Blood Gases
For beginners

Lynsey ward
4th February 2008
Aims

- To have a basic understanding of Blood Gas analysis.
Objectives

- To state what acid and alkaline in the value of PH
- When analysing a blood gas determine which are:
  - Acidotic
  - Alkalotic
  - Respiratory
  - Metabolic
Objectives

- Be able to give the correct values for Three of the Blood gas measurements.
- Give two reasons for poor Blood Gas results
Why do we take blood gases?

- To assess the effectiveness of ventilation, circulation and perfusion.
- Blood gases indicate if the baby is able to move air in and out of the lungs well enough to obtain the oxygen it needs, and dispose of the carbon dioxide it doesn’t.
- Blood gases can also tell us if the baby is having to use its energy stores in anaerobic metabolism.
What do blood gases tell us?

- Changes in the levels of:
  - acidity within the blood
  - oxygen and carbon dioxide within the blood
- The pattern of these changes over time, which helps nursing and medical staff to evaluate and plan care
What is acidity?

- Acidity is a measurement of the number of Hydrogen ions (H+) within a solution.
- A solution is:
  - Neutral if it has a pH of 7
  - Acid if it has a pH less than (<) 7
  - Alkaline if it has a pH greater than (>) 7
What is Acidity?

- Acid = gives up Hydrogen ions when in solution.
- Some give up H+ more readily = Strong and weak Acids
- Base = Alkaline which accepts Hydrogen ions. When acid added to base a weaker acid is formed
Normal values for pH

- For a premature baby or a baby with a respiratory problem the pH of the blood should lie between 7.25 and 7.35 (Neonatal Guidelines 2007, SSBC Newborn Network)

- Babies with a pH below 7.25 are acidotic

- This can be a *respiratory* or a *metabolic* acidosis

- Looking at the balance of carbon dioxide, oxygen, bicarbonate and base excess can tell us which type of acidosis it is
Oxygen

- When we take a blood gas we look at the partial pressure of oxygen (PaO2) dissolved within the blood.
- Partial pressure is the pressure exerted by the oxygen gas molecules within the blood.
- The partial pressure of oxygen is measured in Kilopascals (KPa).
Normal Values of Oxygen

- For a premature baby or a baby with a respiratory problem:
  The partial pressure of oxygen should lie between:
  6 and 12 KPa
Carbon Dioxide

- When we take a blood gas we look at the partial pressure of carbon dioxide (PaCO2) dissolved within the blood.
- Partial pressure is the pressure exerted by the carbon dioxide gas molecules within the blood.
- The partial pressure of carbon dioxide is measured in Kilopascals (KPa).
Normal Values of Carbon dioxide

- For a premature baby or a baby with a respiratory problem:
  The partial pressure of carbon dioxide should lie between: -
  
  **5.5 and 8 KPa**

(Neonatal Guidelines 2007, SSBC Newborn Network)
Buffers

- Minimises changes in pH.
- Addition of strong acid or base become weaker solutions.
- Normally sufficient buffers to keep pH narrow range.
- Three buffers, which are?
Buffers

- Bicarbonate
- Haemoglobin
- Phosphate
Bicarbonate

- Bicarbonate (HCO3) is produced by a buffer within haemoglobin.
- The conversion of carbonic acid to bicarbonate reduces the acidity (lowers the pH) of the blood.

\[
\begin{align*}
H^+ (aq) + HCO_3^- (aq) & \rightleftharpoons H_2CO_3(aq) \rightleftharpoons H_2O(1) + CO_2(g)
\end{align*}
\]
Bicarbonate

- Bicarbonate is measured in millimoles/litre
- The normal range for bicarbonate is 18-25 mm/L
The base excess is the amount of acid which would have to be added to blood to correct the pH to 7.4. Base excess is expressed as a + or – value. The normal range for base excess is from -4 to +4. A baby with a base excess below -4 is acidotic, as H+ ions need to be taken away to return the pH to 7.4. A baby with a base excess above +4 is alkalotic, as H+ ions need to be added to return the pH to 7.4.
Blood

- Blood has a pH of 7.4
- Blood maintains this pH by using buffers
- If the pH of the blood rises (becomes more alkaline) buffers release H+ ions to lower the pH to 7.4
- If the pH of the blood falls (becomes more acidic) buffers absorb H+ ions to raise the pH to 7.4
- Changes in pH should be avoided, as they affect the way in which the body absorbs oxygen and excretes carbon dioxide
Using blood gas results

