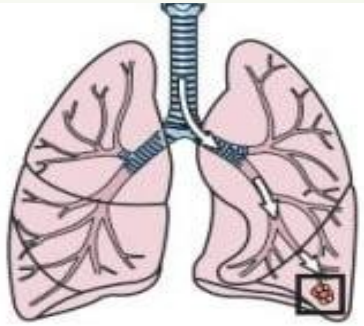
Hypoxia and oxygen therapy

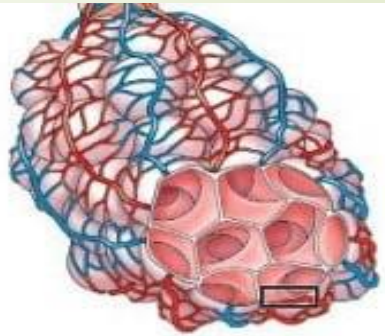
Oxygen

oxygen in the atmosphere air 21% …….mean oxygen pressure is 21% from 760mmhg = 159 mmhg so how can transport o2 from the air to the cell??

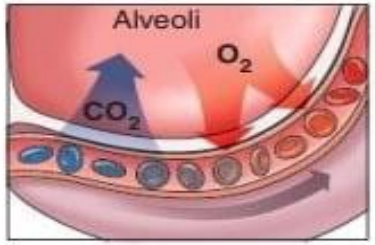
Inspired air has a PO_2 of 159 and a PCO_2 of 0.3.



When it arrives at the alveoli, air has a PO_2 of 104 and a PCO_2 of 40.

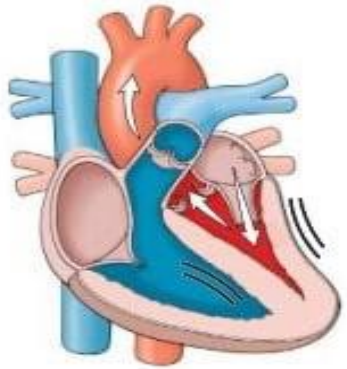


On the other side of the alveoli's thin membrane are pulmonary capillaries that contain venous blood. This blood has a PO_2 of 40 and a PCO_2 of 46.

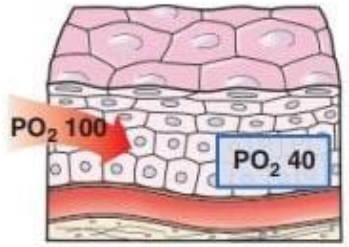


The differences in partial pressures of O_2 and CO_2 on either side of the respiratory membrane cause O_2 to move out of the alveoli and into the capillaries and CO_2 to move out of the capillaries into the alveoli. (In other words, the red blood cells in the capillaries *unload* CO_2 and *load* oxygen.) The CO_2 is later exhaled through the lungs.

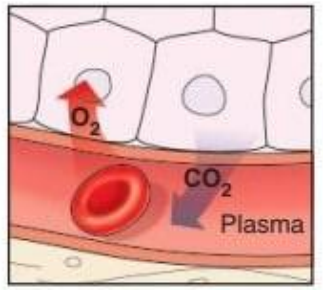
Blood in the capillaries now has a PO_2 of 100 and a PCO_2 of 40.



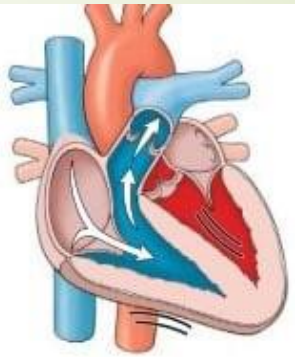
This oxygen-enriched blood travels to the heart's left ventricle, where it's pumped to the body's tissues.



Meanwhile, cells in the body's tissues have been using oxygen for energy production and producing CO_2 as a by-product. The fluid surrounding the cells has a PO_2 of 40 and a PCO_2 of 46.



When the blood from the left ventricle (with a PO_2 of 100) arrives at the tissues (with a PO_2 of 40), oxygen diffuses out of the blood and into the tissues. Simultaneously, carbon dioxide diffuses from the tissues (PCO_2 of 46) and into the blood (PCO_2 of 40).



Once it has released oxygen to the tissues and absorbed CO_2, the capillary blood has a PO_2 of 40 and a PCO_2 of 46. Systemic capillaries carry this oxygen-depleted blood away from the tissues and toward the heart's right ventricle, where it will be pumped back to the lungs.

Hypoxia and Hypoxemia

The hemoglobin binds 98.5% (spo2 or Sao2) of the oxygen content (paO2 100mmhg) so Any reduction in cardiac output, pao2,or hemoglobin level leads to inadequate tissue oxygenation known as **hypoxemia**. So in hypoxemia the pao2 less than 80 mmHg.

Hypoxia is clinical deprivation of cellular

oxygen revealed by tachycardia, hypertensive and hyperventilation.

Hypoxia and Hypoxemia are not the same.

Types of hypoxia

1. Hypoxemic hypoxia: (decrease pao2, low Spo2).

2. Anemic hypoxia (decrease Hb, HCT):

Oxygen delivery is reduced as haemoglobin concentration falls.

