Acid Base Balance – The basics

pH

- Concentration of hydrogen ions
- Expressed as negative logarithm –log(H+)

pCO_2

- Partial pressure of Carbon dioxide in the blood stream

pO2

- Partial pressure of Oxygen carried in the blood stream

HCO_3

- Amount of bicarbonate present in the blood
- Normal range 21-30

Base Excess

- Total of bases, bicarbonate, Haemoglobin, plasma proteins
- Number of mmol of acid needed to be added to 1 litre of hole blood to return it to a pH 7.4
- Range -2 to +2
- Large positive = met alk, large negative = MAcid

Anion Gap

- Gives more of an idea of cause for metabolic acidosis
- Subtracting plasma anions from plasma cations
- $(Na+K) - (Cl- + HCO_3-)$
- Normal 8 – 16
- High anion gap = metabolic acidosis from increase in unmeasured plasma anions
- normal anion gap = nearly always due to loss of bicarb (not increased acid production). Body retains Cl- to remain neutral, therefore hallmark of non-anion gap MA is increase serum Cl-

Causes of anion gap MA

Lactic acidosis

- Increased production
- Tissue hypoxia
- Hypoperfusion/volume depletion
- Exercise, seizures, trauma
- Drugs : metformin, salicylates, cyanide
- Decreased metabolism
- Failure : liver, renal
- Hypothermia, sepsis, diabetes

Ketoacidosis

- Diabetes
- Alcohol
- Starvation

Renal Failure

- Increased PO4, SO4

Poisoning

- Methanol
- Ethylene glycol

Remember this equation……

$$H_2O + CO_2 \leftrightarrow H^+ + HCO_3^-$$

Whichever side of the equation is loaded will drive the equation in the other direction (eg increasing H^+ drives the equation to the left, using up HCO3 and increasing CO_2, which is then blown off from the lungs)

Compensation

1. Compensated vs partial compensation
    - chronic resp alkalosis is the only metabolic derangment where PH completely compensates
2. Buffer systems
    - Bicarbonate buffer system
    - Phosphate buffer system
    - Protein buffer system
    - haemaglobin

Mechanism

1. Respiratory Compensation
    - Altering CO_2 – hyper/hypo ventilation
2. Renal Compensation
    - excreting acidic or basic urine
    - Retain or lose bicarb

Expected levels (a rough guide)

