

METABOLIC ACIDOSIS

(Last updated 07/24/2019; Reviewers: Vimal Ravi, MD; John M. Litell, DO)

IMMEDIATE CONSIDERATIONS

- Treat shock before progressing too far diagnostically

FINDINGS

- **Signs & Symptoms**
 - No specific symptoms
 - Patients may exhibit:
 - Chest pain
 - Palpitations
 - Headache
 - Altered mental status
 - Decreased visual acuity
 - Nausea and vomiting
 - Abdominal pain
 - Muscle and bone pain
 - Patients often exhibit compensatory hyperventilation with deep regular respirations
 - Kussmaul breathing
- **Classification**

Measure serum Anion gap (AG) and correct for albumin
$AG = [Na^+] - [Cl^-] - [HCO_3^-]$
Normal = 8-12 meq/L
Corrected AG = Observed AG + 0.25 (normal albumin - measured albumin)
<i>If albumin measured in g/L</i>

High anion gap metabolic acidosis (HAGMA)	Normal Anion gap metabolic acidosis (NAGMA)
DDx (MUDPILERS): Methanol Uremia Diabetic ketoacidosis Propylene glycol Isoniazid Lactic acidosis Ethanol, ethylene glycol Salicylates	DDx (HARDUPS): Hyperalimentation Acetazolamide Renal Tubular Acidosis Diarrhea Ureteral diversion Post-Hypocapnia Spironolactone

DIAGNOSTIC INTERVENTIONS

- History and physical exam
 - Evaluate:
 - Mental status
 - Airway
 - Respiratory effort
 - Determine possible precipitating events
- Labs
 - ABG
 - Low arterial pH (<7.35) and HCO_3^-
 - Respiratory compensation lowers PaCO_2
 - Metabolic panel
 - Measured (not calculated) HCO_3^-

- Anion gap
 - Serum glucose
 - Ketones
 - Remaining electrolytes
- Lactic acid level
- Urinalysis and urine anion gap
- Complete Blood Count, if relevant
- **Monitoring**
 - Electrocardiogram for changes related to potassium abnormalities
- **Imaging**
 - Based on predisposing condition

THERAPEUTIC INTERVENTIONS

- **General**
 - Stabilize the patient using ABCD
- Treat shock if present
- Treat the suspected cause
 - Diabetes Ketoacidosis
 - Fluid resuscitation
 - Insulin infusion
 - Potassium supplementation
 - Salicylate intoxication and hyperkalemia
 - Supplemental bicarbonate to decrease CNS damage
 - Bicarbonate deficit = $0.5 \times \text{body weight in kg} \times (24 - \text{serum bicarbonate})$
 - Half of the calculated deficit should be administered within the first 3-4 hours

- Alcoholic ketoacidosis
 - Fluid and dextrose infusion
 - +/- insulin
 - Give thiamine 100 mg IV/IM
- Methanol and ethylene glycol intoxication
 - Fomepizole
 - Ethanol in austere settings, but requires careful monitoring
- Normal anion gap acidosis
 - Consider sodium bicarbonate or THAM when $\text{pH} < 7.1$
- Renal Tubular Acidosis
 - Seek nephrologist input
 - Type I distal
 - Consider sodium bicarbonate or THAM
 - May need to supplement potassium
 - Type IV
 - Dietary potassium restriction may be necessary
 - Medications that cause potassium retention should be withdrawn
 - Consider fludrocortisone with loop diuretics and oral alkali supplementation
- Consider **hemodialysis**
- **Consult**
 - Nephrologist
 - Poison control

MANAGEMENT AFTER STABILIZATION

- **Follow-Up**

- Evaluate cause and prevent precipitating factors

CAUTIONS

- **Complications**

- Large amounts of sodium bicarbonate may cause:
 - Hyponatremia
 - Hyperosmolality
 - Volume overload
 - Worsening intracellular acidosis
 - Hypercapnic respiratory failure
- Intubation and mechanical ventilation
 - **Increase respiratory rate** to keep minute volume requirements and prevent worsening acidosis

4) ALGORITHM

Measure the arterial pH and PaCO ₂ , measure simultaneous venous HCO ₃ ⁻
Determine if the degree of respiratory compensation is adequate:
<ul style="list-style-type: none"> • Winter's formula: Expected PaCO₂ = (1.5 x HCO₃⁻) + 8 ± 2
<ul style="list-style-type: none"> • If compensation is not adequate, consider simultaneous respiratory failure
<ul style="list-style-type: none"> • Consider a mixed disorder if the pH is normal (i.e. with respiratory alkalosis in sepsis)
Calculate the Anion Gap
<ul style="list-style-type: none"> • What is the expected HCO₃⁻? (HCO₃⁻ falls 1 for every 1 rise in AG)
<ul style="list-style-type: none"> • Calculate of the Δ anion gap/ΔHCO₃⁻ ratio in patients who have an elevated anion gap

REFERENCES & ACKNOWLEDGMENT

Acknowledgement: Faiza Hashmi, MD

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