/ABG

This page contains some **extra** learning resources, including calculating the **anion gap**, and a brief discussion on **oxygen delivery devices**.

Extras

Anion gap[1]

Metabolic acidosis can occur as a result of either:

- Increased H^+ production or ingestion
- GI or renal HCO_3^- loss

To **determine** which of the above is causing the disruption, a **calculation** called the 'anion gap' may be used.

The anion gap is used to **estimate** the presence of **unmeasured anions.**

In the blood, the total number of **cations** (positive ions) should be equal to the total number of **anions** (negative ions), so that the **overall electrical charge** is **neutral.**

However, ABG analysis **does not** measure all types of ions.

Therefore, the anion gap **estimates** the concentration of ions that are **not measured,** such as **albumin, lactate, phosphate,** and **sulphate.**

$$\textbf{Anion Gap} = [Na^+] – ([Cl^-] + [HCO_3^-])$$

The normal anion gap varies with different assays, but is typically 4 - 12 mmol/L.

A metabolic acidosis can therefore be referred to as having a:

- **High anion gap**
  - Indicates extra cations unaccounted for, such as from increased H^+ production or ingestion, HCO_3^- concentrations decrease by acting as a buffer. The HCO_3^- is consumed by the H^+ - to produce CO_2 and H_2O - resulting in a high anion gap.
- **Normal anion gap**
  - Where a decrease in HCO_3^- is the primary pathology. The HCO_3^- lost is replaced by a chloride anion retained by the kidneys, therefore there is a subsequent increase in Cl^- concentration - therefore

also known as hyperchloremic acidosis - and thus there is a normal anion gap.

- **Low anion gap**
    - A low anion gap is frequently caused by hypoalbuminemia. Albumin is negatively charged and its loss results in the retention of other negatively charged ions such as Cl^- and HCO_3^-, resulting in a subsequent decrease in the gap.

NOTE: The anion gap can be more precisely calculated by including potassium in the equation, however because potassium concentrations are generally very low, it usually has little effect on the calculated gap. Therefore, in daily practice, its omission is widely accepted. In the case of albumin disruption, the anion gap should also be corrected.

Oxygen delivery devices[2]

Nasal Cannula

- Uncontrolled Oxygen Delivery System
- Flow Rate: capable of delivering 2-6l/min (litres per minute)
- Oxygen %: Approx. 24-36%
- Suitability: All patients who require low flow oxygen therapy

Advantages: Relatively comfortable; Not claustrophobic; Patient can eat, drink & talk.

Disadvantages: Oxygen % is uncontrolled; Needs clear nasal airway; Can't humidify; Dries mucous membranes; Headaches.

Simple Face Mask

- Uncontrolled Oxygen Delivery System
- Flow Rate: Min. 5l/min -10l/min
- Oxygen %: Approx. 35-60%
- Suitability: General purpose

Advantages: Can humidify; Can give nebulisers.

Disadvantages: Re-breathing of CO_2 at flows less than 5l/min; Oxygen % is uncontrolled; Claustrophobic; Interferes with eating, drinking and talking.

Fixed Concentration Mask (Venturi System)

- Controlled Oxygen Delivery System
- Flow Rate and Oxygen %: Indicated on each Venturi piece (different colours for different oxygen %; see figure 2 and image reference 6/7)
- Suitability: Patients requiring delivery of controlled oxygen/Patients at risk from hypercapnic respiratory failure e.g. COPD

Benefits: Oxygen % is controlled - not dependent on respiratory pattern; Venturi can be changed as patient improves.

Disadvantages: Noisy. Claustrophobic. Can't be humidified.

Non-Rebreathe Mask & Bag (High Concentration Mask)

- Uncontrolled Oxygen Delivery System
- Flow Rate: Min. 10l/min – 15l/min
- Oxygen %: Approx. 60-80%
- Suitability: System of choice for acutely unwell patients

Benefits: Delivers high oxygen concentrations.