3. Stagnant hypoxia (brady cardia,, cardiac arrest) .

Oxygen delivery to tissue is reduced because blood flow to the tissues is reduced.

4. Histotoxic hypoxia (poisoning).

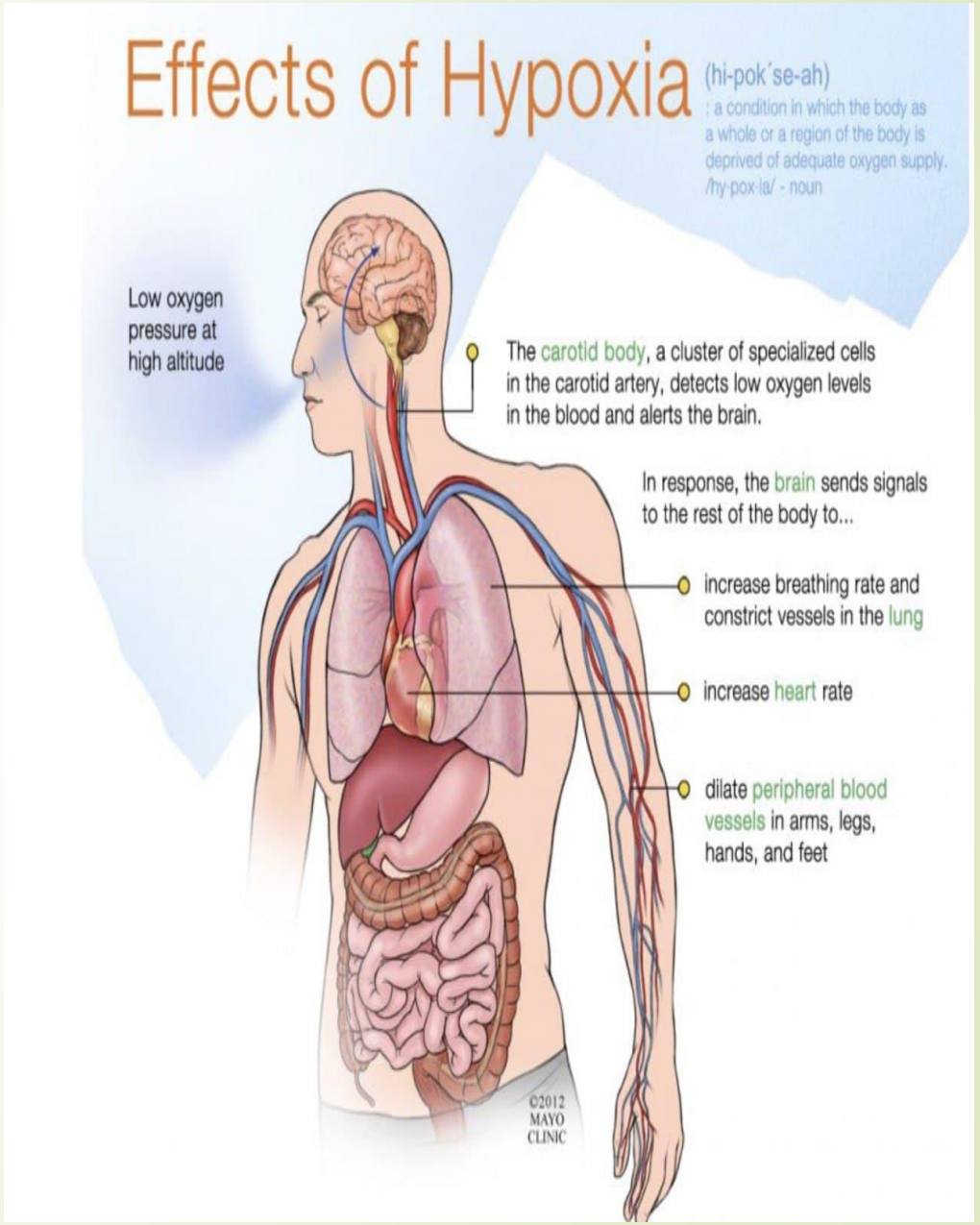
Blue tinges to the skin and lips (cyanosis)

-Increased pulse rate (tachycardia)

-Increased respiratory rate (tachypnoea)

**-CNS manifestations (Confusion , dizziness ,irritability , agitation ,
reduced level of consciousness)**

-Nausea and/or vomiting



Target Saturations

- Aim for 94-98% in most patients
- 88-92% if at risk of type II respiratory failure (high CO_2, low O_2)
- Adapt oxygen delivery device and flow rate

- Causes oh hypoxemia:

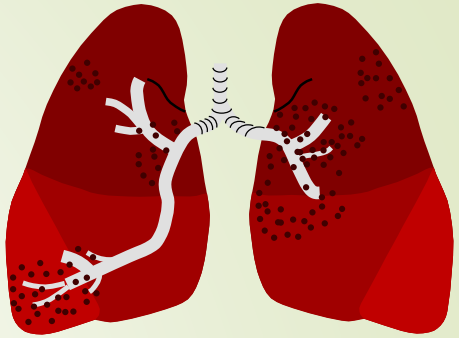
1.decreased FIO2

2. Hypoventilation

3.ventilation perfusion mismatch

4. pulmonary fibrosis

5. Pneumonia, Atelectasis



Types of Respiratory Failure:

