Acid Base (3)

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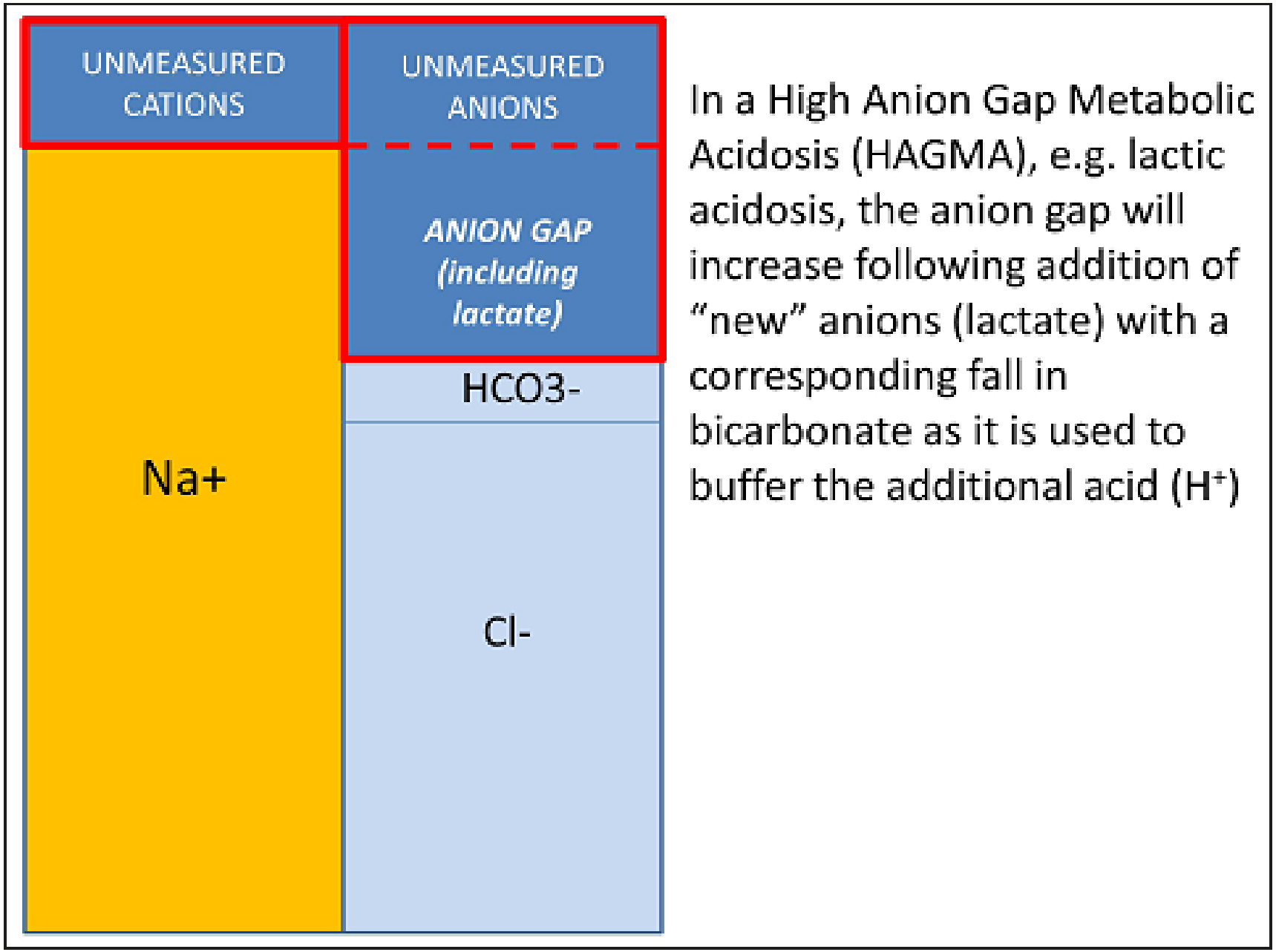
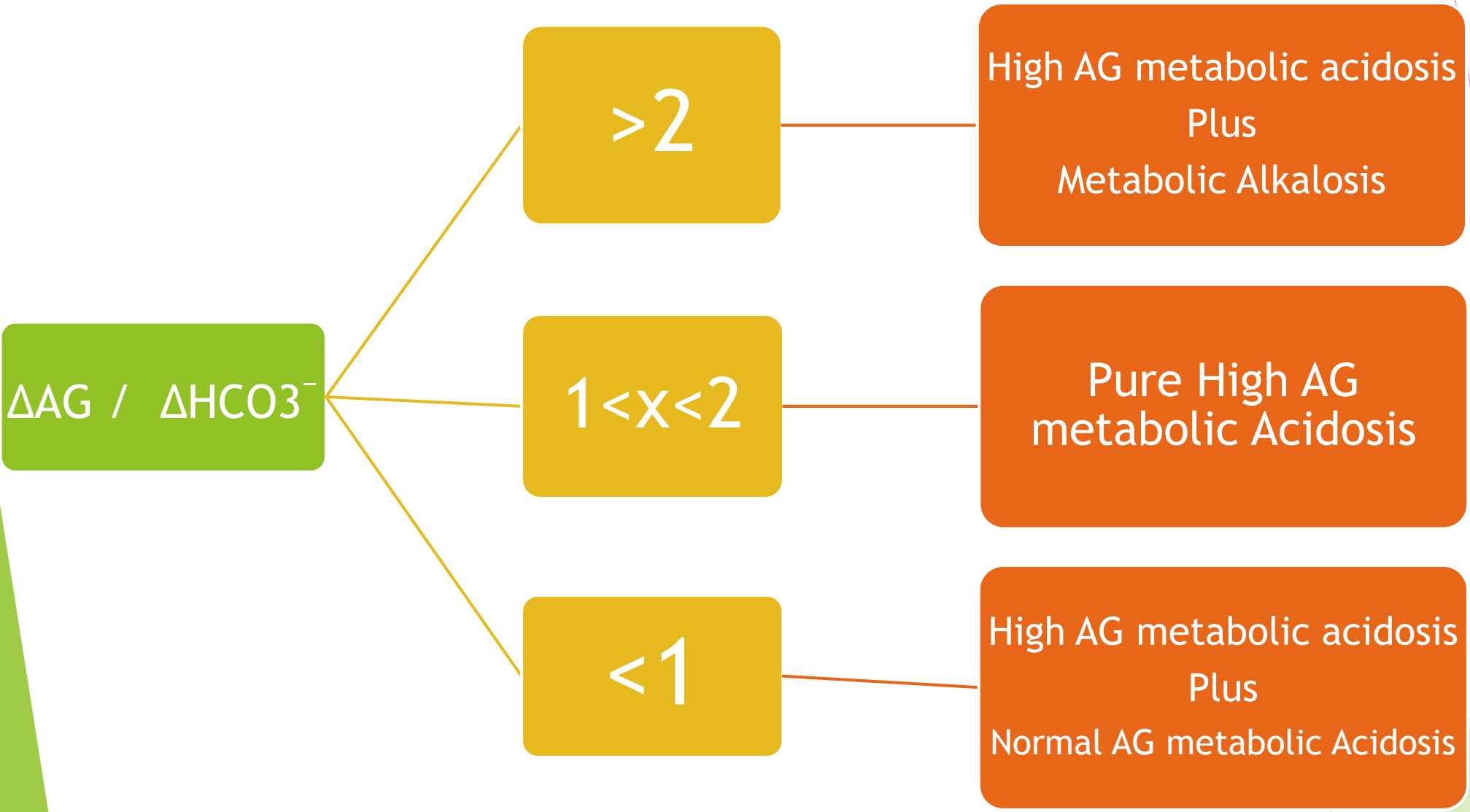


