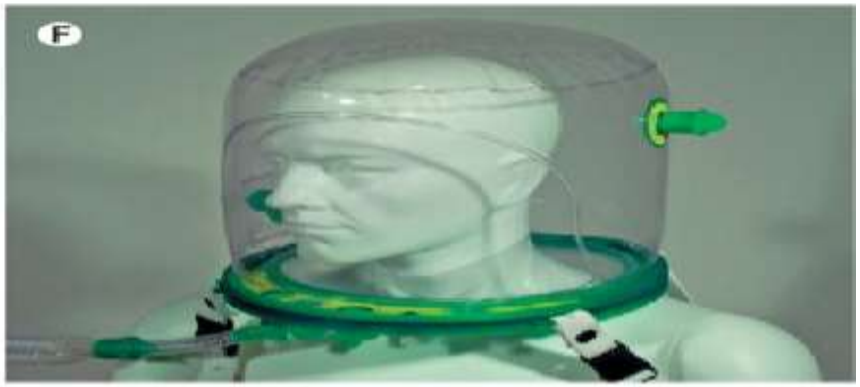
D

Mouthpiece

E

Nasal pillows

F



Helmet

NAME	TYPE	SIZE
Positive Pressure mask	Nasal Mask	L
Positive Pressure mask	Nasal Mask	M
Positive Pressure mask	Nasal Mask	S

Positive pressure ventilation

NIV

Pt close monitoring

Indications	Advantages	Disadvantages
Hypoxia despite full O2 Hypoventilation CO2 retention	Decrease work of breathing	Unprotected airway
	Avoid intubation	Gastric insufflation
Requirements	Improve oxygenation	Slow correction (time)
Conscious - cooperative - vitally stable - airway protected by their own - reversible cause	Improve ventilation	Tight mask problems
		Decrease venous return

