ABG

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How to read ABG

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Test	Normal	↓ Value	↑ Value
pH	7.35 – 7.45	Acidosis	Alkalosis
HCO3	20 – 28 mEq /L	Acidosis	Alkalosis
pCO2	35 – 45 mmHg	Alkalosis	Acidosis


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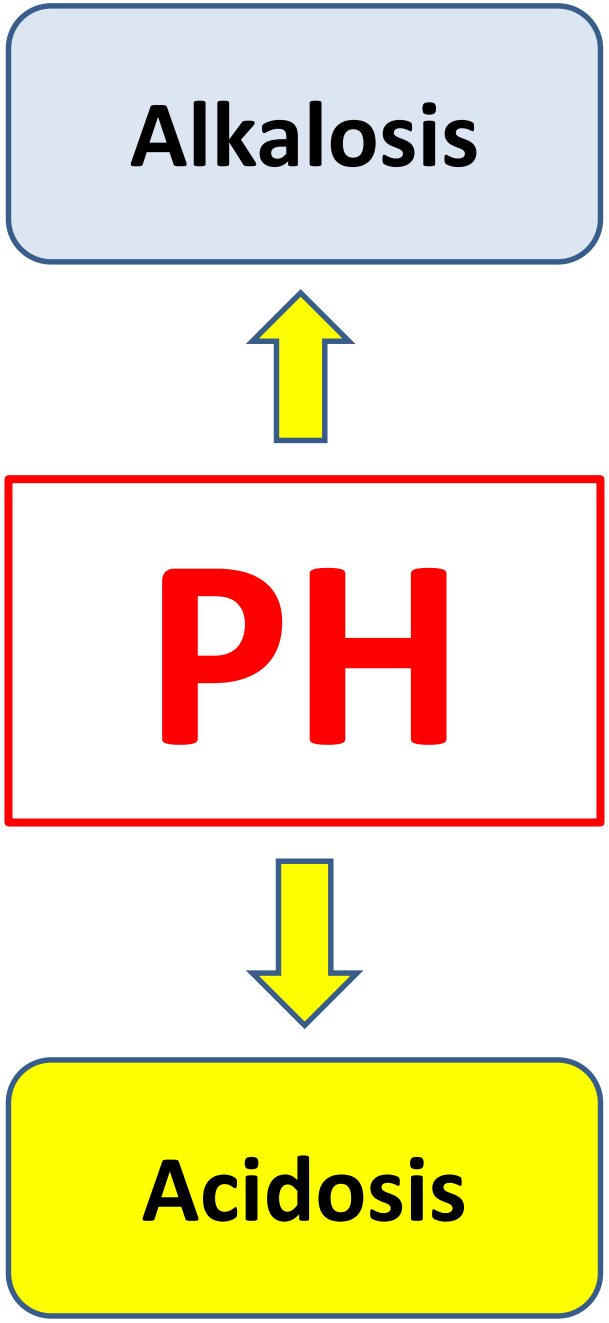
Alkalosis
PH
Acidosis


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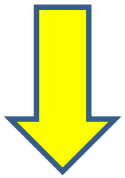
Alkalosis

HCO3



Acidosis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Acidosis
PCO2
Alkalosis


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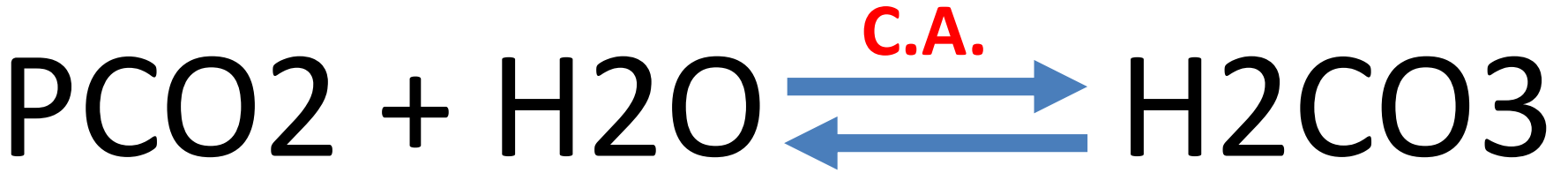

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Steps of ABG Analysis

1. Is the pH normal?
2. Is the CO_2 normal?
3. Is the HCO_3 normal?
4. Match the CO_2 or the HCO_3 with the pH
5. Does the CO_2 or the HCO_3 go the opposite direction of the pH?

