ABG判讀與應用

Arterial Blood Gas Analysis

酸鹼名詞定義

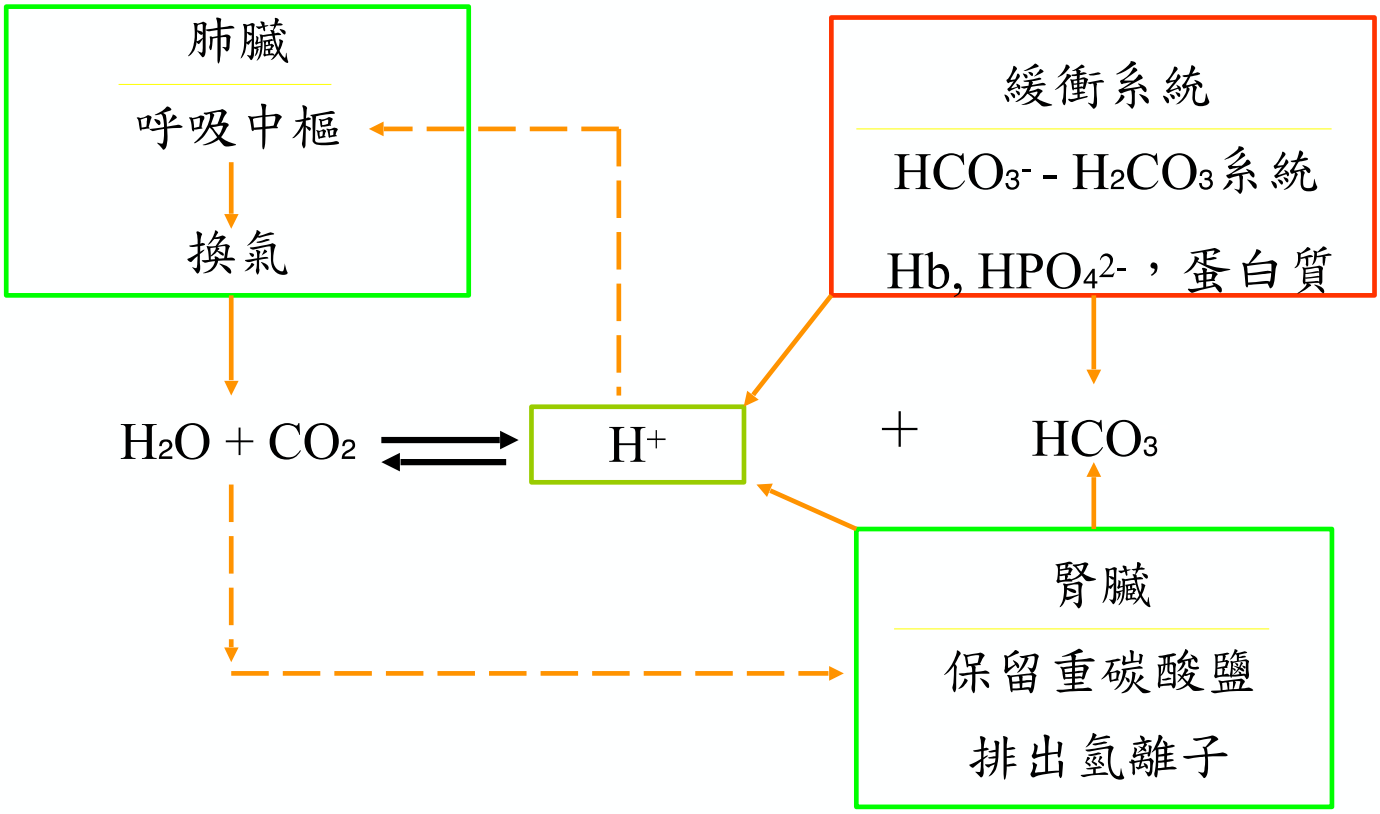
- Acidemia: 血液pH < 7.35
- Alkalemia: 血液pH > 7.45
- Acidosis: 導致acidemia的病理狀態
- Alkalosis: 導致alkalemia的病理狀態
- Acid: 在水中傾向釋放氫離子的物質
- Base: 在水中傾向接收氫離子的物質

酸鹼平衡

- 身體pH維持在7.35-7.45以便細胞生存
- 酸中毒易引起神智不清和低血壓
- 鹼中毒易引起心律不整和痙攣
- 酸鹼平衡即H+及HCO_3^-的調節，調節的器官為肺、腎和體內的即時緩衝系統

緩衝物質(Buffer)

- 弱酸及其共軛鹼組成
- Non-volatile buffers
  - Hb, plasma protein (albumin)
  - Phosphate
  - Organic acid (lactate, ketone bodies)
- Volatile acid
  - CO_2/HCO_3^- buffering



- 氫離子濃度的調節，虛線表示回饋作用，氫離子對於呼吸中樞有直接的刺激作用。溶解在血液中的二氧化碳（由二氧化碳分離反映出來）可影響腎臟對於重碳酸鹽的重吸收作用。

Blood Gas

- 項目: pH, PCO_2, PO_2; HCO_3^-, BE (計算而得)
  - $[H^+]=24 \times PCO2/[HCO_3^-]$
- 測blood gas的原因?
  - 評估病人呼吸的狀況
  - 評估病人血液的酸鹼狀況
  - 評估治療後的效果
- 來源: 動脈(主要)或靜脈

