Aids to Answering the ABG VAQ
Don Liew, May 2013

1. What does the clinical stem suggest? Consider carefully the patient's demographics, symptoms and signs (if provided). Determine a list of differential diagnoses from the stem alone, and prop features you'd expect to see.

2. Is the pH high (alkalaemic) or low (acidaemic)? This is the principal (dominant) finding, and result of the primary pathology. Compensatory mechanisms do NOT fully rectify the pH derangement.

3. Review the pCO_2 and HCO_3 combination:

- If acidaemic:

Primary Derangement	Primary Pathophysiology	Secondary Change	Compensatory Response	Applicable Formula for Expected Secondary Change
Low HCO_3	**Metabolic Acidosis**	Low CO_2	Hyperventilation: **Respiratory alkalosis**	**$pCO_2 = 1.5(HCO_3) + 8$ +/- 2**
High CO_2	**Respiratory Acidosis**	High HCO_3	Increased renal excretion of acid (hours to days): **Metabolic alkalosis**	**$HCO_3 = 24 + 4 \times [(pCO_2 - 40) / 10]$**

- If alkalaemic:

Primary Derangement	Primary Pathophysiology	Secondary Change	Compensatory Response	Applicable Formula for Expected Secondary Change
High HCO_3	**Metabolic Alkalosis**	High CO_2	Hypoventilation: **Respiratory Acidosis**	**$pCO_2 = 0.7(HCO_3) + 20$ +/- 5**
Low CO_2	**Respiratory Alkalosis**	Low HCO_3	Decreased renal excretion of acid (hours to days): **Metabolic Acidosis***	**$HCO_3 = 24 - 5 \times [(40 - pCO_2) / 10]$ +/- 2**

4. If metabolic acidosis, calculate the Anion Gap and Delta Ratio.
Anion Gap = (Measured Na+) – (Measured Cl^- + Measured HCO_3). Should be 12 or less.

- **HAGMA Causes:** Lactate (sepsis, hypovolaemia, hypoxia), ketosis, uraemia, salicylates, toxic alcohols, isoniazid.
- **NAGMA Causes:** Renal tubular acidosis, diarrhoea, acetazolamide**.**

Delta Ratio = (Measured Anion Gap – 12) / (24 – Measured HCO_3)

Delta Ratio	Pathophysiological Processes and Explanation
> 2.0	HCO_3 reduction is less than expected, *AND / OR* pre-existent high HCO_3 There is a **co-existent metabolic alkalosis**
1.0 to 2.0	**"Pure" HAGMA**
< 1.0, > 0.4	HCO_3 reduction is greater than expected, owing to co-existent HCO_3 loss (renal, GI) **This is a mixed metabolic acidosis**
< 0.4	Probably no acid added to system; just HCO_3 loss **This is a normal-anion gap / hyperchloraemic metabolic acidosis**

5. Causes of Other Pathology

Pathology	Causes
Respiratory Acidosis	Severe lung disease (whatever also caused hypoxia) CNS depression Restrictive Pathology Fatigue Paralysis
Respiratory Alkalosis	Pain, Anxiety CNS Stimulation Excessive Artificial Ventilation
Metabolic Alkalosis	*A. Volume Deplete / Urinary Cl <10mmol/L / Saline Responsive:* Diuretics Vomiting *B. Volume Replete / Urinary Cl >10mmol/L / Saline Non-Responsive:* Exogenous Alkali Mineralo-corticoid excess Severe Hypokalaemia Post Hypercapnoeic Hyper-ventilation

6. Correct Na if hyperglycaemic:

Corrected Na+ = (Measured Na+) + [(Measured glucose – 5) / 3]

7. Calculate predicted K (when pH corrected):

Acidaemic: Predicted K+ = (Measured K+) – [(7.40 – Measured pH) x 10 x 0.5]
Alkalaemia: Predicted K+ = (Measured K+) + [(Measured pH – 7.40) x 10 x 0.5]

8. Calculate A-a gradient, by first determining pAO_2

$pAO_2 = FiO_2 \times (760 - 47) - (paCO_2) / 0.8$

Then: A-a gradient = $pAO_2 - paO_2$ Should be (age in years) / 4, or less.

9. Relevant Negatives

Of the stem and the prop. Features absent, but expected to be present, or potentially so.

10. Conclusion(s)

Probable diagnoses, and differentials.

11. Implications

What does all this mean for the patient? Consider if the implication is for:

- *Further assessment (where the diagnosis remains unclear)*
- *Management (clear diagnosis which mandates early therapeutic intervention)*
- *Prognosis (scenario predicts a particular outcome)*
- Combinations of the above