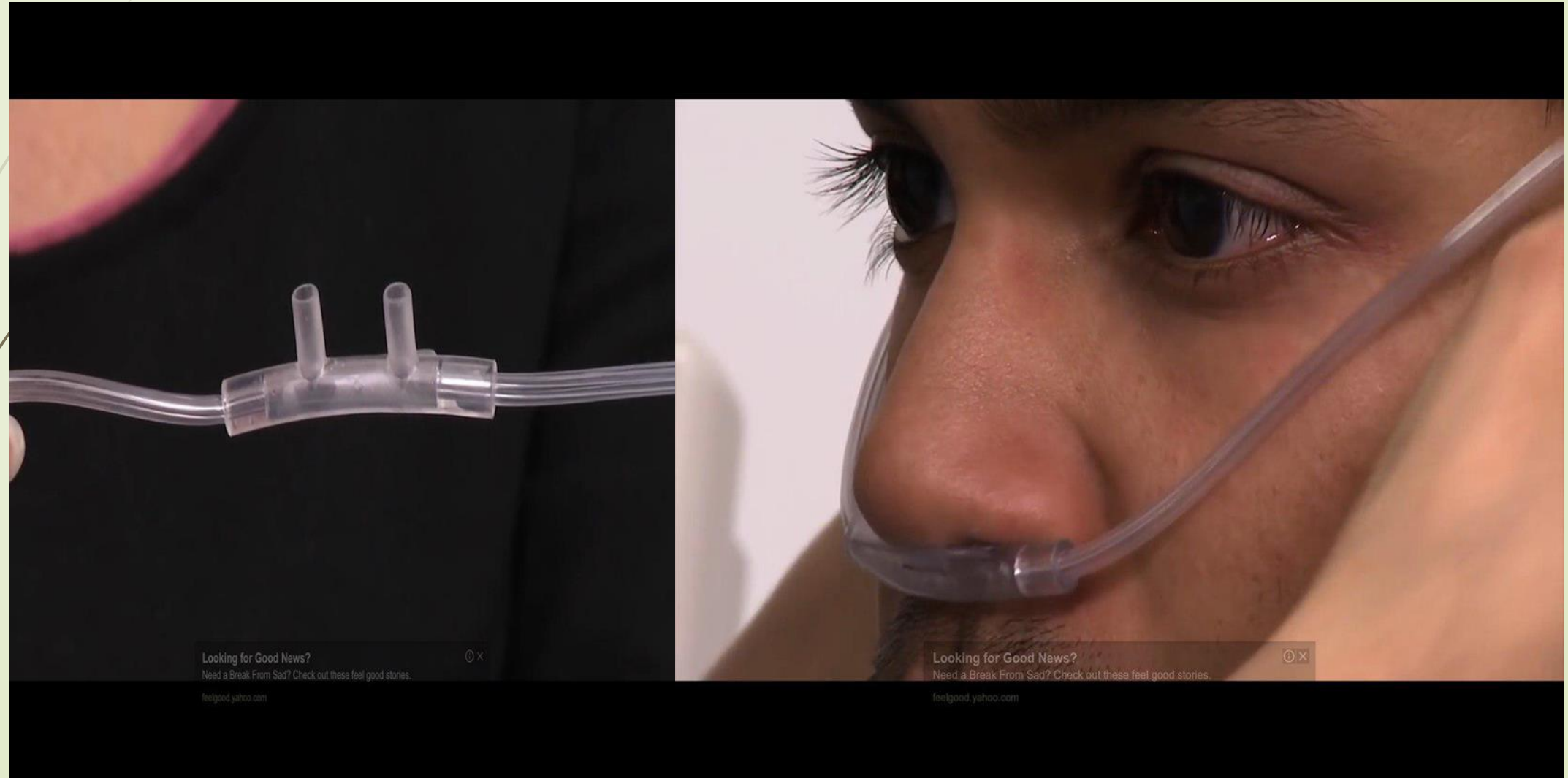
Respiratory failure is a general term that indicates the inability of the heart and lungs to provide adequate tissue oxygenation and/or CO2 removal. There are 2 types of respiratory failure:

