ACID-BASE DISORDERS

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Definitions

- What are the definitions of:
  - Acidemia
  - Alkalemia

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Definitions

- Acidemia
  - The condition of increased [H+] in blood
  - Low blood pH
- Alkalemia
  - The condition of decreased [H+] in blood
  - High blood pH

Definitions

- What are the definitions of:
  - Acidosis
  - Alkalosis

Definitions

- Acidosis
  - The disease process which increases [H+]
- Alkalosis
  - The disease process which decreases [H+]

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Definitions

- Can these 4 conditions coexist?

  - Acidemia
  - Alkalemia
  - Acidosis
  - Alkalosis

Definitions

- Acidemia and alkalemia
  - Generally does not coexist.
- Acidosis and alkalosis
  - More than one etiology may be simultaneously present.

Introduction

- Severe acidemia
- pH < 7.0

- What are 5 effects of severe acidemia?

Severe Acidemia

- Impairs enzyme function
- Interferes with electrophysiology
- Disturbs electrolyte balance
- Blocks calcium influx into cells
- Inhibits catecholamine action

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Basic Principles

- Aerobic cellular metabolism
  - Produces energy

- Carbohydrate + Fat ==> ATP + CO_2

- CO_2+H_2O <==> H_2CO_3 <==> $H+HCO_3$

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Basic Principles

- Acid-base disorders
- Alterations in hydrogen ion activity

- $pH = -\log [H+]$

- In extracellular fluid,
- what is the normal pH and [H+]?

Basic Principles

- In extracellular fluid:
- Normal pH = 7.40
- Normal $[H+]$ = 40 nEq/L

Basic Principles

- What is
- the Henderson-Hasselbalch equation?

Basic Principles

- Henderson-Hasselbalch equation
- Under equilibrium conditions
- pH is related to the molar concentrations of bicarbonate and carbonic acid

Basic Principles

- $pH = pK' + \log (HCO_3^- / H_2CO_3)$
- $pH = pK' + \log (HCO_3^- / [PCO_2 \times 0.03])$

- $pK' = 6.1$
- = – log of dissociation constant for H_2CO_3

- What is total CO_2?

Basic Principles

- $tCO_2 = [HCO_3^-] + \text{dissolved } CO_2$
- $tCO_2 = [HCO_3^-] + [H_2CO_3]$
- $tCO_2 = [HCO_3^-] + 0.03 \times PCO_2$

- What are normal values for :
- pH, PCO_2, PO_2, $[HCO_3^-]$?

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Basic Principles

- pH 7.35 - 7.45
- PCO2 35 - 45 mmHg
- PO2 80 - 100 mmHg
- [HCO3-] 22 - 26 mmol/L

Derangements

- Respiratory
- Net gain or loss of CO_2

- Metabolic
- Net gain or loss of HCO_3^-

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Simple Disturbances

- Primary Disorder / Compensation
- Respiratory acidosis HCO3- retention (renal)
- Respiratory alkalosis HCO3- elimination (renal)
- Metabolic acidosis CO2 elimination (respiratory)
- Metabolic alkalosis CO2 retention (respiratory)

Respiratory Derangements

- How do kidneys compensate?

Respiratory Derangements

- Kidneys adjust HCO3- reabsorption in the proximal tubules.
- The effect appears in 6 to 12 hours and slowly increases to a steady-state response over days.
- What is the relationship between pH and pCO2 in acute renal compensation?

Respiratory Derangements

- In acute respiratory derangement:

- If pCO2 changes 10 mmHg, what is the acute change in pH?

- If pCO2 changes 10 mmHg, what is the compensatory change in [HCO3]?

Respiratory Derangements

- Acute renal compensation
- Change in pH = 0.008 x change in pCO2
- Partial compensation
- change in pH < 0.008 x change in pCO2
- Superimposed acid-base disorder
- change in pH > 0.008 x change in pCO2

Respiratory Derangements

- Acute hypercapnia: $PCO_2 = 50$ mmHg
- Alteration: pH decreases 0.08
- Compensation: HCO_3 increases 2 mM

- Acute hypocapnia: $PCO_2 = 30$ mmHg
- Alteration: pH increases 0.08
- Compensation: HCO_3 decreases 2 mM

Respiratory Derangements

- Chronic hypercapnia: PCO2 = 50 mmHg
- Alteration: pH decreased 0.03
- Compensation: HCO3 increases 4 mM

- Chronic hypocapnia: PCO2 = 30 mmHg
- Alteration: pH increased 0.02
- Compensation: HCO3 decreases 5 mM

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Respiratory Acidosis

- pH < 7.35 and PCO2 > 45
- Causes
- Decreased alveolar ventilation
- Increased CO2 production

Respiratory Acidosis

- Decreased alveolar ventilation

- Neuromuscular etiologies?
- CNS etiologies?
- Pulmonary etiologies?
- Mechanical ventilator

Respiratory Acidosis

- Neuromuscular etiologies

- Disorders of nerve, muscle, or neuromuscular junction
- Drugs / toxins
- Hypokalemia

Respiratory Acidosis

- CNS etiologies

- CNS injury, ischemia, hemorrhage, tumor
- CNS depression
- Narcotics, sedatives, anesthetics

Respiratory Acidosis

- Pulmonary etiologies
- Restrictive disease (fibrosis)
- Obstructive disease
- Pulmonary edema
- Severe pneumonia
- Impaired diaphragmatic excursion
- Hemothorax, pneumothorax, flail chest
- Obesity – hypoventilation
- Mechanical Ventilator

- Increased CO2 Production?

