Acid-base and ABGs

Normal values, the four steps, compensation and the four imbalances

ON THIS SHEET 1 At a glance 2 Priority and safety calls 3 Exam anchors 4 Self-quiz 5 Sources ★ high yield

1 AT A GLANCE

The lungs and kidneys share the job of acid-base balance. A blood gas looks like a jumble of numbers, but four steps, taken in the same order every time, make it readable.

Normal adult blood gas

Value	Normal	Managed by
★ **pH**	**7.35 to 7.45**. Below is acidosis; above is alkalosis	Both
★ **PaCO2 (acid)**	**35 to 45 mmHg**	Lungs: fast, by changing the breathing
★ **HCO3 (base)**	**22 to 26 mEq/L**	Kidneys: slow, over hours to days
PaO2	80 to 100 mmHg	Lungs

Follow policy: Critical values, and when to escalate at once, depend on your lab's policy and the client's condition; pH under 7.25 or over 7.60 is not a universal critical value. Severe acid, like a pH near 7.10, is life-threatening.

Four steps, same order every time

Step	What it means
1. pH	Acidosis under 7.35, or alkalosis over 7.45?
★ **2. PaCO2**	Moves **opposite** to the pH? The lungs are the cause: respiratory
3. HCO3	Moves the **same way** as the pH? The cause is metabolic
4. Compensation	Check it (table below)

Memory aid: ROME: respiratory opposite, metabolic equal. A high CO2 is acid; a high HCO3 is base.

Compensation

Read it as	pH	Cause value	Compensating value
Uncompensated	Abnormal	Abnormal	**Still normal**
Partially compensated	**Still abnormal**	Abnormal	**Shifted** to pull the pH back toward normal
★ **May be fully compensated, or a mixed disorder: compare with the expected response**	Normal	Abnormal	Abnormal

Speed: The lungs compensate quickly for metabolic problems; the kidneys take longer for respiratory ones.

The four imbalances

Imbalance	Gas	Common causes	Clues	Care
Respiratory acidosis	Low pH, **high PaCO2**: breathing too little	Oversedation, asthma attack, COPD, fluid in the lungs	Headache, sleepiness, then confusion, seizures, coma. Oxygen saturation can stay normal	Improve the breathing: clear the airway, reverse oversedation, nebulizers as ordered
Respiratory alkalosis	High pH, **low PaCO2**: breathing too much	Anxiety, panic, pain, fear, head injury, early asthma or a clot in the lung; early aspirin overdose	Dizziness, chest tightness, tingling, palpitations	Treat the cause, reassure, coach slow belly breathing: in about 4 seconds, out about 8. **No paper bag**
Metabolic acidosis	Low pH, **low HCO3**	DKA, lactic acid from poor oxygen delivery, severe diarrhea, kidney disease	Fast, deep breathing can occur, but isn't always the first clue. Confusion, low pressure	Notify the provider quickly. Treat the cause: fluids, glucose control, circulatory support
Metabolic alkalosis	High pH, **high HCO3**	Vomiting, NG suction, diuretics, too much bicarbonate, low potassium	Breathing slows to hold CO2; confusion can occur	Stop the suction, diuretic or bicarbonate if possible; correct a low potassium

Educational use only. Not a substitute for clinical judgment, your facility's policy or the provider's orders. Where practice varies, follow facility policy and state law. No patient information.

Acid-base and ABGs

1 AT A GLANCE, CONTINUED

Read these gases

Client and gas	Read it as
pH 7.30, PaCO2 52 mmHg, HCO3 24 mEq/L	pH acid, CO2 high (opposite), HCO3 normal: **uncompensated respiratory acidosis**
pH 7.25, PaCO2 30 mmHg, HCO3 14 mEq/L	pH acid, HCO3 low (same way), CO2 low but pH still off: **partially compensated metabolic acidosis**
Client with COPD: pH 7.38, PaCO2 56 mmHg, HCO3 32 mEq/L	pH normal on the acid side, both values off: fits **fully compensated respiratory acidosis**, if it matches the expected response
Drowsy after morphine: pH 7.29, PaCO2 58 mmHg, HCO3 25 mEq/L	Low pH, high CO2, normal HCO3: **uncompensated respiratory acidosis**
Prolonged NG suction: pH 7.50, PaCO2 44 mmHg, HCO3 32 mEq/L	High pH, high HCO3, normal CO2, from losing stomach acid: **uncompensated metabolic alkalosis**

2 PRIORITY AND SAFETY CALLS

★ Sleepy or confused after sedation? Rising CO2 can cause it, and the **oxygen saturation can stay normal**. Improve the breathing and reverse oversedation.

Coach deep breaths and coughing; if that fails, expect a noninvasive ventilation mask, or intubation.

★ Some clients with COPD have chronic, compensated respiratory acidosis, tolerated because it built up slowly; many have a normal CO2. **A sudden rise is the danger**: sleepiness can start with a mild rise, so report new drowsiness at once.

Hyperventilation: **no paper bag**; it can drop the oxygen dangerously. If severe symptoms continue, a small dose of a short-acting benzodiazepine may be prescribed.

Early asthma or a clot in the lung can start as alkalosis, then turn to acidosis as the breathing muscles tire.

Metabolic acidosis with confusion or low pressure: notify the provider quickly, so a blood gas is drawn and the cause treated.

★ Before a radial blood gas, do the **Allen test**: press both the radial and ulnar arteries, release the ulnar; color and warmth should return to the hand.

3 EXAM ANCHORS

1. Normal pH 7.35 to 7.45; PaCO2 35 to 45 mmHg; HCO3 22 to 26 mEq/L.
2. Four steps: pH, CO2, HCO3, compensation. Respiratory opposite, metabolic equal.
3. Trap: reading CO2 backwards. A high CO2 is acid.
4. Trap: calling a normal pH normal when both other values are off.
5. Classic stems: oversedation (respiratory acidosis), DKA with fast, deep breathing (metabolic acidosis), vomiting or suction (metabolic alkalosis).
6. A panicking client with tingling hands: respiratory alkalosis. Coach slow breathing, not a paper bag.

4 SELF-QUIZ

1. Normal arterial pH is 7.35 to _____.
2. Normal PaCO2 is 35 to _____ mmHg.
3. Normal HCO3 is 22 to _____ mEq/L.
4. ROME: respiratory opposite, metabolic _____.
5. Before a radial blood gas, do the _____ test.
6. Prolonged NG suction causes metabolic _____.

ANSWER KEY 1. 7.45 · 2. 45 · 3. 26 · 4. equal · 5. Allen · 6. alkalosis

5 SOURCES

1. Open RN, Nursing Fundamentals 2e, 15.5 Acid-Base Balance. wtcs.pressbooks.pub/nursingfundamentals/chapter/15-5-ac…
2. Fundamentals of Arterial Blood Gas Interpretation (PubMed Central). pmc.ncbi.nlm.nih.gov/articles/PMC9416819

Built from RN PocketPal course lessons: Acid-base balance and blood gases (c07-l04). Every line on this sheet comes from those lesson scripts.

Educational use only. Not a substitute for clinical judgment, your facility's policy or the provider's orders. Where practice varies, follow facility policy and state law. No patient information.