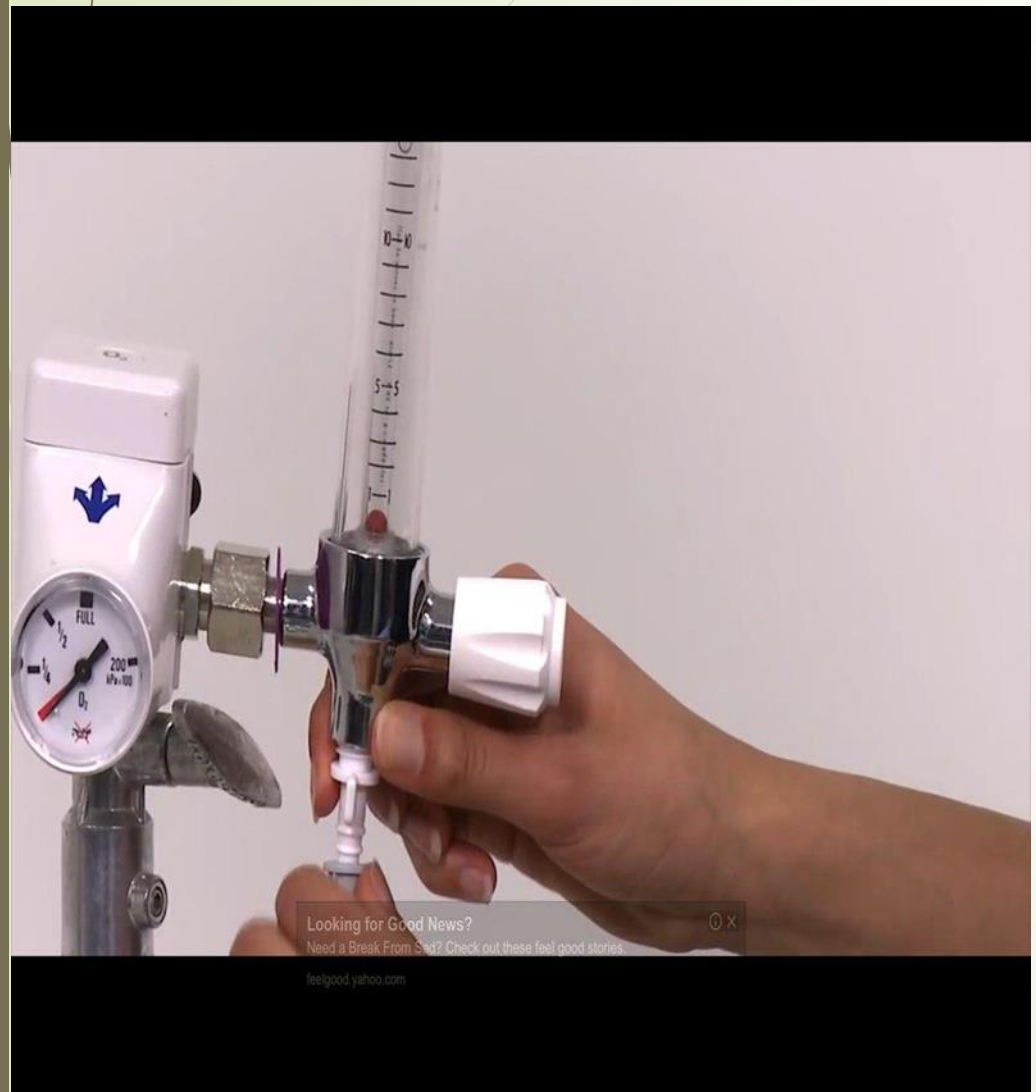
1. Hypoxemic respiratory failure (**lung failure):or type 1 respiratory failure** refer to primary problem with oxygenation (low pao2 less than 60 mmHg with normal or low paco2).
2.hypercapnic respiratory failure (**pump failure): or type 2 respiratory failure:**primary problem with ventilation with ***P*aCO2** more than 60 mmHg

What are the devices I have to improve oxygenation….?

- **Nasal canula.**
- **Simple face mask with or without Venturi .**
- **Nonrebreathing reservoir mask.**
- **High Flow Nasal Canula (HFNC).**
- **Ventilatory support (Invasive or Non invasive with more complicated system**).
- **ECMO (Extra Corporeal Membrane Oxygenator)**

nasal cannula (nasal pronge)

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OXYGEN
AIR

Nasal Cannulae

- 2-6 L/min gives approx 24-50% FiO2
- Indication: Low to moderate oxygen requirement
- Advantages: Easily tolerated, no rebreathing, low cost
- Disadvantages: Easily dislodged and mouth not covered


