Hypoxia and Oxygen Therapy

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Introduction
The hypoxic patient is a common issue that many junior doctors will face when on the wards. Hypoxia can significantly contribute to a patient’s morbidity and mortality and must be managed early. It is therefore important that the junior doctor has a structured approach to the hypoxic patient and sound knowledge of oxygen therapies available for their patients in the hospital setting.

The definition of hypoxaemia: PaO2 less than 80mmHg. Hypoxia and hypoxaemia are often used interchangeably.

The five major cause of hypoxia are split into two major categories base on the alveolar-arterial gradient (AA)

- Normal AA gradient (<15mmHg)
  - Low FiO2
  - Hypoventilation e.g. CNS depression such as in opiate use, sleep apnoea
- Widened AA gradient (>15mmHg)
  - VQ mismatch (ventilation – perfusion - pneumonia, asthma
  - Shunt; the extreme version of VQ mismatch
  - Diffusion Limitation; e.g. in pulmonary fibrosis

Case 1 - You are a junior doctor on night shift. You are asked by the nursing staff to review an 86 year old female patient who is day 2 post total hip replacement. The nurse is asking you to review the patient in regards to her low O2 saturations of 92% on room air.

1. Initial questions over the phone?
   - What are the vital signs?
     - Any evidence of haemodynamic instability?
     - Are they alert? What is the GCS?
     - If unstable or altered GCS you may ask the nurse to apply oxygen

2. Outline your assessment and approach
   - Briefly look at the notes including past investigations for the patient such a previous ABG or history of COPD, opiate use
   - You should perform a detailed clinical examination including taking note of signs of respiratory distress such as positioning, increased work of breathing and GCS followed by a detailed cardio-respiratory examination
   - Look for signs of fluid overload, pneumonia, collapse, consolidation, pneumothorax etc.
3. Limitations of Pulse Oximetry
   - Poor perfusion to extremities may decrease accuracy - ear lobe or forehead may give more accurate reading
   - Carbon monoxide poisoning can give a false normal reading

4. Investigations in the hypoxic patient
   - ABG; particularly to establish pH and CO2 levels
   - ECG
   - CXR
   - Bloods; FBC, EUC and troponin if clinically indicated

5. Types of Oxygen Delivery Methods
   - Nasal prong; 0.5 to 4 litres per minute (more than 4 litres leads to discomfort for the patient and unreliable delivery)
   - Hudson Mask; flow should be more than 4 litres to avoid rebreathing CO2
   - Venturi Mask; allows for the delivery of a set fraction of inspired oxygen
   - Non-rebreather; with a non-rebreather reservoir bags which allows the delivery of large amounts of oxygen without rebreathing CO2

6. Titration of oxygen is done based on pulse oximetry
   - 92-96% for non-CO2 retainers
   - 88-92% for CO2 retainers
   - ABG can be used to titrate in respiratory failure, however in most cases pulse oximetry will be sufficient

7. Hyperoxia
   - The junior doctor should consider oxygen to be a form of therapy like any other medications, with risks and benefits.
   - Overuse of oxygen in certain clinical situations can be harmful, such as:
     - AMI or acute stroke; high flow oxygen may cause hyperoxia which can lead to the production of oxygen free radicals which can worsen areas of infarction
     - Chronic CO2 retainers; can decreased their respiratory drive
     - Respiratory Illness; can paradoxically worsen V/Q mismatch due to its effect on the pulmonary vasculature

8. Take home messages
   - Always target your clinical examination and investigations to establish the cause. Remember there may be more than one cause
   - Target your therapy according to that cause
   - Use oxygen therapy judiciously, to treat hypoxia and not respiratory distress - it can be harmful
   - Be mindful that increasing oxygen requirements may be a sign of significant decline and peri-arrest and the general ward may not be the safest place for such a patient