



血液氣體分析

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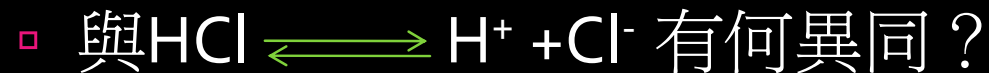
基本原理

- Henderson-Hasselbach equation



- $\text{pH} = 6.1 + \log ([\text{HCO}_3^-] / P_{\text{CO}_2} \times 0.03)$

- 思考：



系統性解讀

- 酸血或是鹼血？
 - pH
- 看二氧化碳，是否解釋pH值？
 - PaCO_2
- 看碳酸氫根，是否解釋pH值？
 - HCO_3^-
- 看代償機轉？
 - 原則：不會過度代償

代償機制

不平衡處	主要改變	期望的代償 (PaCO_2 mmHg; HCO_3^- mEq/L)
Metabolic Acidosis	$\text{HCO}_3^- \downarrow$	$\downarrow \text{PaCO}_2$ 1-1.5 for each $1\downarrow$ in HCO_3^-
Metabolic Alkalosis	$\text{HCO}_3^- \uparrow$	$\uparrow \text{PaCO}_2$ 0.25-1 for each $1\uparrow$ in HCO_3^-
Respiratory Acidosis (acute)	$\text{PaCO}_2 \uparrow$	$\uparrow \text{HCO}_3^-$ 0.1 for each $1\uparrow$ in PaCO_2
Respiratory Acidosis (compensated)	$\text{PaCO}_2 \uparrow$	$\uparrow \text{HCO}_3^-$ 0.4 for each $1\uparrow$ in PaCO_2
Respiratory Alkalosis (acute)	$\text{PaCO}_2 \downarrow$	$\downarrow \text{HCO}_3^-$ 0.2 for each $1\downarrow$ in PaCO_2
Respiratory Alkalosis (compensated)	$\text{PaCO}_2 \downarrow$	$\downarrow \text{HCO}_3^-$ 0.4 for each $1\downarrow$ in PaCO_2

正常值

	pH	PaO ₂	PaCO ₂	HCO ₃ ⁻
NB (birth)	7.26-7.29		55	
NB (24h/o)	7.37	70	33	20
Infant	7.40	90	34	20
Child-Adult	7.35-7.45	90-110	35-45	22-26

代謝性酸血症

- Anion gap (陰離子間隙)
 - $\text{Anion gap} = [\text{Na}^+] - ([\text{Cl}^-] + [\text{HCO}_3^-])$
 - Normal range 12 +/- 4
- 陰離子間隙上昇 (外來酸根, non-titratable)
 - Diabetic ketoacidosis, uremia, salicylate intoxication, starvation ketosis, methanol, alcohol ketoacidosis, unmeasured osmoles, lactic acidosis
- 陰離子間隙正常 (鹼流失, 或外來鹽酸)
 - Renal loss (Renal tubule acidosis)
 - GI loss (diarrhea, uretero- sigmoidostomy).
 - Ingestion (ammonium chloride, hyperalimentation intravenous nutrition)
- Urine anion gap
 - Negative means normal renal NH_4 excretion, non-renal cause

代謝性鹼血症

- 酸流失

- GI:

- Vomiting, Nasogastric drainage

- Renal:

- Diuretics (loss of Cl^- , K^+ fluid volume),
 - Hypochloremia (increased H^+ secretion and HCO_3^- reabsorption),
 - Hypokalemia (increased H^+ secretion and HCO_3^- reabsorption),
 - Hypovolemia (increased H^+ secretion)

- 外來鹼

- Retention of biocarbonate ion:

- NaHCO_3^- infusion or ingestion

呼吸性酸血症

- 呼吸衰竭
 - 中樞神經系統：
 - drugs, brain injury, obesity
- 神經肌肉系統：
 - Guillain-Barre syndrome, myasthenic crisis, poliomyelitis
- 肺部疾病：
 - COPD, sleep apnea, kyphoscoliosis, acute airway obstruction (late phases)

呼吸性鹼中毒

- 正常肺:
 - Anxiety, fever, stimulant drugs, CNS lesion, pain, sepsis, high altitude, iatrogenic hyperventilation
- 異常肺:
 - Hypoxemic-causing conditions, acute asthma, pneumonia, stimulation of vagal lung receptors, pulmonary edema, pulmonary vascular disease
- 症狀
 - Light-headedness, paresthesia, cramps, tetany, arrhythmias.

名詞解釋

Alveolar-arterial Oxygen Gradient
(AaDO₂)

$$AaDO_2 = PAO_2 - PaO_2$$

$$PA = (PB - PH_2O) \times FiO_2 - PaCO_2 / R$$
$$= (760 - 47) \times FiO_2 - PaCO_2 / 0.8$$

A : Alveolar

a: artery

BASE EXCESS

- **base excess**
 - the amount of acid required to return the blood pH of an individual to the normal value (pH 7.4). in units of (mEq/L). The normal value is somewhere between -3 to +3.
- **Actual base excess**
 - the base excess in the blood.
- **Standard base excess**
 - the value of base excess when the hemoglobin-value of 5g/l. This gives a better view of the base excess of the entire extracellular fluid.

Therapy

- $\text{Bicarb} = (0.1-0.3) \times \text{BW} \times \text{BE (mEq)}$