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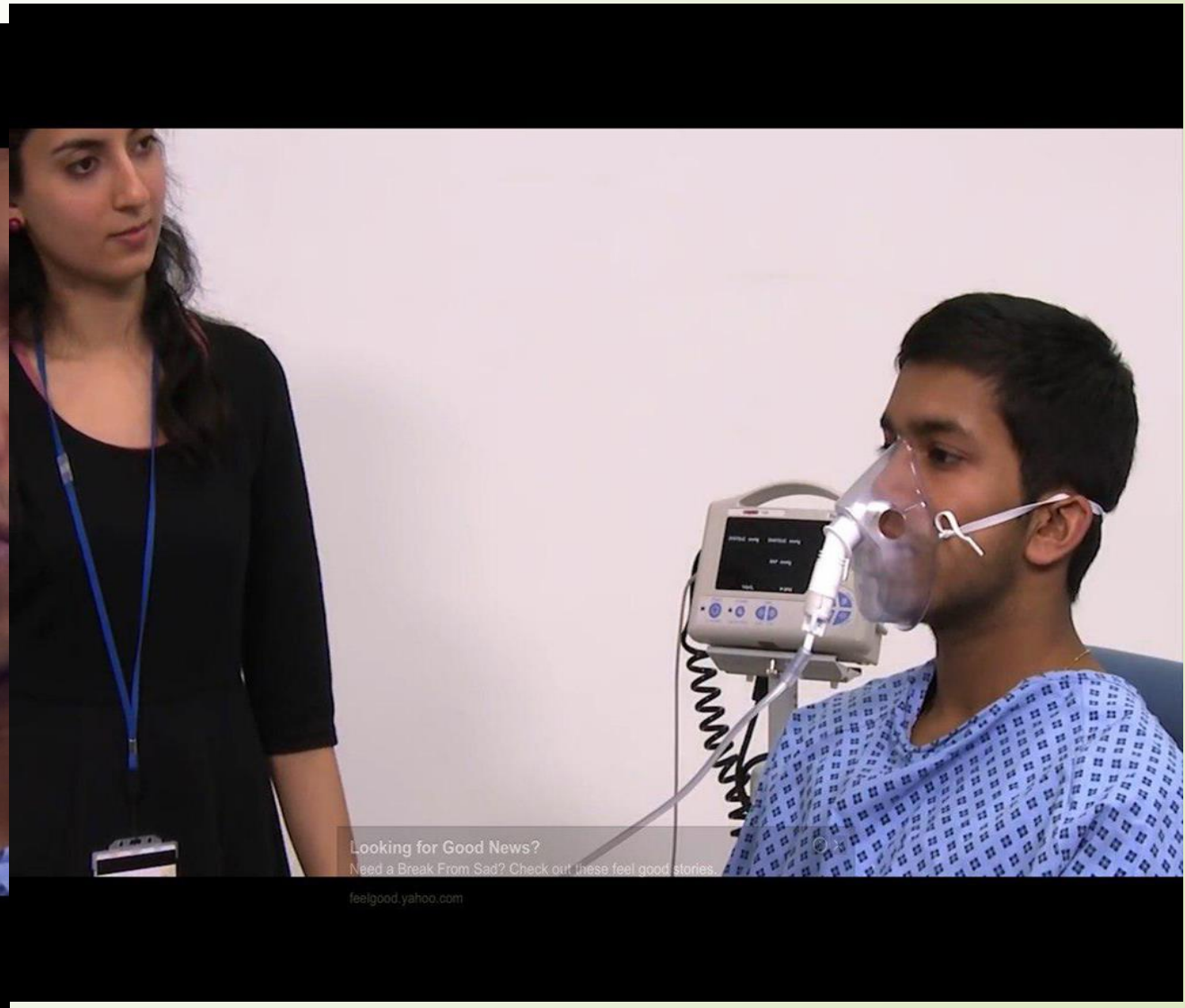
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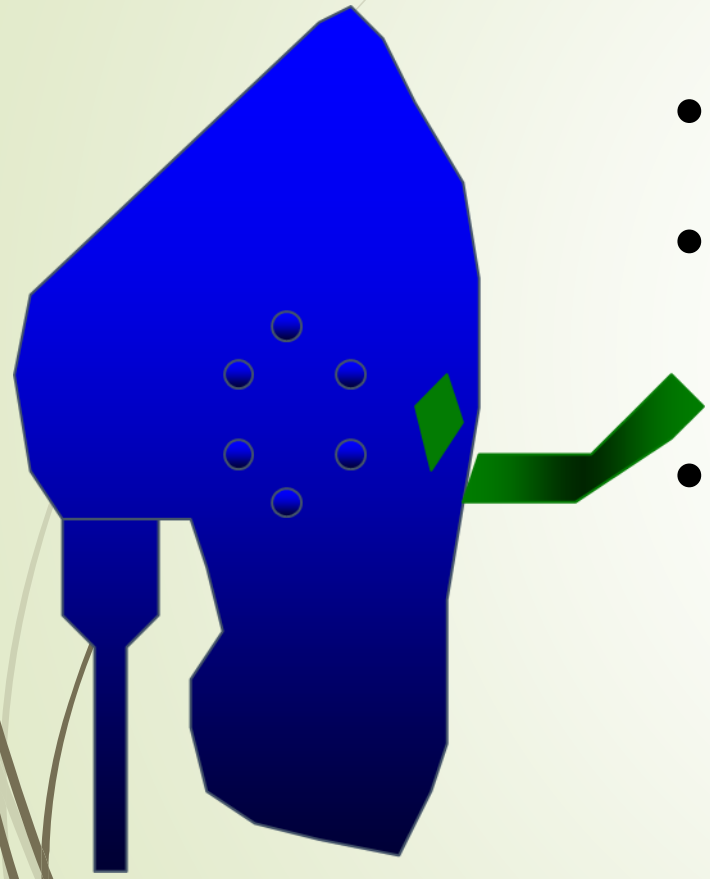
Simple face mask

- Indication: Low to moderate oxygen requirement
- Flow rate: 5-10 L/min
- Oxygen delivery: Variable

Simple face mask



- Open ports for exhaled gas
- Air entrained through ports if O_2 flow through does not meet peak insp flow
- 35-55% O_2 at 5-10 L/min

venturi mask:

The mechanism of action is usually quoted as depending on the Venturi effect (reduction in fluid pressure that results when a fluid flows through a constricted section of a pipe). It delivers 24-60% O2, different **color** jets deliver different **rates**, flow rate varies with color, the correct flow rate to use with each color it is shown on mask, along with the percentage of oxygen delivered. Types: a) BLUE = 2-4L/min = 24% O2 b) WHITE = 4-6L/min = 28% O2 c) YELLOW = 8-10L/min = 35% O2 d) RED = 10-12L/min = 40% O2 e) GREEN = 12-15L/min = 60% O2