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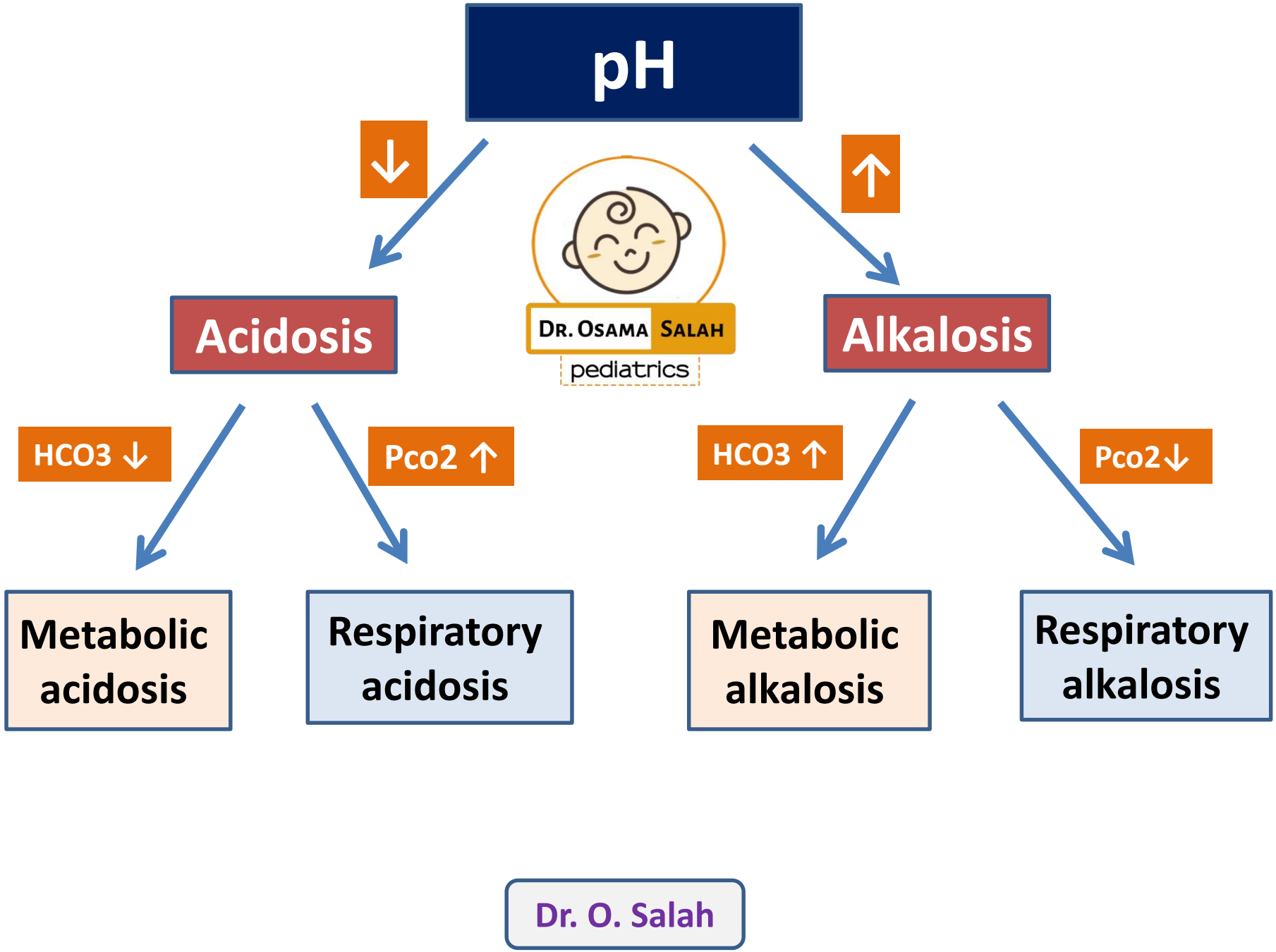
pH
↓
↑
Acidosis
Alkalosis
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HCO3 ↓
Pco2 ↑
HCO3 ↑
Pco2↓
Metabolic acidosis
Respiratory acidosis
Metabolic alkalosis
Respiratory alkalosis
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Example

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pH	7.27	Acidosis
pCO2	53	Acidosis
HCO3	24	Normal

Step 1: The pH is less than 7.35, therefore is acidotic.
Step 2: The CO2 is greater than 45, and is therefore acidotic.
Step 3: The HCO3 is normal.
Step 4: The CO2 matches the pH, because they are both acidotic.
Therefore the imbalance is respiratory acidosis.
It is acidotic because the pH is acidotic,
it is respiratory because the CO2 matches the pH.
Step 5: The HCO3 is normal, therefore there is no compensation. If the HCO3 is alkalotic (opposite direction) then compensation would be present.
The full diagnosis for this blood gas is: respiratory acidosis.

