Oxygen Therapy

• Definitions
  – Hypoxemia: an abnormal ____________ of oxygen in the arterial blood
  – Hypoxia: an abnormal condition in which the oxygen available to the body cells is ____________ to meet their metabolic needs

• Goals
  – Treat hypoxemia
  – Decrease the symptoms associated with chronic hypoxemia
  – Decrease the workload hypoxemia imposes on the cardiopulmonary system
Classifications of Hypoxia

- **Hypoxic (anoxic) hypoxia** - refers to pulmonary conditions that produce low ______ levels of \( O_2 \) caused by inadequate \( PaO_2 \)
  - Low \( PIO_2 \) due to \( FIO_2 < 0.21 \) or reduced barometric pressure. Possible cause:
    - altitude
    - suffocation
    - few medical conditions fit here, but treatment would be to increase \( PIO_2 \) and/or \( FIO_2 \) with supplemental \( O_2 \)

Classifications of Hypoxia

- **Hypoxic hypoxia** - Impaired ____________. Possible causes:
  - narcotic drug overdose
  - neuromuscular weakness (Guillain-Barré)
  - obstruction (COPD, asthma)
  - restriction (pleural effusion, pneumothorax, scoliosis)
  - neurological (cranial/spinal injury)
- Treatment: \( O_2 \) therapy can help in the short-term; reverse narcotics, ventilate if necessary for neuromuscular weakness, surgical interventions

Classifications of Hypoxia

- **Hypoxic hypoxia** - Impaired ____________. Possible causes:
  - pulmonary fibrosis
  - pulmonary edema
  - alveolar injury
  - diffusion defects
- Treatment: \( O_2 \) therapy can help in the short-term, but the primary disorder must be treated - in some instances, chronic hypoxia may result and require long-term \( O_2 \) therapy
Classifications of Hypoxia

- Hypoxic hypoxia
  - Venous to arterial shunts. Possible causes:
    - atelectasis
    - ARDS
  - Treatment: O₂ therapy may have little if any effect
    - primary problem must be diagnosed and treated

Classifications of Hypoxia

- Circulatory (stagnant) hypoxia - refers to inadequate
  - Decreased cardiac output. Possible causes:
    - myocardial infarction
    - cardiac tamponade
    - peripheral vascular disease
    - hypovolemia (actual & relative)
    - heart valve disease
  - Treatment: restoration of fluid volume and cardiac function; O₂ therapy is a short-term solution to increase PaO₂

Classifications of Hypoxia

- Hemic (anemic) hypoxia - refers to conditions in which the content is decreased or the presence of hemoglobinopathies
  - Decreased hemoglobin. Possible causes:
    - anemia
    - hemorrhage
    - hemolysis
    - sickling
  - Correct Hgb deficiency, stop hemorrhage, determine cause of hemolysis and/or sickling - treat appropriately - O₂ is short term fix
Classifications of Hypoxia

- Hemic hypoxia
  - Hemoglobinopathies. Possible causes:
    - carboxyhemoglobinemia - CO poisoning
    - methemoglobinemia - genetic defect; nitrite poisoning; treatment with nitric oxide; inhalation or ingestion of toxins
    - sulfhemoglobinemia - sulfonamides; acetaminophen
  - Treatment: CO poisoning - 100% O₂, hyperbaric O₂

- Demand hypoxia - refers to an _______________
tissue consumption of O₂
  - Hypermetabolic states. Possible causes:
    - trauma
    - surgery
    - significant fever
    - sepsis
    - malignant hyperthermia
    - hyperthyroidism
    - pheochromocytoma

- Histotoxic hypoxia - refers to the tissue's inability to _______________
  - Enzymatic. Possible causes:
    - cyanide poisoning
  - Chemical. Possible causes:
    - fluid & electrolyte imbalance
  - Bacterial. Possible causes:
    - gaseous gangrene
**Oxygen Therapy**