Venturi mask

- Indication: Specific moderate oxygen requirement e.g. COPD
- Flow rate: Specific to adaptor
- Oxygen delivery: 24 -60% depending on adaptor

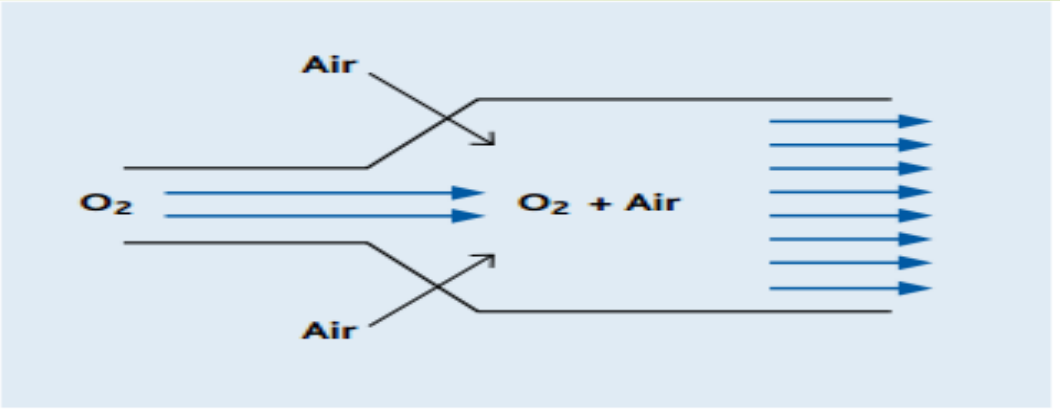
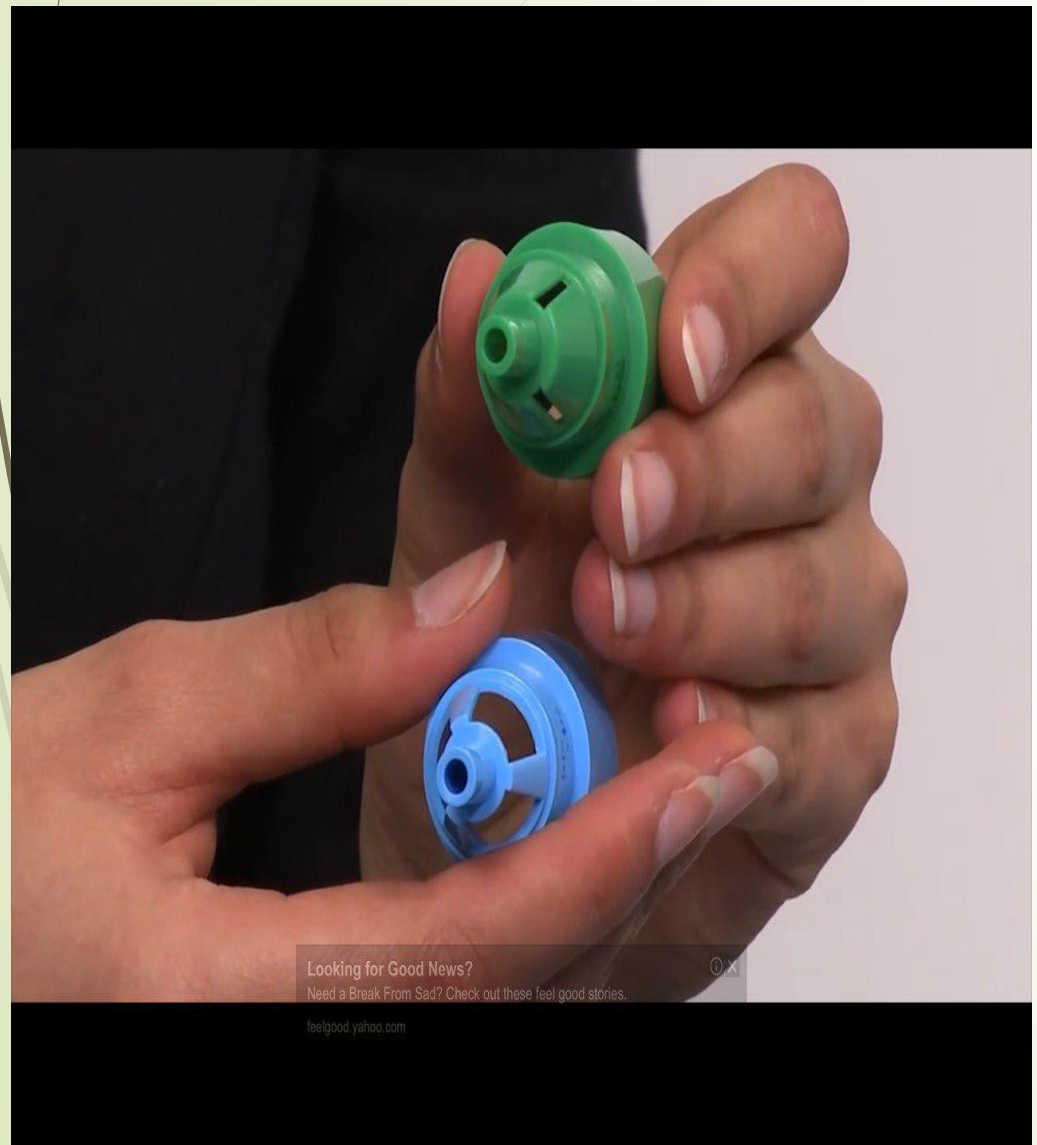