Gas機器構造

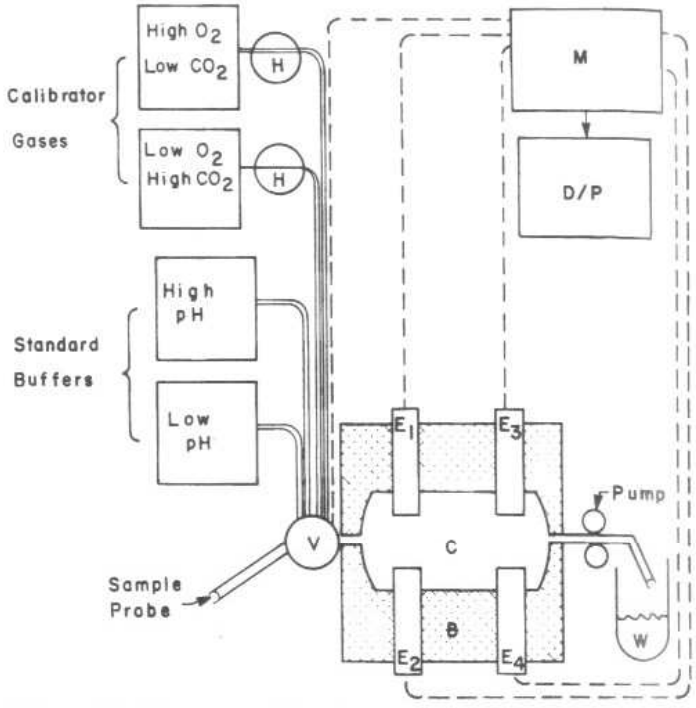


Figure 27-4 Diagram of blood gas instrumentation. *H*, Humidification device; *V*, valve; *C*, chamber; *B*, constant temperature bath at 37 °C; *W*, waste; *M*, microprocessor; *D/P*, display/printer. E (electrodes) where E_1 is PO_2, E_2 PCO_2, E_3 pH, and E_4 reference for pH.

Normal Ranges

- pH: 7.40 ± 0.05
- PCO_2 (mmHg): 40 ± 4
- PO_2 (mmHg): 90 ± 10
  - Sorbini equation: PaO_2=103.5-0.42 * age
- HCO_3^- (mM): 24 ± 2
- BE: 0 ± 2
- SpO_2: > 95%
  - PaO_2=60 mmHg -> SpO_2=90%

Venous Blood Gas?

- Arterial pH=1.004 x venous pH
- Arterial PCO_2=0.873 x venous PCO_2
- Arterial HCO_3^-=0.951 x venous HCO_3^-
- 無法評估$AaDO_2$

其他工具

- Anion gap (AG)
- Osmo gap (OG)
- Delta/delta
- Urine anion gap (UAG)

Anion Gap陰離子間隙

- AG=Na^+-[Cl^-+HCO_3^-]
- 未被量到的陰離子，如磷酸、硫酸、白蛋白、其他有機酸，正常值12 ± 2 meq/L
- 乳酸中毒、酮酸中毒、醇類中毒
- Expected AG=albumin x 2.5
- ΔAG = calculated AG - expected AG
  - If > 6 -> high AG metabolic acidosis (HAGMAC)

HAGMAC

- MUD-PULES or KUSSMALE
  - Methanol
  - Uremia
  - Diabetic ketoacidosis
  - ParAldehyde
  - Isoniazid
  - Lactic acidosis, Sepsis, aLcoholic ketoacidosis
  - Ethylene glycol
  - Salicylates

Normal AG Metabolic Acidosis (NAGMAC)

- GI loss: diarrhea
- Mild renal insufficiency
- Infusion of Cl^- containing fluid
- Ureterosigmoidostomy
- Renal tubular acidosis
- NH_4Cl
- Ketoacidosis treated with insulin

Compensation (1)

- To metabolic acidosis
  - PCO_2 falls ~ 1.2 mmHg for 1 mEq/L HCO_3^- drop
- To metabolic alkalosis
  - PCO_2 rises ~ 0.75 mmHg for 1 mEq/L HCO_3^- rise

