ABGs

- Arteries used are radial , brachial or femoral
- Check the ulnar circulation by doing Allene's test
- Heparin is used in the tube to prevent coagulation but it may cause metabolic acidosis
- Use ice to carry the tube in to prevent further metabolism and avoid respiratory acidosis
- Air bubbles in the tube ⬆️CO_2 and ⬇️O_2 causing false reflexion of ABGs
- Jaundice and hyperlipidemia have wrong interpretation for acid – base not ventilation
- Normal range of pH 7.35 – 7.45 (7.4) , p CO_2 35 – 45 (40) , HCO3 22 – 27 (24+/-2)
- Mixed = normal pH on the narrow range
- Partial compensation = mixed
- DKA : metabolic acidosis or mixed
- Compensation of pH moves it to upper limit of normal (7.45) or lower limit of normal (7.35) by regulating respiratory rate and tidal volume (p CO_2) or kidneys' reabsorption of HCO3
- The ratio of p CO_2 and HCO3 not the absolute levels determines pH
- In the case of three disorders use anion gap or base excess

  BB = buffer base : normally 48

  BE = buffer excess = normal- patient : normal range -6 ➡️ 6

  If more than +6 >> hidden metabolic alkalosis despite pH and compensation
- Lungs : one disorder Metabolic: bone , kidney, GI
- Anion gap = Na – HCO3 – Cl Normal range 10 – 16 (12+/-4) despite pH and ABGs

  If more than 18 >> high AG hidden metabolic acidosis

  Negative urinary AG implies increased renal excretion of NH4 (GI; type II RTA such as Fanconi syndrome, amyloidosis, multiple myeloma, acetazolamide; exogenous acid)

  Positive urinary AG implies failure of kidneys to excrete NH4 (type I RTA, type IV RTA, early renal failure)
- Any increase in unmeasured anions always is 1:1 with the increased H^+
- Compensation:

  Respiratory acidosis :

  Acute ⬆️10 p CO_2 : ⬆️ 1 HCO3

  Chronic ⬆️10 p CO_2 : ⬆️ 3 .5 HCO3

  Respiratory alkalosis:

  Acute ⬇10 p CO_2 : ⬇️ 2 HCO3

  Chronic ⬇10 p CO_2 : ⬇️ 5 HCO3

  Metabolic acidosis:

  Expected p CO_2 : (1.5 * HCO3) + 8

  If > actual: respiratory acidosis If < actual : respiratory alkalosis

  Metabolic alkalosis :

  Expected p CO_2 : change in p CO_2 + 40 = change in HCO3 *0.7

  (highly variable, and in some cases there may be no or minimal compensation. In chronic metabolic alkalosis, the PaCO2 should increase by roughly 5 mmHg for every 10 mEq/L increase in serum HCO3)

Approach

1. Acidosis or alkalosis ?
2. Is the overriding disturbance respiratory or metabolic?

Respiratory acidosis: $PaCO_2 > 40$ mmHg
Metabolic acidosis: serum $HCO_3 < 24$ mEq/L

3. If a respiratory disturbance is present, is it acute or chronic?
4. If metabolic acidosis is present, is there an increased anion gap?

- can have an anion gap acidosis even with a normal anion gap if hypoalbuminemic (decrease in unmeasured anions).
- anion gap may be increased due to metabolic alkalosis, if pH > 7.5 more negative charges are exposed on the surface of albumin therefore there is an increase in unmeasured anions.

5. If a metabolic disturbance is present, is the respiratory system compensating adequately?

- there is a linear relationship between $PaCO_2$ and serum HCO_3 in metabolic acidosis

Winter's formula: expected $PaCO_2 = [1.5 \times (\text{serum } HCO_3)] + 8$
if $PaCO_2$ lower, there is a concomitant primary respiratory alkalosis
if $PaCO_2$ higher, there is a concomitant primary respiratory acidosis

- the normal respiratory response is more difficult to predict for a primary metabolic alkalosis.
- appropriate compensation occurs with decreased alveolar ventilation and increased $PaCO_2$, but the $PaCO_2$ rarely rises to levels above 50 mmHg
- a subnormal $PaCO_2$ clearly indicates a concomitant primary respiratory alkalosis
- if the $PaCO_2$ is ≥ 50 mmHg this suggests a superimposed primary respiratory acidosis

6. Are other metabolic disturbances present in the patient with an anion-gap metabolic acidosis? calculate the corrected HCO_3 = delta gap + measured serum HCO_3

delta gap = calculated anion gap – 12 (normal anion gap)
if the corrected HCO_3 is greater than the expected 24 mEq/L, there is a concomitant primary metabolic alkalosis
if the corrected HCO_3 is less than the expected 24 mEq/L, there is a mixed disorder with a superimposed non-anion gap metabolic acidosis

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Examples

A 20-year-old man presents with obtundation. Past medical history is unobtainable. Blood pressure is 120/70 without orthostatic change and he is well perfused peripherally. The neurological exam is nonfocal. His laboratory values are :

Na: 138 mEq/L
K: 4.2 mEq/L
HCO_3: 5 mEq/L
Cl: 104 mEq/L
Creatinine: 1.0 mg/dL
BUN: 14 mg/dL
Ca: 10 mg/dL
Arterial blood gas on room air: PO_2 96, PCO_2 15, pH 7.02 Blood glucose: 90 mg/dL
Urinalysis: normal, without blood, protein, or crystals. Which of the following is the most likely acid-base disorder?

A. Pure normal anion gap metabolic acidosis
B. Respiratory acidosis
C. **Pure high anion gap metabolic acidosis**
D. Combined high anion gap metabolic acidosis and respiratory alkalosis
E. Combined high anion gap metabolic acidosis and respiratory acidosis

A 50 year old homeless man was brought to ER in stuporous state. BP is 100/50 mmHg , heart rate 120 , respiratory rate 35 and temperature of 40 C. He was found to have left foot cellulitis. His labs are :
Na 150
K 3.5
Cl 107
HCO3 10
pH 7.2
pCO2 25
Alcohol 40
Osmolality 370
Glucose 50
BUN 40
What is his acid base disorder?

A. Metabolic acidosis and metabolic alkalosis
B. **Metabolic acidosis with partial respiratory compensation**
C. Respiratory acidosis with partial metabolic compensation
D. Respiratory acidosis