Fig 5 *The Venturi Principle*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28% OXYGEN
35% OXYGEN
40% OXYGEN
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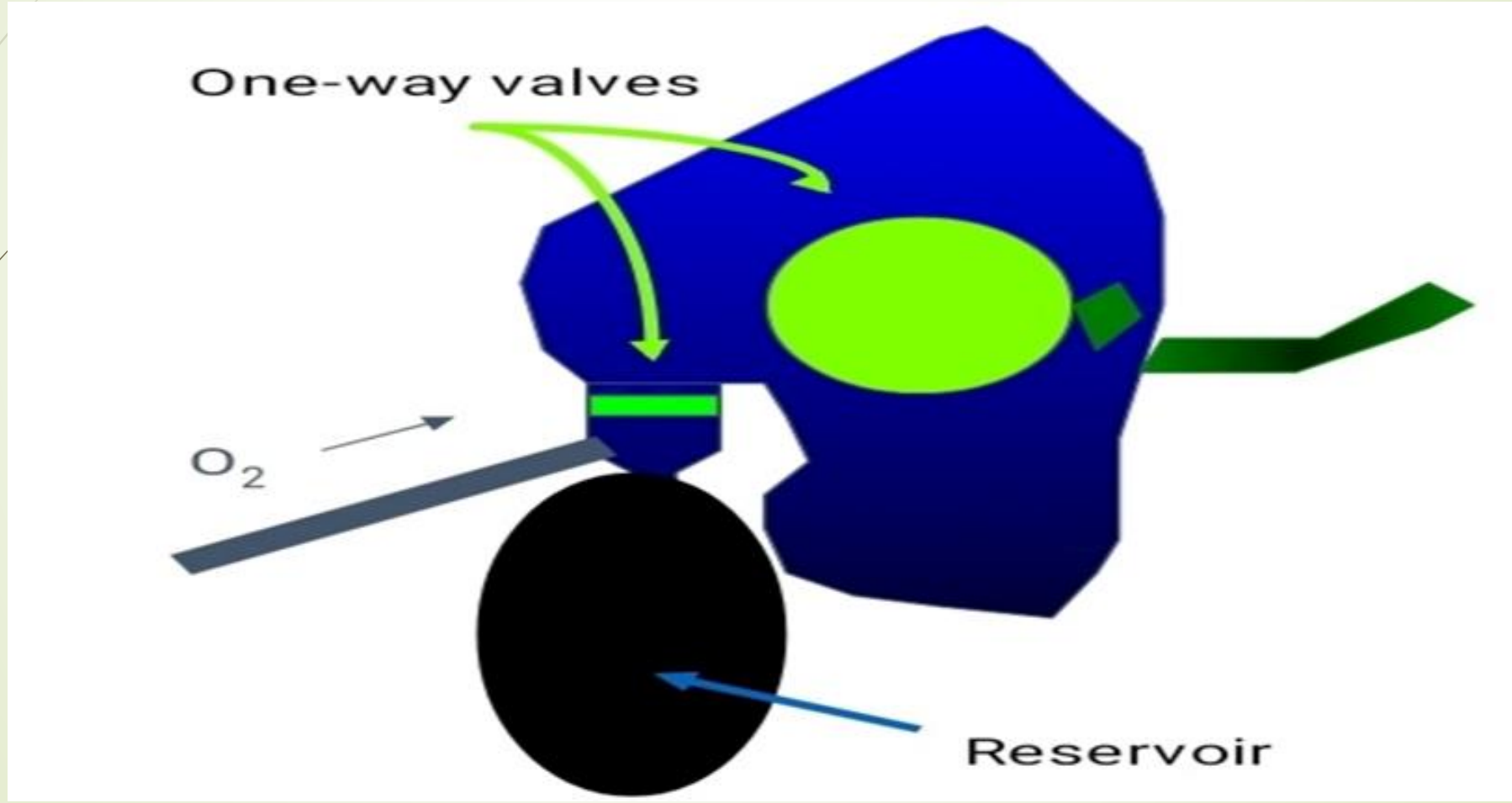
Partial rebreather and Non rebreathing reservoir mask

Non-rebreathing mask

- Valve prevents exhaled gas flow into reservoir bag
- Valve over exhalation ports prevents air entrainment
- Delivers ~100% O_2, if bag does not completely collapse during inhalation


One-way valves
O_2
Reservoir

Reservoir bag mask

- Indication: High oxygen requirement
- Flow rate: 12-15L/min
- Oxygen delivery: 60-80%

High flow oxygen therapy has always been advocated for patients with mild respiratory distress, and in the quest many oxygen delivery systems has been tried. In the setting of infective respiratory diseases with potential for aerosol generation and contamination of the clinical environment, and particularly at this time of the COVID-19 pandemic, the use of high flow nasal cannula is finding special significance.