pH	7.2
pCO2	37
HCO3	12

pH	7.2
pCO2	64
HCO3	24

pH	7.49
pCO2	15
HCO3	26

pH	7.49
pCO2	41
HCO3	39

pH	7.2
pCO2	64
HCO3	12

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pH	7.2
pCO2	16
HCO3	12

pH	7.2
pCO2	64
HCO3	41

pH	7.49
pCO2	15
HCO3	11

pH	7.49
pCO2	56
HCO3	39

pH	7.36
pCO2	15
HCO3	10

D.D. of acid base disturbances

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Metabolic acidosis

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- ✓ **With normal anion gap**
  - Renal tubular acidosis
  - Diarrhea
- ✓ **With high anion gap**
  - **DKA**
  - **Renal failure**
  - **severe dehydration**
  - Lactic acidosis
  - Poisoning e.g. salicylate (late) and methanol
  - Starvation ketoacidosis
  - Inborn errors of metabolism e.g. organic acidemia
  - Shock

Anion gap

12 ± 2 (10 – 14)

12 ± 4 (8 – 16)

(Na + K) – (HCO3 + Cl)

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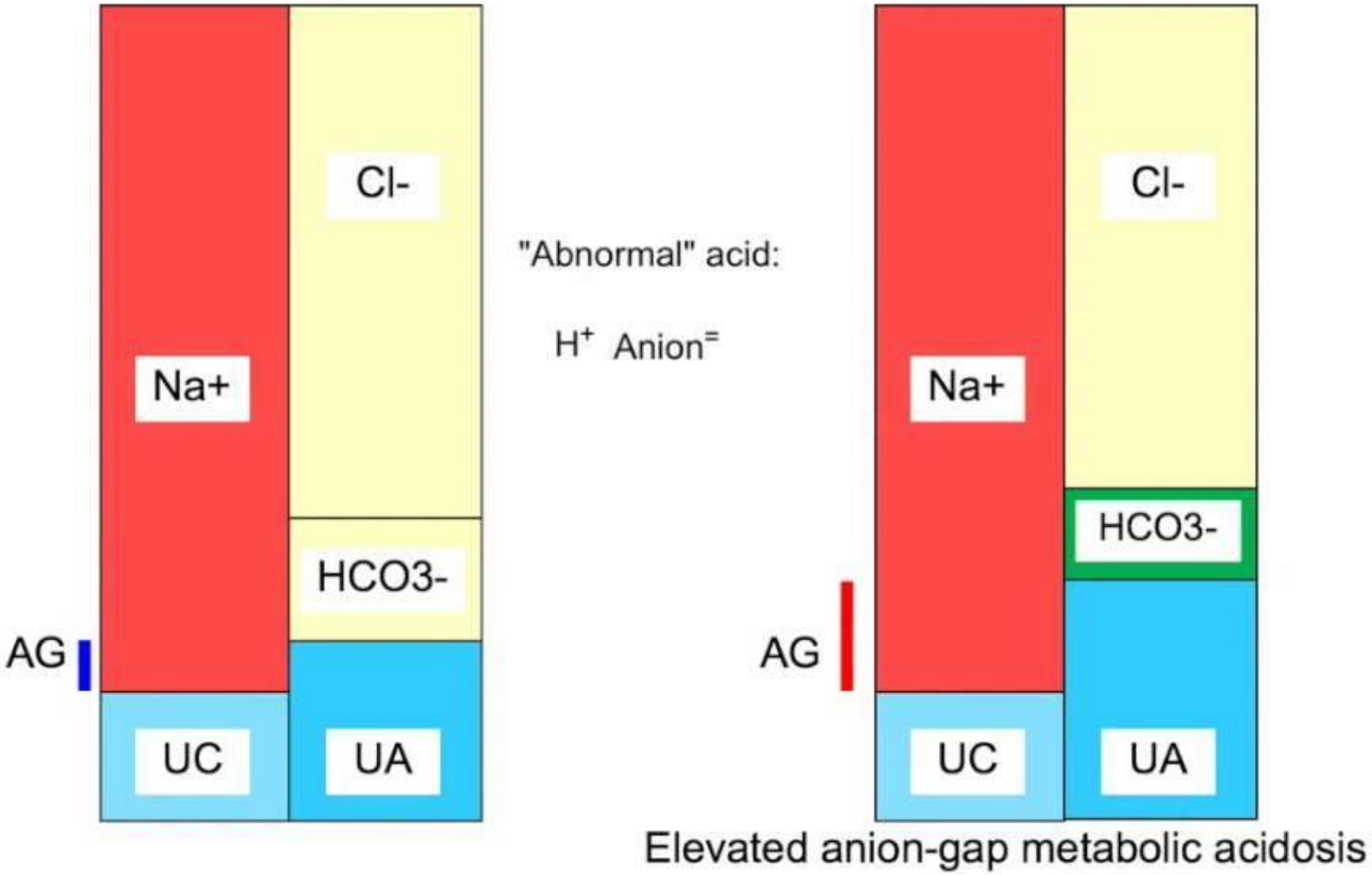