<u>Metabolic Acidosis</u>

- For each mmol decrease in HCO_3, pCO_2 will decrease by 1mmHg

<u>Metabolic Alkalosis</u>

- For each mmol increase in HCO_3, pCO_2 will increase by 0.7mmHg

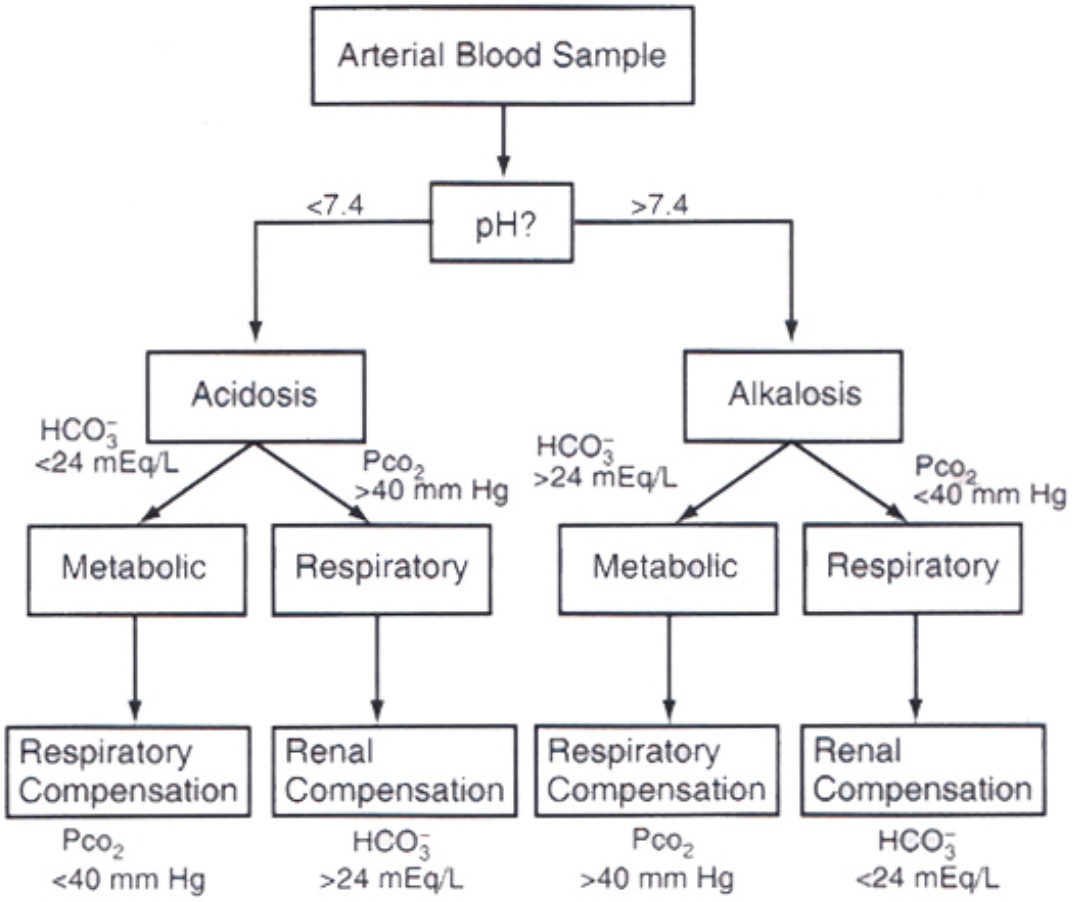
<u>Respiratory Acidosis</u>

- Acute every 10mmHg CO_2 increase expect HCO_3 to increase by 1
- Chronic every 10mmHg CO_2 increase expect HCO_3 to increase by 3

<u>Respiratory Alkalosis</u>

- Acute every 10mmHg CO_2 decrease expect HCO_3 decrease by 2
- Chronic every 10mmHg CO_2 decrease expect HCO_3 decrease by 5

	pH	Pco_2	$[HCO_3^-]$
Metabolic acidosis	↓	↓	↓
Respiratory acidosis	↓	↑	↑
Respiratory alkalosis	↑	↓	↓
Metabolic alkalosis	↑	↑	↑



Questions

1. 5 month old with PDA post surgery. Came in with bronchiolitis and increased work of breathing, on high flow oxygen. pH 7.20, pCO2 59, pO2 74, HCO3 22, BE -3.9. What is the acid-base disturbance and what is the management?
2. 21 yo female, Type 1 diabetic. Vomiting for 12/24. pH 7.14, pCO2 24, HCO3 7.9, BE -19. What is the acid-base disturbance?
3. A 60 year old man was admitted with an exacerbation of chronic obstructive pulmonary disease. His arterial blood gases on air showed pH 7.29, Paco2 65.3 mm Hg, Pao2 62 mm Hg, and standard bicarbonate 30.5 mmol/l. What is the acid-base disturbance and what is the management?
4. A 30 year old man was admitted with status epilepticus. He is given intravenous diazepam. Arterial blood gases on 15 l/min via reservoir bag mask showed pH 7.05, Paco2 61.5 mm Hg, Pao2 115 mm Hg, and standard bicarbonate 16 mmol/l. His other results were sodium 140 mmol/l, potassium 4 mmol/l, and chloride 98 mmol/l. What is the acid-base disturbance and why?
5. A 45 year old lady with previous peptic ulcer disease was admitted with persistent vomiting. She looked dehydrated. Her blood results were sodium 140 mmol/l, potassium 2.5 mmol/l, chloride 86 mmol/l, pH 7.5, Paco2 6.0 50 mm Hg, Pao2 107 mm Hg, bicarbonate 40 mmol/l. What is the acid-base disturbance and why? How would you treat this patient?
6. A 40 year old man with pleurisy for five days was assessed. A moderately sized pneumothorax was seen in a chest radiograph. His arterial blood gases on air showed pH 7.44, Paco2 3.0 kPa (23 mm Hg), Pao2 30.5 kPa (234.5 mm Hg), standard bicarbonate 16 mmol/l. How can you explain the clinical picture?
7. 24yr F, acute asthma post multiple dose salbutamol. pH 7.37, pCO2 40.7, pO2 91.7, HCO3 21.2, BE -3.9.What is the clinical concern? How are you going to proceed?
8. 80 yr old, found at home, confused. pH 7.79, pCO2 39, pO2 53, HCO3 61.2, BE 32.9, Na 117, K2.4, Cl 50, Cr 120, Urea 25.2. What is the acid-base disturbance ?