- **Assessing the need for O\textsubscript{2} therapy**
  - Use laboratory measures to document hypoxemia
    - in adults, children and infants older than 28 days, PaO\textsubscript{2} <____ mmHg or SaO\textsubscript{2} <____% in patients breathing room air
  - Base need on patient’s clinical situation
    - PaO\textsubscript{2} or SaO\textsubscript{2} below desirable range for specific clinical situation
      - post-op, CO poisoning, cyanide poisoning, shock, trauma, acute MI

**Symptoms of Hypoxia**

- **Classic symptoms**
  - _____________ - first clinical sign of hypoxia
  - _____________ - may be present at any stage
    - bluish/gray discoloration of the skin due to increased amount of reduced Hgb (____ gm% of reduced Hgb = approximate PaO\textsubscript{2} of 45) will produce noticeable cyanosis
- **Mild hypoxia**
  - _____________ - subjective
  - PaO\textsubscript{2} may be normal or near normal
Symptoms of Hypoxia

• Moderate hypoxia
  – Paleness
  – Tachycardia
  – Tachypnea/hyperventilation
  – Dyspnea
  – Mild hypertension; peripheral vasoconstriction
  – Restlessness/anxiety
  – Disorientation
  – Headaches
  – Lassitude
  – Decreased \( \text{SpO}_2/\text{PaO}_2 \)

Symptoms of Hypoxia

• Extreme hypoxia
  – All of the above and
  – Cyanosis
  – Euphoria
  – Depression
  – Drowsiness
  – Confusion/disorientation
  – Decreased respirations, progressing to apnea
  – Coma
  – Tachycardia to bradycardia to dysrhythmias

Oxygen Therapy

• Contraindications
  – No specific contraindications to \( O_2 \) therapy exist when indications are judged to be present.
Oxygen Therapy

Precautions, Complications and Hazards
- Depression of _______________
  - when breathing moderate to high O₂ concentrations, COPD patients with chronic hypercapnia tend to ventilate less
  - decreases in ventilation of up to 20% have been noted with a corresponding rise in PaCO₂ of 20-23 mmHg
  - most likely due to suppression of the hypoxic drive of these patients
  - should not prevent O₂ therapy to correct hypoxemia

- Absorption _______________
  - risk is greatest at FIO₂s >0.50
  - breathing high concentrations of O₂ can deplete body nitrogen levels
  - if the alveolar region becomes obstructed, O₂ rapidly diffuses into the blood
  - total gas pressure in the alveoli progressively falls until the alveoli collapse
  - causes a physiological shunt and worsens blood oxygenation

- _______________ of prematurity (retrolental fibroplasia)
  - an abnormal eye condition that occurs in some premature or low birth weight infants who receive supplemental O₂
  - excessive blood O₂ levels cause retinal vasoconstriction, leading to necrosis of the blood vessels
  - in response, new vessels are formed and hemorrhage from these vessels causes scarring behind the retina
Oxygen Therapy

• Precautions, Complications and Hazards
  • Retinopathy of prematurity (retrolental fibroplasia)
    • scarring leads to retinal detachment and
      • ROP mostly affects neonates up to 1 month of age, by which time the retinal arteries mature
      • other factors associated with ROP are: hypercapnia, hypocapnia, intraventricular hemorrhage, infection, lactic acidosis, anemia, hypocalcemia and hypothermia

• Precautions, Complications and Hazards
  • since premature infants often need supplemental O₂, the risk of ROP poses a serious management problem
  • the American Academy of Pediatrics recommends keeping an infant’s PaO₂ below 80 mmHg

• Pulmonary oxygen
  • see Wilkins, p 870-871
Oxygen Therapy

- Careful consideration of all the evidence along with sound clinical principles leads to three generalizations concerning $O_2$ therapy and $O_2$ toxicity – (from Shapiro, B., *Clinical Application of Respiratory Therapy*)

1. Inspired $O_2$ below 50% at one atmosphere rarely produces oxygen toxicity – even with prolonged exposures. Under normobaric conditions, there should be no hesitation in providing appropriate low concentration $O_2$ (<50%) for supportive therapy of the cardiopulmonary system. Even in conjunction with appropriately administered intermittent positive pressure ventilation, low concentration $O_2$ does not produce pulmonary oxygen toxicity.