Elevated anion-gap metabolic acidosis

$$AG = [Na^+] - ([Cl^-] + [HCO_3^-]) = 10 \pm 2 \text{ mEq/L}$$

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Respiratory acidosis

- ✓ **Neurologic disorders:**
  - CNS depression: drug e,g narcotics and benzodiazepines
  - Encephalitis, brainstem disease, and trauma
- ✓ **Neuromuscular diseases:**
  - Guillain-Barré syndrome, myasthenia gravis and botulism
- ✓ **Chest wall disorders:**
  - Severe kyphoscoliosis, pectus excavatum, or pectus carinatum
- ✓ **lung and airway diseases:**
  - Emphysema, chronic bronchitis, severe asthma and ARDS
  - Interstitial lung disease
- ✓ **Airway diseases**: Laryngeal and tracheal stenosis

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Metabolic alkalosis

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- ✓ Excessive vomiting e.g. pyloric stenosis
- ✓ Excess HCO_3 intake
- ✓ Diuretics e.g. Lasix
- ✓ Primary hyperaldosteronism or exogenous mineralocorticoids.
- ✓ Cushing syndrome or exogenous glucocorticoids.

Respiratory alkalosis

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- ✓ Stimulation of respiratory center by
  - ✓ Stress and anxiety
  - ✓ Fever
  - ✓ Thermal insult
  - ✓ High altitude areas (hypoxia)
  - ✓ Salicylate poisoning (early)
- ✓ Hyperventilation
  - ✓ Heart disorder
  - ✓ **Psychogenic**
- ✓ Improperly controlled mechanical ventilation.

Compensation in ABG

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Henderson–Hasselbalch equation

$$\mathrm{pH} = 6.1 + \log_{10}\left(\frac{[\mathrm{HCO_3^-}]}{0.0307 \times p_{\mathrm{CO_2}}}\right)$$

where:

- pH measure of acidity/alkalinity in blood
- $[\mathrm{HCO_3^-}]$ bicarbonate levels in blood
- $p_{\mathrm{CO_2}}$ partial pressure of carbon dioxide in blood

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Renal regulation

- **Acidosis**
  - **HCO3** >> increase reabsorption
  - **H+** >> decrease reabsorption
- **Alkalosis**
  - **HCO3** >> decrease reabsorption
  - **H+** >> increase reabsorption

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Respiratory regulation

- **Acidosis >> Hyperventilation** >> CO2 wash
- **Alkalosis >> hypoventilation >>** Co2 retention

– Acidotic breathing
– Kusmaul breathing
– Air hunger
– Rapid deep breathing

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Metabolic acidosis
Winter formula

- **Pco2** = (HCO3 X 1.5) + 8 ± 2

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Example

- **PH** = 7.2
- **PCO2** = 25
- **HCO3** = 6

- **PH** = 7.2
- **PCO2** = 40
- **HCO3** = 6

- **PH** = 7.2
- **PCO2** = 17
- **HCO3** = 6

- **PH** = 7.2
- **PCO2** = 10
- **HCO3** = 6

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Metabolic alkalosis

- **Pco2** = (HCO3 X 0.7) + 20 ± 5

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Respiratory acidosis and alkalosis

- **Acute respiratory acidosis**
  - **HCO3** = (PCO2 excess / 10) X 1 + 24
- **Chronic respiratory acidosis**
  - **HCO3** = (PCO2 excess / 10) X 4 + 24
- **Acute respiratory alkalosis**
  - **HCO3** = (PCO2 deficit / 10) X 2 – 24
- **Chronic respiratory alkalosis**
  - **HCO3** = (PCO2 deficit / 10) X 4 – 24

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N.B.s in ABG

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ABG VBG CBG

- Good correlation as regards PH, PCO2, HCO3
- Poor correlation as regards PO2

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Heparin

- Syringe should be flushed by 0.5 ml of 1:1000 heparin and emptied
- Increase heparin >> decrease HCO_3 and PCO_2

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Air bubble

- **Air bubble** = 150 mmHg PO2 & 0 PCO2

- **Increase** >> PO2
- **Decrease** >> PCO2

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PO2

- **Normal** = 75 to 150 mmHg

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Thank you