



ACID-BASE INTERPRETATION

A reproducible stepwise read of any ABG

6 STEPS

every gas

NORMAL VALUES

arterial

pH

7.35 - 7.45

PaCO₂

35 - 45 mmHg

HCO₃⁻

22 - 26 mEq/L

Anion gap

8 - 12 mEq/L

THE STEPWISE APPROACH

- 1** pH - Acidaemia (< 7.35) or alkalaemia (> 7.45)? A normal pH can hide a mixed disorder.
- 2** Primary driver - Which of PaCO₂ or HCO₃⁻ moves in the direction that explains the pH?
- 3** Compensation - Calculate the expected value (below). If measured is off, a second disorder exists.
- 4** Anion gap - AG = Na - (Cl + HCO₃). Correct for albumin. Do this on EVERY gas.
- 5** Delta ratio - If the AG is raised, check for a coexisting non-gap acidosis or metabolic alkalosis.
- 6** Correlate - Match the pattern to the history: vomiting, DKA, sepsis, COPD, toxins.

COMPENSATION FORMULAS

measured off expected = second disorder

Primary disorder	Expected compensation
Metabolic acidosis	Winter's: expected PaCO ₂ = (1.5 × HCO ₃) + 8 ± 2
Metabolic alkalosis	expected PaCO ₂ = (0.7 × HCO ₃) + 21
Acute respiratory acidosis	HCO ₃ rises 1 per 10 mmHg rise in PaCO ₂
Chronic respiratory acidosis	HCO ₃ rises 3.5-4 per 10 mmHg rise in PaCO ₂
Acute respiratory alkalosis	HCO ₃ falls 2 per 10 mmHg fall in PaCO ₂
Chronic respiratory alkalosis	HCO ₃ falls 4-5 per 10 mmHg fall in PaCO ₂

Acute vs chronic: acute = minutes to hours (buffering only); CHRONIC = renal compensation complete at 3-5 days (larger HCO₃ shift).

ANION GAP

AG = Na - (Cl + HCO₃) normal 8-12

Albumin correction: add 2.5 mEq/L per 1 g/dL albumin below 4. Uncorrected, it hides a raised gap.

A raised AG = unmeasured anions: lactate, ketones, toxins, urate / phosphate (uraemia).

DELTA RATIO

unmask a 2nd / 3rd disorder

USE ONLY IN HIGH-AG METABOLIC ACIDOSIS

(AG - 12) / (24 - HCO₃)

< 0.4 pure non-gap (hyperchloraemic) acidosis

0.4 - 1 high-AG PLUS non-gap acidosis

1 - 2 pure high-AG acidosis

> 2 + metabolic alkalosis (or chronic resp acidosis)

CAUSES BY DISORDER

acidosis mnemonics · alkalosis by urine chloride

HIGH-AG ACIDOSIS (MUDPILES)

Methanol · Uraemia · DKA · Propylene glycol · Iron / Isoniazid · Lactic acidosis · Ethylene glycol · Salicylates

NON-GAP ACIDOSIS (HARD ASS)

Hyper-alimentation · Acetazolamide · RTA · Diarrhoea · Addison's · Spironolactone · Saline

ALKALOSIS · saline-RESPONSIVE

Urine Cl < 20: vomiting / NG suction, diuretics, contraction, post-hypercapnia → give 0.9% saline + KCl

ALKALOSIS · saline-RESISTANT

Urine Cl > 20: hyperaldosteronism (Conn's), Cushing's, severe ↓K, Bartter / Gitelman, liquorice → treat the CAUSE

COMMON TRIPLE DISORDERS

metabolic acidosis + metabolic alkalosis + ONE respiratory (never two)

Setting	Acidosis (high-AG)	Alkalosis	Respiratory
Vomiting alcoholic	Alcoholic ketoacidosis	Vomiting	Resp alkalosis (withdrawal / sepsis)
DKA + vomiting + sepsis	DKA ketoacidosis	Vomiting / NG	Resp alkalosis (sepsis)
Salicylate overdose	Salicylate	Vomiting	Resp alkalosis (central drive)
COPD + sepsis + diuretics	Lactic acidosis	Loop diuretics	Resp ACIDOSIS (CO ₂ retention)

COMMON DOUBLES (mixed): salicylate = high-AG acidosis + resp alkalosis · DKA / AKA + vomiting = high-AG acidosis + met alkalosis · COPD on diuretics = resp acidosis + met alkalosis · cardiac arrest = lactic acidosis + resp acidosis (both drop the pH). Delta ratio + Winter's formula expose the extra disorder.

PEARLS & PITFALLS

- Calculate the anion gap on every gas - a normal pH with a raised AG signals a hidden mixed disorder.
- A triple disorder = high-AG acidosis + metabolic alkalosis + a respiratory disorder; the delta ratio exposes it.
- Saline-responsive alkalosis (urine Cl < 20) resolves with 0.9% saline + K; resistant needs the cause treated.
- Chronic (3-5 day) respiratory disorders shift HCO₃ far more than acute - don't mislabel it metabolic.

References: Winter's formula · Berend et al, NEJM 2014 · Kraut & Madias (anion gap) · critical-care references.

Educational aid; verify doses against local protocol and patient factors.

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