Blood Gas Question

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80 years old from nursing home with altered conscious state. Arterial blood gas results.

- FiO2 .21
- pH 7.09
- paCO2 72 mmHg
- HCO3 27 mmol/L
- paO2 50 mmHg

What is your interpretation?

Acute pure respiratory acidosis with hypoxaemia but no ventilation/perfusion mismatch. Pure hypoventilation.

Show 4 calculations to justify your answer.

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- Expected pH for pure resp acidosis = 7.35 – 0.08 x (72 – 40)/10 = 7.09
- Expected HCO3 for acute resp acidosis = 24 + (72 – 40)/10 = 27.32
- Alveolar pO2 = (713 x 0.21) – (1.25 x 72) = 60
- A-a gradient = (713 x 0.21) – (1.25 x 72) – 50 = 10
- Maximum expected A-a gradient for age = 80/4 + 4 = 24
- Expected paO2 for age with this paCO2 = > (60 – 24) = >36

Give 2 likely causes and for each an intervention to quickly reduce the paCO2.

Causes

- Opiates
- Benzodiazepines and other sedatives
- Stroke and other acute intracranial events
- Cervical spine injury and other causes of acute respiratory paralysis
- Recent onset status epilepticus
- Hypoglycaemia
- Airway obstruction

Interventions

- Naloxone
- Flumazenil
- Ventilation
- Anticonvulsants
- Glucose
- Provide an unobstructed airway

What is his O2 saturation approximately?

- paO2 50 equates to O2 sat of approximately 80% (accepted 75-85)
- Remember the Hb/O2 saturation curve

- Useful numbers:
  - 90% = pO2 60
  - 75% = pO2 40

If a patient with chronic CO_2 retention is administered excessive oxygen list 2 important mechanisms by which CO_2 may rise.

- Increased shunting due to increased blood flow to poorly ventilated alveoli.
- Haldane effect causing offloading of CO_2 from red cells.

- Not suppression of hypoxic drive that is a mythological concept.

Results

- Pass mark set at 11/18
- 8/43 candidates passed
- Range 0-14
- Mean and median scores = 8/18

Most common errors

- Calculations
  - Lack of knowledge of the alveolar gas equation
  - Using the P/F ratio
  - Not determining if this was purely respiratory or mixed respiratory and metabolic
  - Irrelevant calculations (If primarily metabolic?)
- Causes and interventions
  - Causes that are not consistent with normal V/Q matching, ie COPD, asthma, sepsis
  - Interventions that increase pO2 not decrease pCO2
- Interpretation of pulse oximeter results
- Effects of excessive O2 delivery

How to correct errors

- Have a systematic approach to ABG analysis.
- When you are asked for differential diagnoses only include conditions that fit the scenario. Read the details of the scenario.
- Know how to use and interpret simple monitors like the pulse oximeter.
- Be up to date with current concepts in management of critically ill patients.
- Learn the correlation between venous and arterial gases.

Blood gas analysis rules page 1/3

- Acute respiratory acidosis expected HCO_3 = $24 + (CO_2 - 40)/10$
- Chronic respiratory acidosis expected HCO_3 = $24 + 4(CO_2 - 40)/10$
- Acute respiratory alkalosis expected HCO_3 = $24 - 2(40 - CO_2)/10$
- Chronic respiratory alkalosis expected HCO_3 = $24 - 5(40 - CO_2)/10$
- Acute respiratory acidosis expected pH = $7.35 - 0.08(CO_2 - 40)/10$
  - Reverse for acute respiratory alkalosis
- Chronic respiratory acidosis expected pH = $7.35 - 0.03(CO_2 - 40)/10$
  - Reverse for chronic respiratory alkalosis

Blood gas analysis rules page 2/3

- Metabolic acidosis expected pCO_2 = 1.5 x HCO_3 + 8
- Metabolic alkalosis expected pCO_2 = 0.7 x HCO_3 + 20
- Anion gap (normal = 12 or less) = Na – (Cl + HCO_3)
- Osmolar gap (Osmolality measured in lab – Osmolarity calculated from U+Es)
  - Osmolarity = (1.86 x Na) + glucose + urea + 9
- Delta Ratio = (AG – 12) / (24 – HCO_3)
  - <0.4 = NAGMA; 1-2 = HAGMA

Blood gas analysis rules page 3/3

- A-a gradient = (713 x FiO_2) – (1.25 x CO_2) – paO_2
- Expected A-a for age = Age/4 + 4
- paO_2/FiO_2 = respiratory failure if <300

- Correlation between Arterial and Venous gases
  - pH and BE correlate well
  - pCO_2 and HCO_3 correlate poorly (CO_2 +/- 10; HCO_3 +/- 2)