Disadvantages: Oxygen % is uncontrolled; Short term use only; Can't humidify; Claustrophobic

Non-invasive ventilation (CPAP/BiPAP):

- CPAP (continuous positive airways pressure)
    - High pressure air/oxygen with a tight-fitting mask
    - Positive pressure all the time to help keep airways open
    - Used in acute pulmonary oedema and sleep apnoea
- BiPAP (bilevel positive airways pressure)
    - High positive pressure on inspiration and lower positive pressure on expiration (Positive end-expiratory pressure)
    - Used in exacerbations of COPD and ARDS

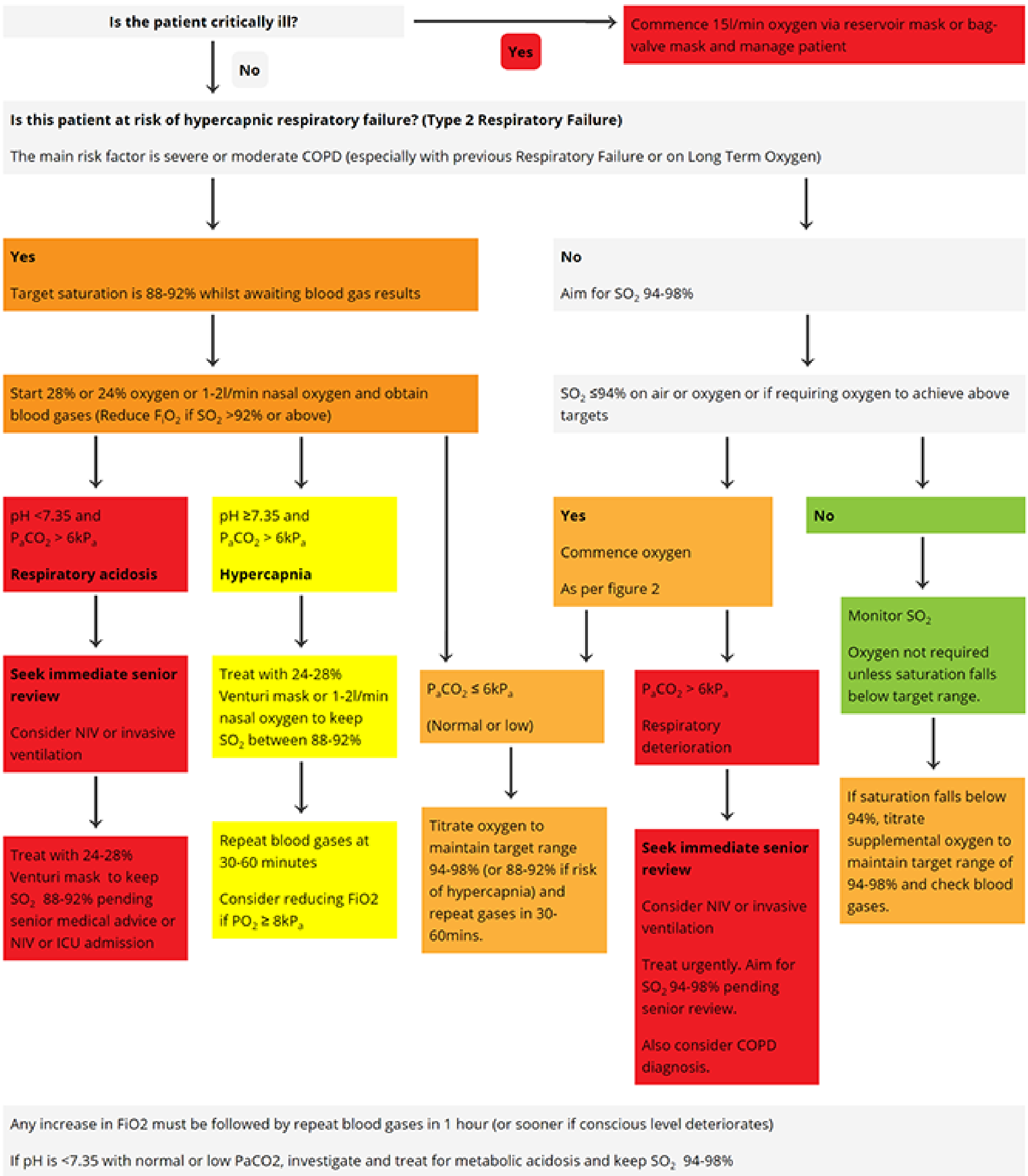
Invasive ventilation

- Fully controlled oxygen delivery up to 100%

- A ventilation bag or machine is attached to an artificial airway to ventilate lungs.
- Used in intensive care and theatre

