Interpretation of Blood gases and Hypercapnia

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Impact Team
• You’ve got this far and now you need to interpret the results.

• Confused??????
• Too many rules???
• Leads to incorrect diagnosis.
Make it simple.

Only refer to 4 blood gas values.

- pH [acid base balance] 7.35 – 7.45
- pCO₂ [carbon dioxide] 4.5 -6.0
- HCO₃ [bicarbonate] 22 -26
- PO₂ [oxygen] 11 – 13
Ask 6 simple questions

1. Analyze the pH. Is it acidotic or alkalotic? Label it.

Acidotic – pH < than 7.35

Alkalotic pH > than 7.45
2. Analyze the CO$_2$. Is it acidotic or alkalotic? Label it.

Acidotic CO$_2$ > than 6.0

Alkalotic CO$_2$ < than 4.5
Remember – CO$_2$ is the respiratory component.

HCO$_3$ is the metabolic component.
3. Analyze the HCO$_3^-$ Is it acidotic or alkalotic? Label it.

Acidotic HCO$_3^-$ < than 22

Alkalotic HCO$_3^-$ > than 26
4. Is the cause Respiratory or Metabolic?

- Look at the pH and compare it with the CO$_2$ and HCO$_3$.
- If the pH is acidotic, look for whichever value is acidotic.
- If the pH is alkalotic, look for whichever value is alkalotic.

- **SO** - Match the pH with the CO$_2$ and HCO$_3$
- If the pH matches with the CO$_2$ it is Respiratory
- If the pH matches with the HCO$_3$ it is metabolic
In other words……

- **Respiratory acidosis** – pH is acidic and CO$_2$ is acidotic

- **Metabolic acidosis** – pH is acidic and HCO$_3^-$ is acidotic

- **Respiratory alkalosis** – pH is alkalotic and CO$_2$ is alkalotic

- **Metabolic alkalosis** – pH is alkalotic and HCO$_3^-$ is alkalotic
5. Is the cause compensated or uncompensated?

- **Compensated** – the pH is within normal range.

- **Uncompensated** – the pH is outside of the normal range and the value [either CO₂ or HCO₃] that does **not** match the pH will still be in the normal range.

- **For example:** pH 7.32 [acidotic]  
  CO₂ 8.4 [acidotic]  
  HCO₃ 24 [normal]
Partially compensated

• pH is anywhere outside the normal range

• The value that does not match the pH will be outside the normal range indicating that the body is trying to correct the pH.

• **For example:**
  pH 7.20 [acidotic]
  CO2 8.2 [acidotic]
  HCO3 29 [alkalotic]
Finally…..

6. Analyze the $\text{pO}_2$ and oxygen saturation

If they are below normal, there is evidence of hypoxia
Example 1
pH 7.02, CO₂ 9.3, HCO₃ 23 and PaO₂ 7.9.

How would you interpret this?

pH is Acidotic
CO₂ is Acidotic [respiratory component]
HCO₃ is Normal [metabolic component]
PaO₂ is low indicating hypoxia.

The CO₂ matches the pH as they are both acidotic. The HCO₃ is normal so there is no compensation
SO…The diagnosis is uncompensated Respiratory acidosis with hypoxia
Example 2
pH 7.30, CO$_2$ 3.5, HCO$_3$ 19, pO2 7.1

How would you interpret this?

pH is *acidotic*
CO$_2$ is *alkalotic* [respiratory component]
HCO$_3$ is *acidotic* [metabolic component]

The HCO$_3$ matches the pH as they are both *acidotic*. The CO2 does not match the pH and it is also outside the normal range.

SO.. The diagnosis is partially compensated metabolic acidosis with hypoxia
Example 3
pH 7.52, CO$_2$ 3.9, HCO$_3$ 23, pO$_2$ 12.9

How would you interpret this?

pH is **alkalotic**
CO$_2$ is **alkalotic** [respiratory component]
HCO$_3$ is normal [metabolic component]

The CO$_2$ matches the pH as they are both **alkalotic**. The HCO$_3$ is normal so there is no compensation.

**SO...the diagnosis is uncompensated Respiratory Alkalosis**
The key to understanding Blood gases 

- PRACTICE, PRACTICE, PRACTICE.... AND MORE PRACTICE.
Hypercapnia

Or Type 2 Respiratory Failure
Respiratory Failure

• Defined as a failure of the respiratory system to maintain adequate gas exchange and is characterised by abnormalities in arterial blood gas tensions.

• Respiratory failure may be:

1. Hypoxaemic respiratory failure [Type 1]

2. Hypercapnic respiratory failure [Type 2]
Hypoxaemic or Type 1RF

- Defined as a PaO$_2$ of < than 8kpa with a normal or low PaCO$_2$

- Usually caused by a ventilation-perfusion mismatch.
Hypercapnia or Type 2 RF

- Defined as a PaCO$_2$ of $> 6.0$kpa and usually a PaO$_2$ of $< 8$kpa.
- Usually caused by inadequate alveolar ventilation.
- Can be acute or chronic

- **Acute T2RF** - develops over minutes to hours and pH is $< 7.35$ with a raised paCO$_2$
- **Chronic T2RF** – develops over several days or longer and the pH is normal with a raised paCO$_2$
Causes of Hypercapnia

• Increased airway resistance
• Neuromuscular disorders
• Reduced breathing effort
• Deformities
Signs and Symptoms of T2RF

Main symptoms of Carbon dioxide toxicity

Volume % in air
- 1%
- 3%
- 5%
- 8%

Visual
- Dimmed sight

Auditory
- Reduced hearing

Central
- Drowsiness
- Mild narcosis
- Dizziness
- Confusion
- Headache
- Unconsciousness

Respiratory
- Shortness of breath

Skin
- Sweating

Heart
- Increased heart rate and blood pressure

Muscular
- Tremor
Management of Hypercapnia [BTS 2008]

- Arterial blood gas analysis - to confirm diagnosis

- If the pH is within normal limits but the paCO$_2$ is increased then the hypercapnia is probably long-standing.

- If the pH is $< 7.35$ and paCO$_2$ is $> 6.0$ then patient is hypercapnic and acidotic

- Controlled oxygen to maintain oxygen saturations between 88-92%

- Re-check blood gases after 30-60 minutes [or if clinical deterioration]
Management cont.

- If acidosis still persists after 30 minutes of appropriate therapy, consider referral for Non-invasive ventilation. [The provision of ventilatory support through the patients upper airway, using a mask]

- Repeat blood gases 1-2 hours after commencing NIV

- Wean patients from NIV depending on response to treatment.

- Intermittent blood gases should be used to monitor recovery from hypercapnic respiratory failure

- Target saturation range 88-92% on room air or normal flow rate of oxygen when stable
Discharge Planning

- Satisfactory oximetry or ABG/CBG result.

- Re-established on all usual treatment.

- Oxygen alert card and 24% or 28% Venturi mask.

- OOH service should be informed patient has had an episode of hypercapnic respiratory failure and carries an alert card.

- Community follow up with Specialist teams.

- Referral for home NIV if indicated.
Thank you for listening