Arterial Blood Gases

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Arterial Blood Gases

Introduction:
- Arterial blood gas analysis is an essential part of diagnosing and managing a patient’s oxygenation status and acid–base balance

- However, it is important to remember that results are not always definitive
  - Should not replace clinical judgement
  - A normal result does not exclude an acid–base disorder
  - Additional information is often needed to make a conclusive diagnosis
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Normal Values for Arterial Blood Gases
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- pH

- Measurement of *acidity or alkalinity*, based on the hydrogen (H\(^+\)) ions present

- The normal range is 7.35 to 7.45
PaO2

The *partial pressure of oxygen* that is dissolved in arterial blood

- The normal range is 10.5 – 13.5 kPa (70 – 100 mmHg)
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- SaO2
- The *arterial oxygen saturation*
- The normal range is >94%
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- PaCO2

  The amount of *carbon dioxide* dissolved in arterial blood.

  The normal range is 4.7 – 6.0 kPa (35 – 45 mmHg)
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- HCO₃

- The calculated value of the amount of *bicarbonate* in the bloodstream.

- The normal range is 22 – 26 mEq/L
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- B.E.

- The base excess indicates the amount of excess or insufficient level of \textit{bicarbonate} in the system.

- The normal range is $-2$ to $+2$ ml litre

- (A negative base excess indicates a base deficit in the blood.)
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Steps to Arterial Blood Gas Interpretation

- The arterial blood gas is used to evaluate both acid–base balance and oxygenation, each representing separate conditions. Acid–base evaluation requires a focus on three of the reported components: pH, PaCO2 and HCO3.
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This process involves three steps

- **Step One**
  - Assess the pH to determine if the blood is within normal range, alkalotic or acidotic. If it is above 7.45, the blood is alkalotic. If it is below 7.35, the blood is acidotic.
Step Two

If the blood is alkalotic or acidotic, we now need to determine if it is caused primarily by a respiratory or metabolic problem.
To do this, assess the PaCO2 level.

- Remember that with a respiratory problem, as the pH decreases <7.35, the PaCO2 should rise. If the pH rises >7.45, the PaCO2 should fall.

- Compare the pH and the PaCO2 values. If pH and PaCO2 are indeed moving in opposite directions, then the problem is primarily respiratory in nature.
Finally, assess the HCO3 value. Recall that with a metabolic problem, normally as the pH increases, the HCO3 should also increase. Likewise, as the pH decreases, so should the HCO3.
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- Compare the two values. If they are moving in the same direction, then the problem is primarily metabolic in nature.
The following chart summarizes the relationships between pH, PaCO2 and HCO3:

<table>
<thead>
<tr>
<th>Condition</th>
<th>pH</th>
<th>PaCO2</th>
<th>HCO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Acidosis</td>
<td>↓</td>
<td>↑</td>
<td>Normal or ↑</td>
</tr>
<tr>
<td>Respiratory Alkalosis</td>
<td>↑</td>
<td>↓</td>
<td>Normal or ↓</td>
</tr>
<tr>
<td>Metabolic Acidosis</td>
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</tbody>
</table>
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Acid Base Disorders
Respiratory acidosis is defined as a pH less than 7.35 with a PaCO2 greater than 45 mm Hg.

Acidosis is caused by an accumulation of CO2 which combines with water in the body to produce carbonic acid, thus, lowering the pH of the blood.
Any condition that results in hypoventilation can cause respiratory acidosis. These conditions include:

- CNS depression related to head injury
- CNS depression related to medications such as narcotics, sedatives, or anaesthesia
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- Impaired respiratory muscle function related to spinal cord injury
- Neuromuscular diseases, or neuromuscular blocking drugs
- Pulmonary disorders such as pneumonia, pneumothorax, pulmonary oedema, bronchial obstruction
Massive pulmonary embolus

Hypoventilation due to pain, chest wall injury/deformity, or abdominal distension
Respiratory Alkalosis is defined as a pH greater than 7.45 with a PaCO2 less than 35 mm Hg
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- Any condition that causes hyperventilation can result in respiratory alkalosis. These conditions include:

  - Psychological responses, such as anxiety or fear
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- Pain

- Increased metabolic demands, such as fever, sepsis, pregnancy, or thyrotoxicosis

- Medications, such as respiratory stimulants

- Central nervous system lesions
Metabolic Acidosis is defined as a bicarbonate level of less than 22 mEq/L with a pH of less than 7.35

Metabolic acidosis is caused by either a deficit of base in the bloodstream or an excess of acids, other than CO2.
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Causes of increased acids include:

- Renal failure
- Diabetic ketoacidosis
- Anaerobic metabolism
- Starvation
- Salicylate intoxication
Metabolic alkalosis is defined as a bicarbonate level greater than 26 mEq/liter with a pH greater than 7.45.

Either an excess of base or a loss of acid within the body can cause metabolic alkalosis.

Excess base occurs from ingestion of antacids, excess use of bicarbonate, or use of lactate in dialysis.
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- Loss of acids can occur secondary to protracted vomiting, gastric suction, excess administration of diuretics
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Procedure
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- Greet the patient and introduce yourself.
- Check the identity of the patient by asking and checking the name band.
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- Explain to the patient that due to the nature of his condition you need to take a blood sample from his wrist. It may hurt slightly and will feel uncomfortable and he will feel a sharp scratch.

- Get verbal consent.

- Check if the patient has any preference on which hand you use
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- Collect all your equipment in a tray: (ANTT)
  - ABG Syringe – blue needle
  - 1% lidocaine (1 – 2 mls) and syringe
  - Alcohol wipes
  - Gauze swabs
  - Mefix tape
  - Gloves (not sterile) and Apron
  - Ice
  - Form
  - Sharps Bin
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- Position the patients arm – help them to extend the wrist

- Perform the **ALLENS test** to check that the patient can tolerate a temporary blockage of the radial artery
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- Ask patient to clench fist
- Compress both radial and ulnar arteries together
- Ask patient to relax hand
- Release ulnar artery and observe capillary refill
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- Identify suitable artery for radial artery puncture – extend the wrist over a rolled towel or 500 ml bag of fluid. Place an Inco pad under the area to protect the bedclothes.
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- Wash hands apply gloves and apron
- Clean the area using a chlorhexidine wipe
- Consider subcutaneous lidocaine
Roll syringe then expel heparin from the syringe

Let the patient know you are about to proceed and to expect a sharp scratch.
Insert the needle at 30º to the skin at the point of maximum pulsation of the radial artery. Advance the needle until arterial blood flushes into the syringe.
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- The arterial pressure will cause the blood to fill the syringe

- When you remove needle apply gauze swab and pressure to the site

Note: In adults with adequate blood pressure the syringe will fill itself – In patients with hypotension or children the syringe will need to be aspirated
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- Remove the needle/syringe placing the needle into the bung. Press firmly over the puncture site with the cotton wool. Press for 5 minutes.
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- Put sharps into sharps bin
- Expel any air bubbles from syringe and place in rubber square
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- Label clearly – oxygen, temp and SaO2
- Place in pack of ice and send to lab immediately
- Don’t forget to document procedure
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References:

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