

# Blood Gas #9

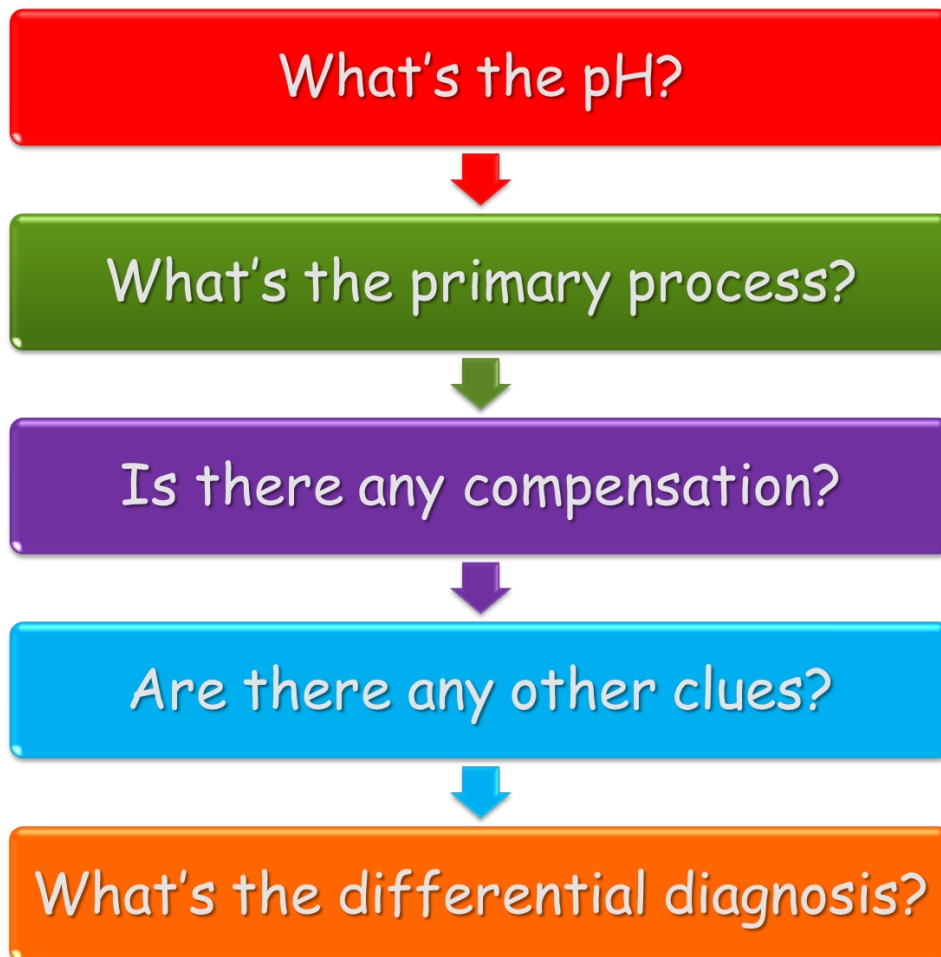
**History:** A 24-year-old man with a severe intellectual disability is brought in by his family who report that he is lethargic and drowsy and has had a cough for 1 week. Below is his arterial blood gas on arrival:

|                                                 |                   |
|-------------------------------------------------|-------------------|
| pH 7.31                                         | Na 174 mmol/L     |
| pCO <sub>2</sub> 52 mmHg                        | K 3.1 mmol/L      |
| pO <sub>2</sub> 120 mmHg (FiO <sub>2</sub> 0.4) | Cl 137 mmol/L     |
| HCO <sub>3</sub> 25 mmol/L                      | Glucose 33 mmol/L |
| Osmolality 402 mmol/kg                          | Urea 25.7 mmol/L  |

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## What's the pH?

7.31 = acidaemia

## What's the primary process?

pCO<sub>2</sub> 52 = primary respiratory acidosis

## Is there any compensation?

**Expected HCO<sub>3</sub> = 24 + ((Measured pCO<sub>2</sub> – 40)/10)**

= 24 + ((52 – 40)/10)

= 25.2

Therefore there is full metabolic compensation for an acute respiratory acidosis.

## Are there any other clues?

$$\text{Expected PAO}_2 = (713 \times \text{FiO}_2) - (\text{pCO}_2 \times 1.25)$$

$$= (713 \times 0.4) - (52 \times 1.25)$$

$$= 220.2$$

$$\text{A-a gradient} = \text{PAO}_2 - \text{PaO}_2$$

$$= 220.2 - 120$$

$$= 100.2$$

Therefore there is a significantly elevated A-a gradient.

$$\text{Corrected sodium} = \text{Na} + (\text{glucose} - 5)/3$$

$$= 174 + (33 - 5)/3$$

$$= 183.3$$

There is severe hyponatraemia.

$$\text{Calc osmolality} = (2 \times \text{Na}) + \text{urea} + \text{glucose}$$

$$= (2 \times 174) + 25.7 + 33$$

$$= 406.7$$

$$\text{Osmolar gap} = \text{Measured osmolality} - \text{Calculated osmolality}$$

$$= 402 - 406$$

$$= -4$$

Therefore there is no osmolar gap.

### Electrolyte clues:

Serum osmolality is markedly elevated. There is hyperglycaemia, severe hyponatraemia and severe hyperchloraemia. Urea is markedly elevated. Potassium is

slightly low.

## What's the differential diagnosis?

**Description:** This arterial blood gas reveals a maximally compensated primary acute respiratory acidosis with an elevated A-a gradient. There is severe hyperglycaemia and evidence of significant dehydration with severe hypernatraemia, hyperchloraemia and elevated urea. There is significant hyperosmolality, but no osmolar gap. Mild hypokalaemia is also present.

**Interpretation:** In this clinical context, this gas would be consistent with severe hypernatraemic dehydration and type 2 diabetes complicated by [hyperglycaemic hyperosmolar state \(HHS\)](#). It is likely that there is some alteration in conscious state resulting in failing ventilation and acute respiratory acidosis. Considering the history of cough and elevated A-a gradient, pneumonia should be suspected as a precipitating factor. Treatment will include gradual rehydration, correction of potassium, insulin, and management of sepsis.

**Additional information:** Strong ion difference  $\text{Na} - \text{Cl} = 37$ , suggesting a normal anion gap. Urine osmolality 609 mmol/kg.

Patient has a rare congenital abnormality, limited mobility and severe intellectual delay (2y old), eats a mostly soft diet and has a well-established preference for sugary foods and drinks, in particular strawberry milk. This was a first presentation of type 2 diabetes with hyperglycaemic hyperosmolar state secondary to community acquired pneumonia with sepsis. HbA1C 11%.