Respiratory Acidosis

- Increased CO2 production

- High carbohydrate diet
- Hypermetabolism
- Fever
- Shivering

Respiratory Acidosis

- What is treatment?

Respiratory Acidosis

- Correct underlying cause
- Bronchospasm
- Pulmonary edema
- Reverse depressed ventilatory drive
- Sedation
- Narcotics
- Mechanical ventilation

Severe Alkalemia

- What are some effects of severe alkalemia?

Severe Alkalemia

- Cerebral vasoconstriction
- Seizures
- Confusion
- Coma
- Hypoventilation
- Arrhythmias
- Electrolyte disorder

Respiratory Alkalosis

- pH > 7.45 and $PCO_2 < 35$
- Caused by increased alveolar ventilation

Respiratory Alkalosis

- Causes
- CNS etiologies?
- Pulmonary etiologies?
- Pregnancy
- Thyrotoxicosis
- Hypoxemia
- Salicylates
- Sepsis
- Mechanical ventilation
- Burns
- Hepatic failure
- Severe anemia
- Carbon monoxide poisoning

Respiratory Alkalosis

- CNS etiologies

- Hyperventilation syndromes
- Anxiety
- Pain
- Tumor
- Trauma
- Infection
- Encephalopathy

Respiratory Alkalosis

- Pulmonary etiologies

- Pulmonary edema
- Pneumonia
- ARDS
- Pulmonary embolism
- Asthma
- Secretions

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Respiratory Alkalosis

- What is treatment?

Respiratory Alkalosis

- Correct underlying cause

- Anxiety
- Infection
- Fever
- Pain
- Hypovolemia

Metabolic Derangements

- How can we estimate the quantity of metabolic acids?

Metabolic Derangements

- What is anion gap?
- What is normal anion gap?

Metabolic Derangements

- Anion gap = Na – (Cl + HCO3)

- Principle of electroneutrality
- Total serum cations = total serum anions
- Na + UC = (Cl + HCO3) + UA
- UC = K + Ca + Mg
- UA = PO4 + SO4 + protein + organic acids

- Normal AG $\leq$ 12 mEq/L

Metabolic Derangements

- What is the relationship between hypoalbuminemia and anion gap?

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Metabolic Derangements

- Plasma proteins are the major source of UA.
- Decrease in plasma proteins decreases UA,
  - Results in realative increase in measured anions.
  - Results in decreased AG.
- The AG decreases 2.5 mEq/L for every 1 g/dL decrease in albumin.
- Is the AG a sensitive marker of lactic acidosis?

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Anion Gap

- What is the Delta AG?

Anion Gap

- Delta AG = Measured AG – Normal AG

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Pre-acidosis HCO3

- What is the pre-acidosis HCO3?

Pre-acidosis HCO3

- Pre-acidosis HCO3 =
  Delta AG + Measured HCO3

Decreased AG

- Hypoalbuminemia
- Renal anion excretion
- Paraproteinemia
- Hyponatremia
- Hyperosmolar states
- Hypercalcemia
- Hypermagnesemia
- Halide poisoning (Br, I; false elevation in Cl)
- Lithium intoxication (cation)
- Polymyxin B (cation)

Increased AG

- Carbenicillin (anion)
- Exposure of sample to air

Metabolic Acidosis

- pH < 7.35 and normal PCO2
- Causes
- Increased acids – AG acidosis
- Decreased HCO3 – normal AG acidosis
- Increased Cl – normal AG acidosis

Metabolic Acidosis

- Increased acids - AG acidosis
- Lactic acidosis
- Renal failure (impaired excretion)
- Ketoacidosis
- Diabetic, alcoholic
- Rhabdomyolysis
- Toxins
- Salicylates, methanol, paraldehyde,
- ethylene glycol, propylene glycol, toluene

Metabolic Acidosis

- Decreased HCO3 – normal AG acidosis
- Renal tubular acidosis
- Tubulointerstitial disease
- Acetazolamide therapy
- Hyperchloremic acidosis
- NaCl, NH4Cl, HCl, arginine Cl
- Renal failure
- Dilutional acidosis
- GI HCO3 loss
- Biliary or pancreatic drainage, diarrhea, fistula
- Ureteral diversions
- Adrenal insufficiency

Renal Tubular Acidosis

- Kidneys unable to account for normal acid production
- 4 Types

- I. Proximal H+ secretion, normal GFR
- TX: NaHco3
- II. Classical distal, normal GFR
- TX: NaHCO3
- III. Buffer deficiency distal, Low GFR
- TX: NaHCO3
- IV. Generalized distal, Low GFR
- TX: NaHCO3, K restriction, furosemide, fludrocortisone

Metabolic Acidosis

- What causes respiratory compensation?
- Rule of sevens?