2. Pulmonary oxygen toxicity in man has not been demonstrated from breathing 100% $O_2$ for 24 hours or less. Therefore, oxygen toxicity should not be a consideration intraoperatively, in resuscitation or in transport situations. *Pure $O_2$ has no contraindication for brief periods in emergency situations!* However, absorption atelectasis must be kept in mind as a potential problem, since this can occur within 30 minutes. The lowest possible $FIO_2$ should be administered as early as feasible in the clinical course.
Oxygen Therapy

3. Patients with pre-existing pulmonary disease are no more susceptible to oxygen toxicity than patients with pre-existing normal lungs. However, pre-existing pulmonary disease is more susceptible to absorption atelectasis. Our clinical concerns of acute oxygen toxicity must not differ between the pre-existing diseased and non-diseased lung. The general principle of minimal oxygen administration consistent with adequate cardiopulmonary homeostasis always holds true.

Oxygen Therapy

“... an overreaction to the dangers associated with oxygen supplementation has led to an extremely hazardous circumstance – poorly informed clinicians withholding essential oxygen therapy from hypoxic or hypoxemic patients. To allow a patient to be exposed to dangerous levels of hypoxia for fear of developing oxygen toxicity is intolerable! It is essential to remember that hypoxia is common and that the damage it causes is rapid and severe. On the other hand, pulmonary injury from oxygen is uncommon and its development is relatively slow.”

- Barry Shapiro, MD

Oxygen Therapy

- Selecting a delivery device
  - Remember the 3 P's
    . __________
    . __________
    . __________
Oxygen Therapy

- Selecting a delivery device
  - Purpose
    - The primary purpose or goal of O₂ therapy is to _______ sufficiently to correct arterial hypoxemia
    - Other goals stem from the first

Oxygen Therapy

- Selecting a delivery device
  - Patient – key factors are
    - Severity & cause of hypoxemia
    - Patient age
    - Level of consciousness (LOC)
    - Presence/absence of tracheal airway
    - Stability of minute volume

Oxygen Therapy

- Selecting a delivery device
  - Patient – key factors are
    - Severity & cause of hypoxemia
      - The critically ill patient with severe hypoxemia will probably require an FIO₂ of at least _______
      - Changes in the device or FIO₂ will then be based on further assessment (ABGs) with the goal of keeping the PaO₂ >____ mmHg and the SaO₂ >90%
      - Remember, FIO₂ should be kept to the minimum capable of achieving these goals
Oxygen Therapy

- Selecting a delivery device
  - Patient – key factors are
    - Patient age
      - Obviously, the ____________ of the patient is important
    - What will the patient wear?
    - For children and infants, will you require and enclosure?
    - For the elderly, will the patient wear a mask, etc?

- Selecting a delivery device
  - Patient – key factors are
    - Level of consciousness (LOC)
      - Confused patients may not tolerate ______
      - Exercise caution when using masks on comatose patients
      - Patients who are alert and oriented may prefer ____________

- Selecting a delivery device
  - Patient – key factors are
    - Presence/absence of tracheal airway
      - Presence of a tracheal will probably mean using ________________ aerosol
      - ETT – Brigg’s adapter (t-tube)
      - Tracheostomy tube – either Brigg’s adapter or tracheostomy mask
Oxygen Therapy

• Selecting a delivery device
  – Patient – key factors are
    • Stability of minute volume
      – If patient's minute volume is not stable, ______-flow devices will not be the best choice
      – Use ______-flow device or reservoir mask

Performance

• Look at stability of FIO\textsubscript{2} under changing demands
• Generally, the more critically ill the patient, the __________ the need for stable, high FIO\textsubscript{2}s
• Less acutely ill patients generally will require lower, less exact FIO\textsubscript{2}s

Protocol-based oxygen therapy

– See Wilkins, p. 891