NIV

Monitoring

Mask

- Fit, Comfort, Air leak, Secretions, Skin necrosis

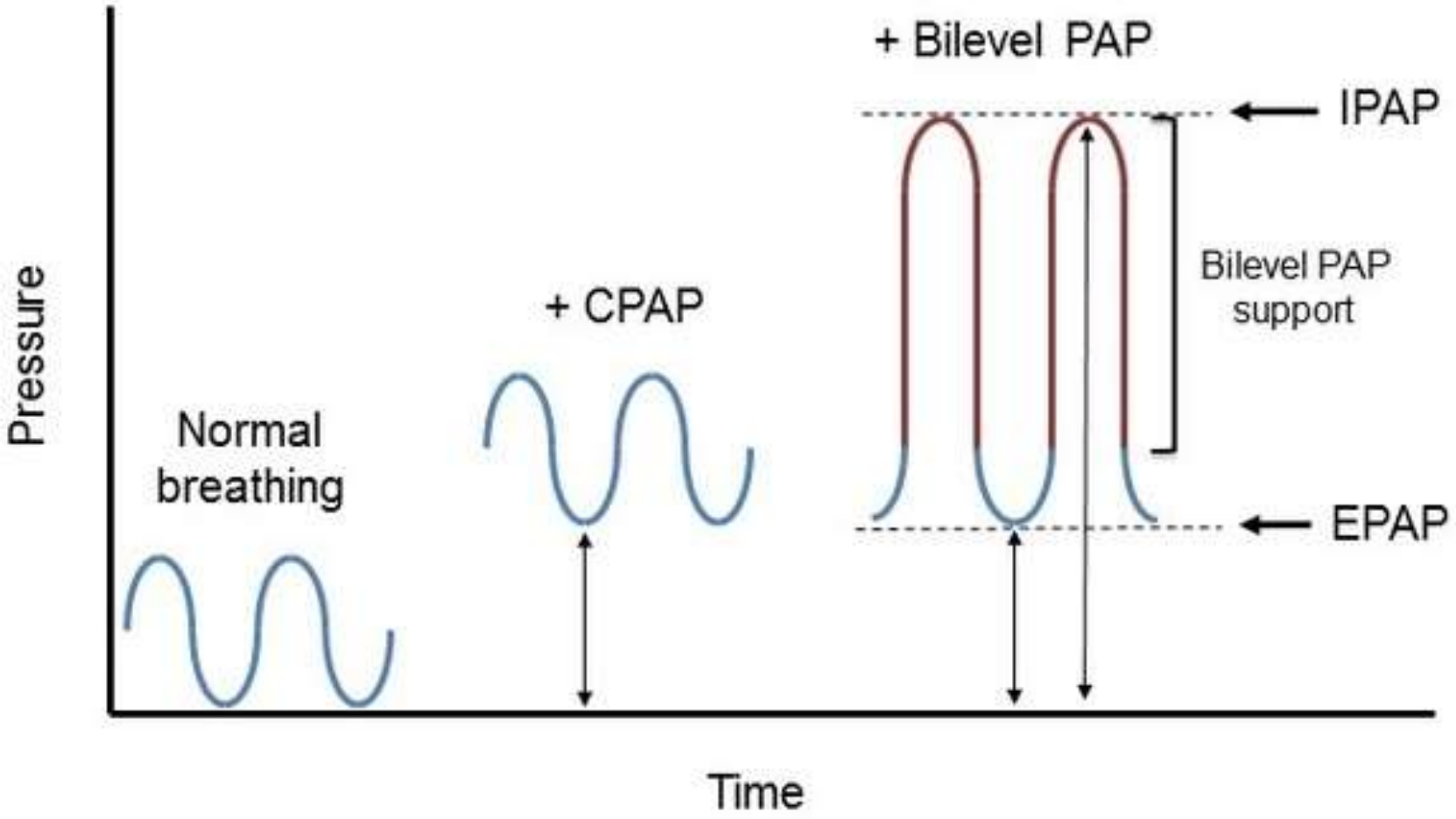
Respiratory muscle unloading

- Accessory muscle activity, paradoxical abdominal motion

Abdomen

- **Gastric distension**

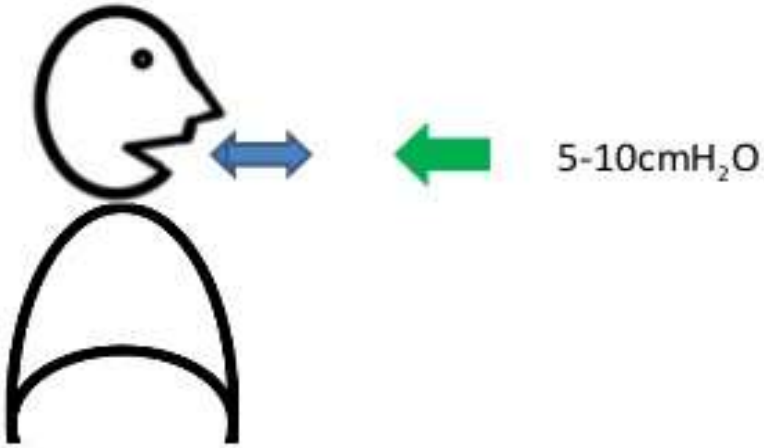
CPAP vs BiPAP


+ Bilevel PAP
IPAP
Bilevel PAP support
+ CPAP
Normal breathing
EPAP
Pressure
Time

CPAP

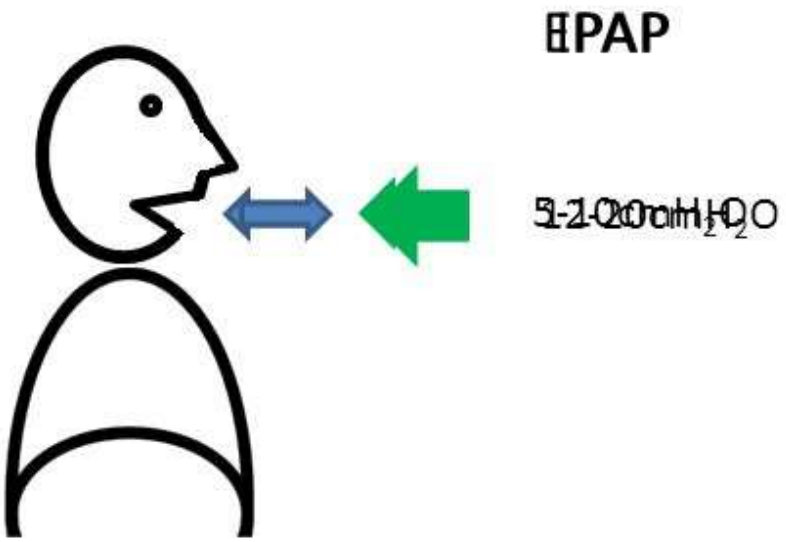
- Continuous Positive Airways Pressure
  - Same pressure (5-10 cmH_2O) throughout respiratory cycle

- Increases intra-alveolar and intra-bronchiolar pressure
  - Recruits alveoli
  - Dec Pulmonary oedema
  - Increase FRC
  - Dec WOB