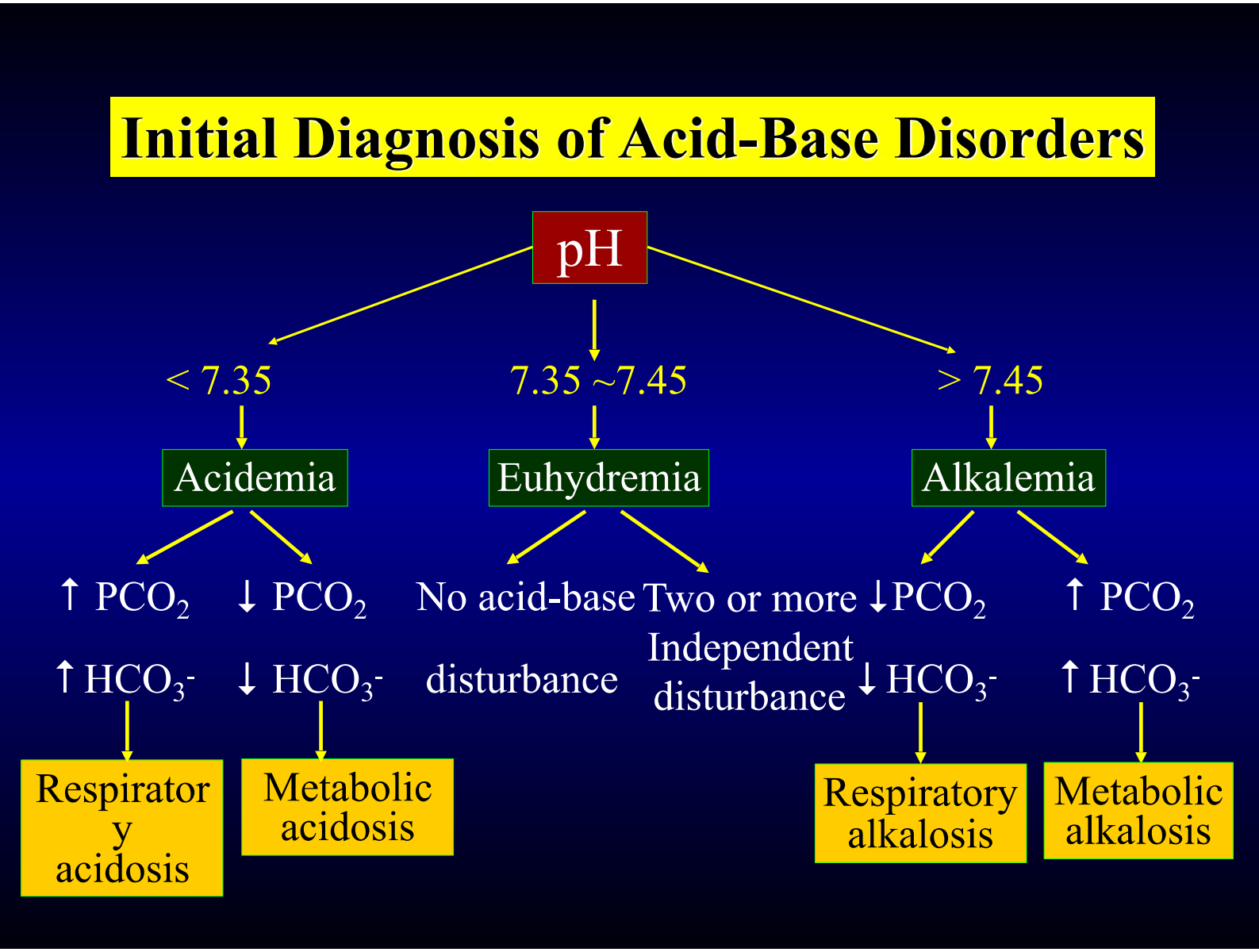
Compensation (2)

- To respiratory acidosis
  - Acute
    - HCO_3^- ↑ 1 mEq/L for 10 mmHg PCO_2; $100\Delta pH/\Delta PCO_2=0.8$
  - Chronic
    - HCO_3^- ↑ 3.5 mEq/L for 10 mmHg PCO_2; $100\Delta pH/\Delta PCO_2=0.33$
- To respiratory alkalosis
  - Acute
    - HCO_3^- ↓ 2 mEq/L for 10 mmHg PCO_2; $100\Delta pH/\Delta PCO_2=0.75$
  - Chronic
    - HCO_3^- ↓ 5 mEq/L for 10 mmHg PCO_2; $100\Delta pH/\Delta PCO_2=0.4$

第一步

- 換氣功能
  - 評估O2
- 主要酸鹼問題?
  - 評估pH
  - 評估PCO_2與HCO_3^-

Initial Diagnosis of Acid-Base Disorders



第二步

- 計算AG
- 需要Cl^-, albumin數據

第三步

- Expected HCO_3^-=24 - ΔAG
- 比較預期 vs. 量測之HCO3-
- Expected < measured -> 另有metabolic alkalosis
- Expected > measured -> 另有NAGMAC

第四步

- 回推PCO_2看是否有3rd primary resp. problems
- Expected PCO_2=15 + measured HCO_3^-

第五步

- 與臨床狀況結合

總結

- pH正常為7.35-7.45
- PCO_2正常為40，HCO_3^-正常為24
- AG正常為12±2
- Expected HCO_3^-=25-ΔAG
- Expected PCO_2=15+HCO_3^-

酸血症治療

- 7.5% $NaHCO_3$
  - 不是好buffer
  - 會增加CO_2 (>200 mmHg in Jusomin)
  - 會增加lactate
- 不一定要治療
- If pH < 7.0
  - HCO_3 deficit=0.6 x BW x (15-measured HCO_3)