

Turning

ABGs

into child's play

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What do ABGs and
tic-tac-toe
have in common?

Homeostasis

- The body must maintain a delicate balance of acids and bases.
- Metabolic and respiratory processes must work together to keep hydrogen ion (H^+) levels normal and stable.

pH of Blood

- The pH of blood indicates the concentration of H^+
- Normal pH – 7.35 – 7.45
 - Less than 7.35 is acidosis
 - Greater than 7.45 is alkalosis

pH of Blood

- Principle substance affecting acid
 - Carbon dioxide combines with water
 - Partial pressure exerted by carbon dioxide
 - 35 – 45 mmHg
- Principle alkaline substance
 - Bicarbonate, or HCO_3^-
 - Slowly binds with free H^+ making H_2CO_3
 - HCO_3^- levels 22-26

The body compensates for the imbalance

- The body strives to maintain a normal pH.
 - Sometimes the causes of an acid-base imbalance can't be corrected or changed.
 - In these cases a healthy renal or respiratory system can partially or completely offset the ill effects of a fluctuating pH.

The body compensates for the imbalance

- Ex.
 - A pt with COPD may experience respiratory acidosis as a result of elevated CO₂ levels caused by hypoventilation.
 - Since both CO₂ and HCO₃⁻ affect the pH, and the body is unable to correct the CO₂ problem, the renal system compensates: ↑ excretion of H⁺ and reabsorption of bicarbonate
 - Likewise, the respiratory system can compensate for a metabolic acid-base imbalance by regulating CO₂ levels

Tic-tac-toe, three in a row

- To diagnose an acid-base imbalance, you need to ask yourself three questions:
 - 1) Does the pH indicate acidosis or alkalosis?
 - 2) Is the cause of the pH imbalance respiratory or metabolic?
 - 3) Is there compensation for the acid-base imbalance?

To answer these questions

ACID	NORMAL	ALKALINE

- pH 7.35 – 7.45
- PaCO₂ 35-45 mmHg
- HCO₃⁻ 22-26

- Once three items – including the column head – are in a vertical row, you are ready to diagnose the patient's condition.

Let's play tic-tac-toe

- Robert is a 70-year-old diabetic who has a long history of not taking his insulin. You are transferring him from one facility to another and his ABG results:

– pH 7.26

– PaCO₂ 42

– HCO₃⁻ 17

ACID	NORMAL	ALKALINE
pH	PaCO ₂	
HCO ₃ ⁻		

- The column that the pH is in tells you acidosis, or alkalosis.
- The relative positions of the pH, PaCO₂, and HCO₃⁻ reveal the origin of any acid-base imbalance:
 - If the pH and PaCO₂ fall in the same column – other than normal – the problem is respiratory.
 - If the pH and HCO₃⁻ fall in the same column, the problem is metabolic.

ACID	NORMAL	ALKALINE
pH	PaCO ₂	
HCO ₃ ⁻		

Metabolic Acidosis

- Look at the parameter not associated with the pH...in this case PaCO₂.
 - Since the PaCO₂ is normal, there is no evidence of compensation, and the full diagnosis is acute metabolic acidosis.

Causes of acid-base imbalances

- Metabolic acidosis
 - Diabetic ketoacidosis
 - Diarrhea
 - Renal failure
 - Shock
 - Salicylate overdose
 - Sepsis

Causes of acid-base imbalances

- Metabolic alkalosis
 - Loss of gastric secretions
 - Overuse of antacids
 - Potassium-wasting diuretics

Causes of acid-base imbalances

- Respiratory acidosis
 - Hypoventilation, may be related to:
 - Drug overdose
 - Chest trauma
 - Pulmonary edema
 - Airway obstruction
 - COPD
 - Neuromuscular disease

Causes of acid-base imbalances

- Respiratory alkalosis
 - Hyperventilation, may be related to:
 - Anxiety
 - High altitude
 - Pregnancy
 - Fever
 - Hypoxia
 - Excessive tidal volume in ventilated patients
 - Initial stage of pulmonary embolus

Let's play tic-tac-toe

- Elizabeth is brought to the ED following an auto accident. She sustained no injuries, but is extremely upset and anxious. She has been breathing rapidly since the crash and now feels faint. Her ABG results are:

– pH 7.49

– PaCO₂ 30

– HCO₃⁻ 23

ACID	NORMAL	ALKALINE
	HCO ₃ ⁻	Respiratory Alkalosis
		PaCO ₂

Let's play tic-tac-toe

- Luis is a 64-year-old patient who has a long history of COPD. He presents today with a slight fever and complains of shortness of breath and coughing up green-colored sputum. His ABG results are:

– pH	7.26
– PaCO ₂	52
– HCO ₃ ⁻	34

ACID	NORMAL	ALKALINE
pH		HCO ₃ ⁻
PaCO ₂		

Respiratory Acidosis

- With Luis notice the parameter not associated with the pH, in his case HCO_3^- and you will notice it is on the opposite side of the scale.
- This indicates partial compensation. If the compensation had been complete, the pH results would have been within the normal range

Let's play tic-tac-toe

- Kate was diagnosed with congestive heart failure six months ago and was placed on Lanoxin and Lasix. Her ABG results are:
 - pH 7.48
 - PaCO₂ 51
 - HCO₃⁻ 29

ACID	NORMAL	ALKALINE
PaCO ₂	Metabolic alkalosis with partial compensation	pH
		HCO ₃ ⁻

- If pH is within the normal range but the other parameters are not, you're looking at a case of complete compensation.
- You will need to do one extra step to diagnose the origin of the imbalance.
- You will be noting two pH values on the grid.....

You will be noting two pH values on the grid....

- Record the one in the normal range as “pH(1)”
- Recalculate pH using the exact midpoint of the normal range, or 7.40, for your reference point.
 - Thus, a pH of less than 7.40 would indicate acidosis, and one greater than 7.40 would be alkalosis
- Note this adjusted pH in the appropriate box as “pH(a)”

Let's play tic-tac-toe

- Greta is a 45-year-old female and was diagnosed with myasthenia gravis five years ago. She is presenting today with increasing shortness of breath, even at rest. Her ABG results are:

– pH 7.36

– PaCO₂ 50

– HCO₃⁻ 34

ACID	NORMAL	ALKALINE
pH(a)	Respiratory acidosis with complete compensation	HCO ₃ ⁻
PaCO ₂		

Let's play tic-tac-toe

- Daniel is a 50-year-old executive who complains of indigestion and heartburn that has increased over the last six months. He says that he took a commercial antacid solution every half hour or so throughout the previous night for symptom relief. His ABG results are:

– pH	7.43
– PaCO ₂	49
– HCO ₃ ⁻	30

ACID	NORMAL	ALKALINE
PaCO ₂	pH	pH
		HCO ₃ ⁻

**Metabolic alkalosis
with
complete compensation**

Summary

- Treatment of any of these imbalances should be directed at correcting the underlying cause with immediate care focused on correcting the pH level.

And...REMEMBER

- Although this tic-tac-toe technique is a convenient tool for interpreting a patient's blood gas values, do not allow it to overshadow the importance of the patient history and assessment when you are prioritizing your interventions.

Questions???

Good Night!!