In a High Anion Gap Metabolic Acidosis (HAGMA), e.g. lactic acidosis, the anion gap will increase following addition of "new" anions (lactate) with a corresponding fall in bicarbonate as it is used to buffer the additional acid (H^+)

(b) High anion gap present in a metabolic acidosis


ΔAG / ΔHCO3⁻
>2
1<x<2
<1
High AG metabolic acidosis
Plus
Metabolic Alkalosis
Pure High AG
metabolic Acidosis
High AG metabolic acidosis
Plus
Normal AG metabolic Acidosis

Symptoms of Metabolic Acidosis

- Hyperpnea
  - 4 – 8 fold increase in minute ventilation
- Ventricular arrhythmias
- Neurologic symptoms (lethargy to coma)
- Nonspecific symptoms in infants
  - Anorexia
  - Nausea
  - Weight loss
  - Muscle weakness

Major causes of metabolic acidosis according to mechanism and anion gap

Mechanism of acidosis	Increased AG	Normal AG
Increased acid production	Lactic acidosis	
	Ketoacidosis	
	Diabetes mellitus	
	Starvation	
	Alcohol-associated	
	Ingestions	
	Methanol	
	Ethylene glycol	
	Aspirin	
	Toluene (if early)	
Loss of bicarbonate or bicarbonate precursors		Diarrhea or other intestinal losses (eg, tube drainage)
		Type 2 (proximal) RTA
		Posttreatment of ketoacidosis
		Toluene ingestion
		Carbonic anhydrase inhibitors
		Ureteral diversion (eg, ileal loop)
Decreased renal acid excretion	Chronic renal failure	Some cases of chronic renal failure
		Type 1 (distal) RTA
		Type 4 RTA (hypoaldosteronism)

Causes of High Anion-Gap Metabolic Acidosis

- Lactic acidosis
- Ketoacidosis
  - Diabetic
  - Alcoholic
  - Starvation
- Renal failure (acute and chronic)
- Toxins
  - Ethylene glycol
  - Methanol
  - Salicylates
  - Propylene glycol
  - Pyroglutamic acid

TABLE 51-2 Examples of Mixed Acid-Base Disorders

Mixed Metabolic and Respiratory

Metabolic acidosis—respiratory alkalosis

Key: High- or normal-AG metabolic acidosis; prevailing $Paco_2$ *below* predicted value (Table 51-1)

Example: Na^+, 140; K^+, 4.0; Cl^-, 106; HCO_3^-, 14; AG, 20; $Paco_2$, 24; pH, 7.39 (lactic acidosis, sepsis in ICU)

Metabolic acidosis—respiratory acidosis

Key: High- or normal-AG metabolic acidosis; prevailing $Paco_2$ *above* predicted value (Table 51-1)

Example: Na^+, 140; K^+, 4.0; Cl^-, 102; HCO_3^-, 18; AG, 20; $Paco_2$, 38; pH, 7.30 (severe pneumonia, pulmonary edema)

Metabolic alkalosis—respiratory alkalosis

Key: $Paco_2$ does not increase as predicted; pH higher than expected

Example: Na^+, 140; K^+, 4.0; Cl^-, 91; HCO_3^-, 33; AG, 16; $Paco_2$, 38; pH, 7.55 (liver disease and diuretics)

Metabolic alkalosis—respiratory acidosis

Key: $Paco_2$ higher than predicted; pH normal

Example: Na^+, 140; K^+, 3.5; Cl^-, 88; HCO_3^-, 42; AG, 10; $Paco_2$, 67; pH, 7.42 (COPD on diuretics)

Mixed Metabolic Disorders

Metabolic acidosis—metabolic alkalosis

Key: Only detectable with high-AG acidosis; $\Delta AG >> \Delta HCO_3^-$

Example: Na^+, 140; K^+, 3.0; Cl^-, 95; HCO_3^-, 25; AG, 20; $Paco_2$, 40; pH, 7.42 (uremia with vomiting)

Metabolic acidosis—metabolic acidosis

Key: Mixed high-AG—normal-AG acidosis; ΔHCO_3^- accounted for by combined change in ΔAG and ΔCl^-

Example: Na^+, 135; K^+, 3.0; Cl^-, 110; HCO_3^-, 10; AG, 15; $Paco_2$, 25; pH, 7.20 (diarrhea and lactic acidosis, toluene toxicity, treatment of diabetic ketoacidosis)