High flow nasal cannula:

- Available with many names such as Optiflow..
- Preset parameters : flow rate (5- 60 l/m) and Fio2 (21-100 %)
- Heating and humidification is very essential
- Can be used in treating hypoxaemic respiratory failure .
- Monitoring is very essential….

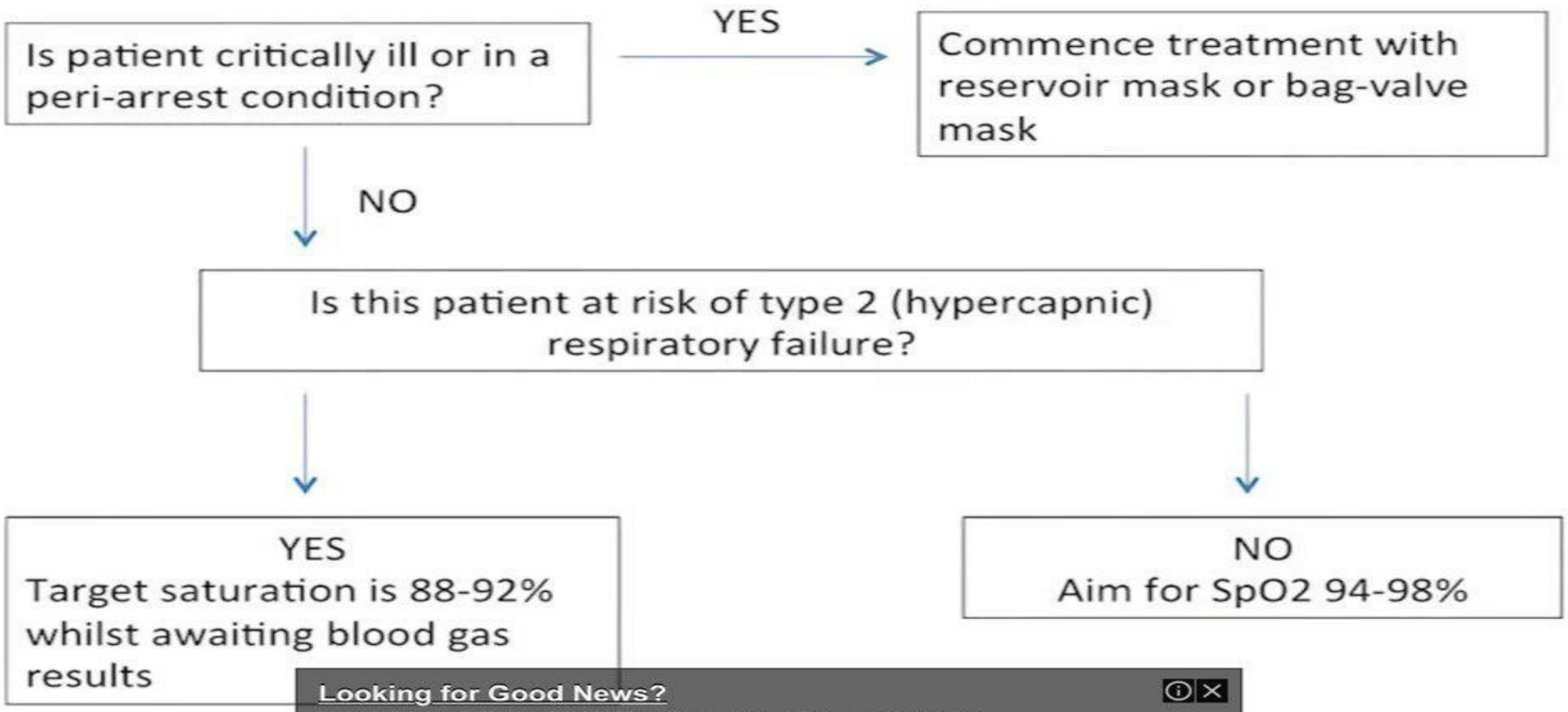
Estimating FiO_2

O_2 Flow rate	FiO_2
Nasal cannula	
1	0.24
2	0.28
3	0.32
4	0.36
5	0.4
6	0.44

O_2 Flow rate	FiO_2
Oxygen mask	
5-6	0.4
6-7	0.5
7-8	0.6

O_2 Flow rate	FiO_2
Mask with reservoir	
6	0.6
7	0.7
8	0.8
9	0.80+
10	0.80+

Oxygen therapy in acute hypoxia



Oxygen toxicity: (hyperoxia)

It is generally agreed that rich oxygen breath for long time increase the risk of lung complication so patient inhaled an FIO2 of more than 60% or Pao2 more than 80 mmhg for more than 48 hours in a newborn or premature infant can lead to pulmonary oxygen toxicity Adults can .atelectasis and bronchopulmonary dysplasia and retinopathy this lead togenerally breathe an FIO2 of up to 50% for extended periods without significant lung damage. But when use FIO2 100% for 7 hours can induce oxygen toxicity. studies suggest normal lung tissues may be more susceptible to oxygen damage than diseased tissue

Thank you
Any question??