Arterial Blood Gases

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Aims and Objectives

- To understand the composition of gas in the air
- What does arterial gas analysis show?
- Indications for recording arterial blood gases
- Describe where acids come from and how they are eliminated from the body
- Normal values
- Describe how the body maintains the ‘balance’
- Describe Acids/Alkaline/buffers
- How is it done?
- Nursing Considerations
- Arterial blood gases examples from clinical practice
- Questions
What’s in Air?

- Nitrogen – 78%
- Oxygen – 21%
- Carbon dioxide – 0.03%
- Argon – 0.93%
What do ABG measure?

- Oxygenation levels
- Acid-base disturbances
- pH
- Partial pressure Oxygen
- Partial pressure carbon dioxide
What do ABG measure?

- Haemoglobin
- Sodium
- Potassium
- Haematocrit
- Base excess/deficit
- Chloride
- Lactate
So when would we do ABG?
A few examples ....

- Respiratory monitoring
- Unstable patients
- Post cardiac arrest
- Intra-operatively
What is an acid?
Acid and Bases made easy!

- An acid provides hydrogen ions
- A base can accept hydrogen ions
- Acidity determined by amount of free hydrogen ions
Where does the acid come from?

- Acid is a byproduct of normal metabolism - cellular respiration.
- When cells produce energy (ATP) they release a hydrogen ion

(The Kreb cycle/Citric Acid Cycle)
What is pH?

- Scale of hydrogen ion concentration
  - Low pH = ACID
  - High pH = BASE

- What is the pH of water?
Why do we need a constant pH?

**Acid is a product of metabolism**

The body is continually producing acid as a by product of metabolism. However, it must also maintain a narrow range of pH values necessary for normal enzyme activity.
pH

Normal values for ABG

7.35-7.45
How is acid and base controlled?

- Homeostatic pH of human blood is controlled through 3 mechanisms:
  - Respiratory
  - Renal
  - Chemical

- Narrow range: 7.35 –– 7.45
Acidosis pH=<7.35

- An abnormal process causing a relative increase in hydrogen ions and thus decrease in pH
- Increase in acid or decrease in base

Examples

- Metabolic examples – chronic renal failure (not enough bicarbonate)
- Respiratory examples – Inadequate respiration (excess carbon dioxide)
Alkalosis pH => 7.45

- An abnormal process causing a relative decrease in hydrogen ions and thus increase in pH
- Decrease in acid or an increase in base

Examples
- Metabolic alkalosis – Vomiting (loss of acid)
- Respiratory alkalosis – Hyperventilation (loss of carbon dioxide)
Buffers

- Systems to change strong acids into weak acids and bases
- Work within a fraction of a second
- Carbonic acid system
- Phosphate
- Haemoglobin
- Proteins
Carbonic acid system

Bicarbonate – ‘the mop’

- HCO₃
- Collects H ions and neutralises them

The most important buffer system in the body is the carbonic acid-bicarbonate system

H₂O + CO₂ → H₂CO₃ → HCO₃⁻ + H⁺
**Normal Values**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.35-7.45</td>
</tr>
<tr>
<td>PaO2</td>
<td>&gt;10.6kPa (80-100mmHg)</td>
</tr>
<tr>
<td>PaCO2</td>
<td>4.7 - 6.1Kpa</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>18-22</td>
</tr>
<tr>
<td>Base</td>
<td>-2 to +2</td>
</tr>
</tbody>
</table>
How do you perform a ABG?

- Arterial blood gases (ABG) are samples of blood taken from the radial, brachial or femoral artery or an arterial catheter.

- ABG provide essential information on cardio-respiratory conditions. i.e Oxygen and Carbon dioxide.
What to do when you get the sample!

- Gloves on!
- Ensure syringe heparinised
- Expel all air (absorbs oxygen in bubbles)
- Mix gently to avoid separation of sample
- Do not shake - haemolysis of red cells (potassium release)
- Analyse within 10 mins (60 mins on ice)
- Temperature correction - debatable if beneficial
- Trend is key not individual results
Nursing Considerations

- Is patient fully aware of procedure?
- Pain?
- Anticoagulant therapy?
- Only 2 attempts very painful procedure
### Making it easy!

<table>
<thead>
<tr>
<th></th>
<th>Acidosis</th>
<th>Alkalosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiratory</strong></td>
<td>CO₂</td>
<td>CO₂</td>
</tr>
<tr>
<td><strong>Metabolic</strong></td>
<td>Bicarbonate/base excess</td>
<td>Bicarbonate/Base excess</td>
</tr>
</tbody>
</table>
Questions ?
ABG analysis made easy!

- First look at pH – is it normal, acid or base?
- Then look at PaCO2 – is it normal, acid or base?
- Next the Bicarbonate – is it normal acid or base?
An example!

- Tim – 67 admitted with chest infection
  - Ph 7.3 – ACID
  - PaCO2 - 8.9kpa - ACID
  - PaO2 – 10.4 kpa – LOW
  - Bicarbonate HCO3 – 30mmol/l – BASE
A word about compensation …

- The body wants to maintain a normal pH - so will take action to normalise pH where possible.
- Compensation can only be said to have occurred when the pH is still normal.