MIXED ACID-BASE DISORDERS

Double and triple primary acid-base disturbances are common...

Clues to the presence of a mixed acid-base disturbance can either be historical (e.g., polydrug ingestion) or clinical, with varied chemistry and arterial blood gas findings that differ from those anticipated.

STEP 1.

Measure the pH.

- pH < 7.36 = acidaemic
- pH > 7.44 = alkaemic

STEP 2.

Is the primary disturbance *respiratory vs metabolic ?*

pH	pCO2	Interpretation
↓	↓	Metabolic acidosis
↑	↑	Metabolic alkalosis
↑	↓	Respiratory alkalosis
↓	↑	Respiratory acidosis

STEP 3.

Calculate the Anion Gap.

$$\boxed{AG = Na^+ - (Cl^- + HCO_3^-)}$$

- Normal AG = 12 (±3)

STEP 4.

Calculate the Delta Gap.

$$\boxed{\Delta G = (\text{calculated AG} - 12) - (24 - \text{measured } HCO_3^-)}$$

- Normal = 0 ± 6
- Positive (>6) = HAGMA + primary metabolic alkalosis
  - eg. DKA w/ severe vomiting or Lactic acidosis w/ chronic diuretic use.
- Negative (< -6) = varied... either
  - mixed HAGMA & NAGMA *OR*
  - HAGMA w/ chronic respiratory alkalosis & compensating hyperchloraemic acidosis.
  - Often have profound metabolic disease (hypermagnesaemia, hyponatraemia or hypercalcaemia).

STEP 5.

Is the respiratory disturbance *acute vs chronic ?*

- **If acute;** for each 10mmHg $PaCO_2$,
  - pH drops by 0.08
  - HCO_3^- increases by 1 mmol/L

- **If chronic;** for each 10mmHg $PaCO_2$,
  - pH drops by 0.03.
  - HCO_3^- increases by 4 mmol/L

STEP 6.

Has the respiratory system compensated fully ?

Use Winter's Formula.

$$\boxed{PCO_2 = (1.5 \times [HCO_3^-] + 8) \pm 2}$$

BOX 122-6 RELATIONSHIPS IN ACID-BASE DISTURBANCES

Respiratory Acidosis

Acute

HCO_3^- increases 1 mEq/L (range, 0.25–1.75) for every 10-mm Hg increase in PCO_2.

pH drops 0.08 for every 10-mEq/L rise in HCO_3^-.

Chronic (>5 days of hypercapnia)

HCO_3^- increases 4 mEq/L for every 10-mm Hg increase in PCO_2 (±4).

Limit of compensation: bicarbonate will rarely exceed 38–45 mEq/L.

Metabolic Acidosis

Note: It may take 12–24 hours for maximal respiratory response to develop.

$Paco_2 = (1.5 \times HCO_3) + 8 \pm 2$.

$Paco_2$ is equivalent to last two digits of pH (e.g., if Pco_2 is 20, pH should be 7.20).

$\Delta PCO_2 - 1\ [1.3 \times (\Delta HCO_3^-)]$

For pure AG acidosis, the rise in anion gap should be equal to the fall in $[HCO_3^-]$ (i.e., ΔG should equal 0).

For pure non-AG (hyperchloremic) acidosis, the fall in HCO_3^- should be equal to the rise in $[Cl^-]$ (i.e., $\Delta HCO_3^- = -\Delta Cl^-$).

Limit of compensation: $PaCO_2$ will not fall below 10–15 mm Hg.

Respiratory Alkalosis

Acute

HCO_3^- drops 1 to 3.5 mEq/L for every 10-mm Hg drop in PCO_2.

Limit of compensation: bicarbonate is rarely below 18 mEq/L.

Chronic (renal compensation starts within 6 hours and is usually at a steady state by 1½–2 days)

HCO_3^- drops 2–5 mEq/L for every 10-mm Hg drop in PCO_2.

Limit of compensation: bicarbonate is rarely below 12–14 mEq/L.

Metabolic Alkalosis

$Pco_2 = 0.9\ (HCO_3^-) + 9$.

Pco_2 increases 0.6 mm Hg for each 1-mEq/L increase in HCO_3^-.

Limit of compensation: PCO_2 rarely exceeds 55 mm Hg but has been reported as high as 75.