British Thoracic Society Guideline for oxygen use in adults in healthcare and emergency settings[10]

Figure 1: Oxygen prescription guidance for acutely hypoxaemic patients in hospital.[11]



Choose the most suitable delivery system and flow rate

Titrate oxygen **up** or **down** to maintain the target oxygen saturation.

The table below shows available options for stepping dosage up or down.

The chart does NOT imply any equivalence of dose between Venturi masks and nasal cannulae.

Allow at least 5 minutes at each dose before adjusting further upwards or downwards (except with major and sudden fall in saturation).

Once your patient has adequate and stable saturation on minimal oxygen dose, consider discontinuation of oxygen therapy.

Blue	Venturi **24%** **2-3**l/min*	Nasal cannulae **1**l/min
White	Venturi **28%** **4-6**l/min*	Nasal cannulae **2**l/min
Yellow	Venturi **35%** **8-12**l/min*	Nasal cannulae **4**l/min
Red	Venturi **40%** **10-15**l/min*	Nasal cannulae or simple face mask at **5-6**l/min
Green	Venturi **60%** **12-15**l/min*	or simple face mask **7-10**l/min

Reservoir mask at **15**l/min

(If reservoir mask required, seek senior medical input immediately)

Signs of Respiratory Deterioration

- ↑ Resp Rate (especially if >30)
- ↓ SO_2
- ↑ oxygen dose needed to keep SO_2 in target range
- ↑ NEWS/Trigger score

Signs of CO_2 Retention

- Drowsiness
- Headache
- Flushed face
- Flapping Tremor

Seek medical advice if a patient appears to need increasing oxygen therapy or if there is a rising NEWS/trigger score.

All patient must have ABG within 1 hour of requiring increased oxygen dose.

* For Venturi masks, the higher flow rate is required if the respiratory rate is >30

Patients in a peri-arrest situation and critically ill patients should be given oxygen therapy at 15l/min via reservoir mask or vag-valve mask whilst immediate medical help is arriving.

(Except for patients with COPD with known oxygen sensitivity recorded in patient's case notes and drug chart; keep saturation at 88-92% for this sub-group of patients)

Figure 2: Flow chart for oxygen administration on general wards in hospitals.[12]

References

1. Kaufman, David A. *Interpretation of Arterial Blood Gases (ABGs).* American Thoracic Society. http://www.thoracic.org/professionals/clinical-resources/critical-care/clinical-education/abgs.php

2. Beckett, D. *HYMS NLaG Oxygen Workbook.* Northern Lincolnshire and Goole NHS Foundation Trust.

3. Nasal prongs; 4. Simple face mask; 5. Nebulizer mask ; 8. Non rebreather mask; 9. BiPAP using a ventilator.
By James Heilman, MD (Own work) [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Commons

6. Venturi mask; 7. Venturi entrainers.
Charles Gomersall, February, 2015 (https://www.aic.cuhk.edu.hk/web8/venturi_mask.htm)

10. O'Driscoll BR, Howard LS, Earis J on behalf of the BTS Emergency Oxygen Guideline Development Group, *et al*. British Thoracic Society Guideline for oxygen use in adults in healthcare and emergency settings. *BMJ Open Respiratory Research* 2017;4:e000170. doi: 10.1136/bmjresp-2016-000170

11. Oxygen prescription guidance for acutely hypoxaemic patients in hospital; 12. Flow chart for oxygen administration on general wards in hospitals.
Adapted from: O'Driscoll BR, Howard LS, Earis J on behalf of the BTS Emergency Oxygen Guideline Development Group, *et al.* British Thoracic Society Guideline for oxygen use in adults in healthcare and emergency settings. *BMJ Open Respiratory Research* 2017;4:e000170. doi: 10.1136/bmjresp-2016-000170 under: CC BY-NC 4.0