- Look at results
- Check previous results
- Inform Medical Staff/Senior Nurse
Looking at blood gases

- So looking at blood gases means looking at absolute values and patterns.
- We need to consider the numerical results of the blood gas in relation to previous blood gases and take into account the patients’ history.
- Which is why blood gases can be so confusing; results which are fine for some patients are unacceptable for others!
Normal Gas values

- Ph
- P02
- Co2
- Standard bicarbonate.
- Base Excess.
## Normal blood gas values

<table>
<thead>
<tr>
<th>Value</th>
<th>Parameter Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.25&lt;pH&lt;7.35</td>
<td>pH/ acidity (Premature baby or baby with respiratory problem)</td>
</tr>
<tr>
<td>6&lt;PaO2&lt;12</td>
<td>Partial pressure Oxygen (O2)</td>
</tr>
<tr>
<td>5&lt;PaCO2&lt;7</td>
<td>Partial pressure Carbon Dioxide (Co2)</td>
</tr>
<tr>
<td>-4 to +4</td>
<td>Base Excess (Be)</td>
</tr>
<tr>
<td>18 – 25 mm/L</td>
<td>Bicarbonate (HC03)</td>
</tr>
</tbody>
</table>
Disturbances of Acid/Base.

Respiratory Acidosis

- Poor gases exchange
- Low pH
- Raise Co2
- Other values normal.
- what do we need to do?
Respiratory Alkalosis

- Over ventilation.
- Low co2 = reduce cerebral blood flow
- Therapeutic in cerebral oedema.
- pH is high
- pCo2 is low
- Management
Metabolic Acidosis

- Accumulation of acids
- Anaerobic respiration
- Metabolic disorders
- TPN.
- Low pH
- Negative base Excess
- Normal Co2, O2 normal or low.
- Treat acidosis, correction, O2, stop TPN.
Metabolic Alkalosis

- Too much Bicarbonate
- Persistent Vomiting
- High pH
- High bicarbonate
- Normal values for pco2 and o2
- Correct underlying cause.
Mixed Acidosis

- Poor gaseous exchange results in anaerobic metabolism and excessive hydrogen ions
- pH Low
- O2 Low
- CO2 High
- Bicarbonate is low
- Negative base excess
- Treat by improving gaseous exchange and bicarbonate
<table>
<thead>
<tr>
<th></th>
<th>Respiratory acidosis</th>
<th>Respiratory alkalosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cause</strong></td>
<td>Unable to move CO2 out of lungs (poor ventilation)</td>
<td>Losing too much CO2 (over ventilation)</td>
</tr>
<tr>
<td><strong>Signs</strong></td>
<td>Low pH</td>
<td>High pH</td>
</tr>
<tr>
<td></td>
<td>High pCO2</td>
<td>Low pCO2</td>
</tr>
<tr>
<td></td>
<td>pO2, HCO3 and BE may be normal</td>
<td></td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>CPAP, Ventilation, change ventilation</td>
<td>Change CPAP, change ventilation</td>
</tr>
<tr>
<td></td>
<td>Metabolic Acidosis</td>
<td>Metabolic Alkalosis</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td><strong>Cause</strong></td>
<td>Large loss HCO₃</td>
<td>Too much Sodium Bicarbonate</td>
</tr>
<tr>
<td></td>
<td>Anaerobic metabolism</td>
<td>Loss of H⁺ (vomiting)</td>
</tr>
<tr>
<td><strong>Signs</strong></td>
<td>Low pH</td>
<td>High pH</td>
</tr>
<tr>
<td></td>
<td>Base excess is negative</td>
<td>High HCO₃</td>
</tr>
<tr>
<td></td>
<td>pO₂ is normal</td>
<td>Normal pCO₂</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Minimise the risk of anaerobic metabolism</td>
<td>Correct Cause</td>
</tr>
<tr>
<td></td>
<td>pH</td>
<td>pO2</td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td>Respiratory</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Metabolic</td>
<td>Low</td>
<td>Low or Normal</td>
</tr>
<tr>
<td>Mixed</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
Practical Implications.

- Quality of the specimen-flowing clots.
- Poorly perfuse baby
- Beware bubbles
- Beware unexpected results-? Comparable with last gas,? repeat