General
- basic requirements are:
  1. control of fractional inspired oxygen concentration
  2. prevention of excessive CO2 accumulation
  3. minimal resistance to breathing
  4. efficient and economical use of oxygen
  5. acceptance by patients
    - apart from ventilators and some manual resuscitator bags, device will deliver 100% oxygen unless the oxygen is supplied at a greater rate than the patient's PIFR (PIFR is 25-35L/min at rest and increases to greater than 80L/min in dyspnoea)

Fixed performance systems
- deliver a particular FIO2 independent of patient factors
  1. venturi masks
    - allow delivery of set oxygen concentration depending on mask with oxygen flow set at 6-8L/min depending on the FIO2 chosen and entrains room air to give a resultant flow of 40-60 L/min
    - these masks may not deliver intended FIO2 if severe dyspnoea is present
  2. low flow breathing circuits
    - incorporate a reservoir bag to deliver an FIO2 set by the fresh gas mixture via and ETT or tight face mask or LMA

Variable performance systems
- FIO2 depends on oxygen flow, device factors and patient factors
  1. nasal prongs
    - at flows from 2-6 L/min concentrations of 25-40% are delivered
  2. simple face masks (MC, Hudson mask, Harris, Edinburgh)
    - some CO2 rebreathing occurs especially at low flow therefore flow should be set at 4L/min or greater
    - approximate concentrations of O2 delivered are:
      - 4 L/min (FIO2 0.35)
      - 6 L/min (FIO2 0.50)
      - 8 L/min (FIO2 0.55)
      - 10 L/min (FIO2 0.60)
      - 12 L/min (FIO2 0.65)
      - 15 L/min (FIO2 0.70)
    - large discrepancies between delivered FIO2 and that received by the patient occur with increased PIFR
  3. tracheostomy masks
    - small plastic masks placed over the tracheostomy tube
    - the patients will inspire less oxygen than is delivered due to dilution by room air
  4. T-piece
    - a T-piece is a simple large bore non-rebreathing circuit attached directly to an endotracheal tube or tracheostomy tube with humidified oxygen delivered through one limb of the T-piece and expired gas leaving via the other limb

Positive Pressure Devices:
- CPAP maintains a continuous positive airway pressure throughout the spontaneous breathing cycle with oxygenation improved mainly as a result of increased FRC
- CPAP can be applied via an ETT, facemask or via the nose

Paediatric oxygen therapy:
- specific paediatric delivery devices include oxygen headbox or hood, incubator, oxygen tent
  - Hyperbaric oxygen:
    - delivers 100% oxygen at a pressure above atmospheric in a pressurised chamber
    - hyperbaric oxygen therapy is used to treat decompression sickness, CO poisoning, osteomyelitis, osteoradionecrosis, crush injuries & ischaemic skin grafts
  - complications of oxygen therapy include barotrauma to ears, sinuses & lungs, oxygen toxicity, seizures & changes in visual acuity

CO2 narcosis:
- when high FIO2 is administered to those patients who depend on a hypoxic chemoreceptor drive, severe respiratory depression may occur with loss of consciousness

Neurological effects
- idopathic seizures occur with exposure to oxygen at more than 3 atmospheres
  - this is known as the Paul Bert effect

Pulmonary toxicity:
- pulmonary toxicity following exposure to high FIO2 is recognised problem
  - it involves a progressive decrease in lung compliance associated with the development of haemorrhagic interstitial & intra-alveolar oedema & ultimately fibrosis
  - it is generally agreed that pulmonary oxygen toxicity is dependent on the duration of exposure & the concentration; however, precise safe periods and safe concentrations are unknown

- bronchopulmonary dysplasia which is a paediatric chronic lung disease originating in the neonatal period has also been attributed to pulmonary oxygen toxicity

- retrolental fibroplasia:
  - blindness occurs in premature babies exposed to high oxygen concentrations due to the effect of high concentrations of oxygen on the immature retina

indications for oxygen therapy:
1. cardiac and respiratory arrest
2. respiratory failure:
   - (a) type 1 (hypoxaemia without CO2 retention)
     - asthma, pneumonia, pulmonary oedema, PE
   - (b) type 2 (hypoxaemia with CO2 retention)
     - chronic bronchitis, chest injuries, unconscious drug overdose, neuromuscular disease
3. cardiac failure or myocardial infarction
4. shock
5. increased metabolic demands (eg burns, multiple injuries and severe infections)
6. CO poisoning

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**oxygen dissociation curve**

**oxygen therapy**

**oxygen toxicity**

**oxygen tension**

**devices**

**clinical applications**

**clinical significance of some PaO2 and SaO2 values**
- PaO2 97mmHg (12.9 kPa) and SaO2 97% is a young normal male
- PaO2 80mmHg (10.6 kPa) and SaO2 95% is a young man asleep
- PaO2 70 (9.3 kPa) and SaO2 93% is the lower limit of normal
- PaO2 60mmHg (8.0 kPa) and SaO2 90% is mild respiratory failure & represents the shoulder of the oxygen dissociation curve
- PaO2 40mmHg (5.3kPa) and SaO2 75% is normal venous blood & represents severe respiratory failure when measured arterially
- PaO2 30 mmHg (4kPa) and SaO2 60% is associated with unconsciousness if not acclimitised

**NOTE:** PaO2 150mmHg (20 kPa) is inspired air at sea level