BIPAP

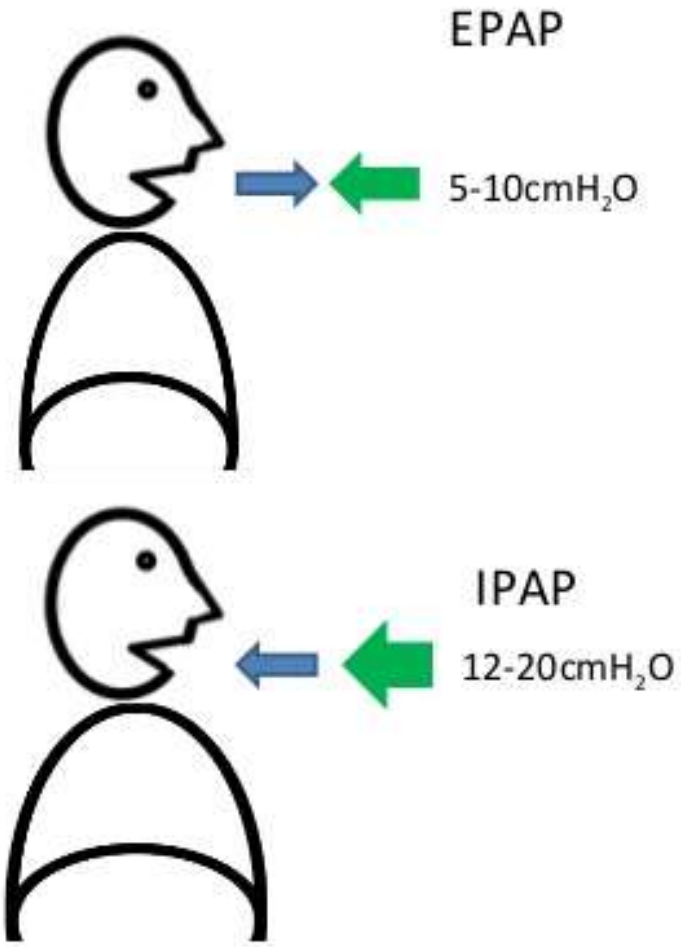
- Bi-level Positive Airways Pressure
  - Lower positive pressure during expiration (EPAP) (equivalent to CPAP)
  - Higher positive airways pressure during inspiration (IPAP)
- CPAP + Increases tidal volume



BIPAP

- EPAP (PEEP)
  - Recruits alveoli
  - Increases VQ matching
  - Improves oxygenation

- IPAP – EPAP (pressure support)
  - Increases tidal volume
  - Reduces CO_2
  - Improves Ventilation and decrease work of breathing



Indications for continuous positive airway pressure (CPAP) and bilevel non-invasive ventilation (NIV)

CPAP	Bilevel NIV
▸ Pulmonary oedema ▸ Basal collapse ▸ Assistance to wean from the ventilator	▸ Chronic obstructive pulmonary disease exacerbation with type 2 respiratory failure and respiratory acidosis ▸ Pulmonary oedema (non-responsive to CPAP) ▸ Neuromuscular disease ▸ Assistance to wean from the ventilator

Summary

- O2 is a drug, so it must be used judiciously.
- You should set your targets:
- Before you move to mechanical ventilation, consider to make the maximum use of simple devices available.
- It is important to keep in mind each device capabilities and limitations.
- Monitoring during O2 therapy is vital.
- NIV is an option but patient should meet the criteria for its application.

A 60 year man is a moderate smoker. He has chronic cough and difficulty in breathing for 10 years. His symptoms have worsened and he presents to hospital. On examination, patient is fully conscious; He has diffuse wheezes and is using his respiratory muscles. Arterial blood gases (on room air): pH 7.33, pO2 52 mmHg, pCO2 61.5 mmHg, Hco3 30.7 mmol/L,Sa O2 83%.

What is the appropriate oxygen therapy for this patient?

A. Nasal cannula (5 litres/min)
B. Simple face mask (5 litres/min)
C. Intubation and ventilation
D. Venturi mask (Fio_2 28%)
E. Partial rebreathing mask (Fio_2 50%)

A 60 year old man has a long history of smoking and COPD. He has resting hypoxemia (PaO2 is 57 mmHg) and continues to be breathless despite being on adequate medical treatment. On examination: There are lower limb oedema and congested pulsating neck veins. What is the treatment of choice?

A. Home nebulizer
B. Diuretics
C. Intermittent oxygen therapy (8 hours / day)
D. Stop smoking
E. Long term oxygen therapy (15 hours / day)

A 40 year old lady presents with breathlessness, hyperventilation, tachycardia and confusion. She has a temperature of 38°C. Over the last 5 days she had been deteriorating despite a course of oral antibiotics.WCC is 18 x 109 /l ,CRP is 220 mg/l , PaO_2 / FiO_2 = 180. The chest X-ray shows bilateral lung shadowing

What is the appropriate intervention now?

A. High flow o2 therapy.
B. Non-invasive mechanical ventilation
C. Mechanical ventilation: High tidal volume strategy.
D. Mechanical ventilation: Low tidal volume strategy.
E. High frequency oscillatory ventilation (HFOV)

Before The end