

# Sources of acid

- respiratory/volatile →  $CO_2$
- fixed/non-volatile → dietary

**PH**  
7.4

< 7.25

> 7.6

## ACIDOSIS

## ALKALOSIS

### Acid excretion

- Pulmonary →  $CO_2$  excretion
- metabolic → use of organic acid
- renal → fixed acid excretion

Low  $HCO_3^-$

High  $PaCO_2$

Low  $PaCO_2$

High  $HCO_3^-$

### METABOLIC ACIDOSIS

#### CALC ANION GAP

If low  $PaCO_2$

#### Respiratory Compensation

Hyperventilation  
Kussmaul breathing  
labored, deep, rapid

For every 1↓ in  $HCO_3^-$ ,  
 $PaCO_2$  ↓ by 1.2

loss of bicarb from:

- GI tract: diarrhea
- Kidney: proximal renal tubular acidosis
- ↓ renal excretion of  $H^+$
- distal renal tubular acidosis
- acute/chronic kidney injury
- excess acid
- endogenous: lactic acidosis, ketoacidosis
- exogenous: ethylene glycol, methanol, salicylates

#### Anion gap

Sodium - (chloride + bicarb)

normal 9-15

Unmeasured acid raises anion gap

### NON-ANION GAP

- Diarrhea
- Renal tubular acidosis

### ANION GAP

- Glycols
- Oxoproline
- L-lactic acidosis
- D-lactic acidosis
- Methanol
- Aspirin
- Renal failure
- Ketoacidosis

osmolar gap =  
measured serum osmolality  
- calculated

### RESPIRATORY ACIDOSIS

Hypoventilation, COPD,  
Brain damage, drug toxicity

If high  $HCO_3^-$

#### Metabolic Compensation

Renal absorption of bicarbonate

Acute: 10↑  $PaCO_2$ ,  
 $HCO_3^-$  ↑ by 1 (< 2 days)  
Chronic: 10↑  $PaCO_2$ ,  
 $HCO_3^-$  ↑ by 4 (2-5 days)

### RESPIRATORY ALKALOSIS

Hyperventilation, fever,  
Panic attack, drug toxicity

If low  $HCO_3^-$

#### Metabolic Compensation

increase bicarbonate wasting (excretion)

Acute: 10↓  $PaCO_2$ ,  
 $HCO_3^-$  ↓ by 2 (< 2 days)  
Chronic: 10↓  $PaCO_2$ ,  
 $HCO_3^-$  ↓ by 4 (2-5 days)

### METABOLIC ALKALOSIS

Prolonged vomiting/gastric suctioning, diuretic use, hypovolemia

If high  $PaCO_2$

#### Respiratory Compensation

Hypoventilation

For every 1↑ in  $HCO_3^-$ ,  
 $PaCO_2$  ↑ by 0.7

loss of acid from:

- GI tract: vomiting
- Kidney: hyperaldosteronism
- excess exogenous bicarb
- Sodium bicarb or citrate administration but **only** if there's also impaired renal excretion of bicarb

#### LOW/NORM BP

↓ effective circulating volume

#### HIGH BP

↑ ECF

#### Loss of HCl, Loss of volume

• Vomiting ↑ Na (> 15)  
alkaline urine ↓ Cl (< 15)

• NG suction

• Diuretics (hypokalemic)  
new: ↑ Na (> 15), ↑ Cl (> 15)  
chronic: ↓ Na (< 15), ↓ Cl (< 15)

• Bartter syndrome

• Gitelman syndrome

#### Primary Aldosteronism

Na > 15  
Cl > 15

increased aldosterone

Sodium retention

volume expansion

hypertension

natriuresis (aldosterone escape)