Metabolic Acidosis

- H+ sensitive chemoreceptors located in the carotid body and in the brainstem modulates respiratory drive.

- Rule of sevens

- With pH decrease of 0.1
- PCO2 decreases 7 mmHg

Respiratory Compensation

- What is the expected PCO2 in respiratory compensation of
- metabolic acidosis?

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Respiratory Compensation

- Expected $PCO_2 = 1.5 \times HCO_3 + 8 \pm 2$

Metabolic Acidosis

- What is treatment?

Metabolic Acidosis

- Correct underlying cause
- Shock, DKA, toxin
- Administer $NaHCO_3$
- HCO_3 deficit =
- Weight x 0.2 x (24 mM – actual HCO_3)
- 0.2 = 20% extracellular fluid

Metabolic Alkalosis

- Adverse effects?

Metabolic Alkalosis

- Neurologic
- Depressed consciousness
- Seizures
- Carpopedal spasms
- Hypoventilation
- Tissue oxygenation?
- Increases calcium binding to albumin – decreased ionized (free) calcium impairs myocardial contractility.
- Shifts oxyhemoglobin dissociation curve to the left, decreasing oxygen release in tissues.

Metabolic Acidosis

- Excessive use of $NaHCO_3$
- Increased Na load
- Shifts oxyhemoglobin distribution curve to the left
- compromising O_2 delivery

Metabolic Alkalosis

- pH > 7.45 and HCO3 > 26
- Causes
- Cl-responsive?
- Cl-resistant?

Metabolic Alkalosis

- Cl-responsive – Urine Cl < 10 mM
- Reduced ECF volume (contraction)
- Vomiting
- Nasogastric suction
- Diuretics
- Diarrhea
- Posthypercapnia
- Carbenicillin
- Penicillin
- Villous adenoma

Metabolic Alkalosis

- Cl-resistant – Urine Cl > 20 mM
- Normal ECF volume
- Hyperaldosteronism
- Cushing's disease
- Glucocorticoids
- Refeeding alkalosis
- K depletion
- Excess alkali (HCO3, citrate, lactate)
- Mg depletion

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Metabolic Alkalosis

- What is treatment?

Metabolic Alkalosis

- Correct underlying cause
- NG suction, diarrhea, diuretics
- Life-threatening alkalosis
- 0.1 N HCl infusion
- Restoration of intravascular volume
- 0.9 NaCl
- Correction of electrolyte abnormalities
- K and Mg
- Carbonic anhydrase inhibitor
- Acetazolamide (carbonic anhydrase inhibitor)
- Blocks HCO3- reabsorpiton in the proximal tubules.

Key Points

- In primary acid-base disorders:
- the process that caused the pH shift is the primary disorder
- compensation cannot overcorrect the pH derangement
- A mixed disorder is present when:
- Unexpected pH for a given PCO2 change
- Unexpected pH for a given HCO3- change

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True or False?

- The bicarbonate–carbonic acid system is the primary intracellular buffering system.

True or False?

- False
- Important intracellular buffers include proteins and phosphates.

True or False?

- The ratio of the base bicarbonate to carbonic acid determines the extracellular fluid pH.

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True or False?

- True

True or False?

- The functions of the extracellular buffering system are expressed in the Henderson-Hasselbalch equation:

- pH = pK + log ([H2CO3] / [HCO3-])

True or False?

- False
- $pH = pK + \log([HCO_3^-] / [H_2CO_3])$

True or False?

- A bicarbonate–carbonic acid ratio of 10:1 is associated with a normal pH (7.4).

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True or False?

- False
- 20:1

True or False?

- Hyperkalemia is a frequent complication of respiratory alkalosis.

True or False?

- False
- In alkalosis, preferential excretion of potassium, rather than hydrogen ion, in exchange for sodium occurs at the level of the distal convoluted tubule.

True or False?

- Potassium restriction is an important adjunct in the treatment of respiratory alkalosis.

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True or False?

- False
- Hypokalemia contributes to alkalosis because hydrogen ion rather than potassium is excreted for sodium resorption.

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True or False?

- The most common cause of acid excess in the critical care patient is prolonged NG suction.

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True or False?

- False
- Shock and lactic acidosis.

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True or False?

- Restoration of blood pressure with vasopressors corrects the metabolic acidosis with circulatory failure.

True or False?

- False

- Volume replacement results in the restoration of circulation.

Stepwise Analysis

- 1. Does the patient have an acidemia or alkalemia?
- 2. Is the primary disturbance respiratory or metabolic?
- 3. Is the compensation appropriate?
- 4. Is the anion gap elevated?
- 5. Determine whether an additional disorder is present.

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO_3 = 6
  - PCO_2 = 15
  - PO_2 = 102
  - pH = 7.19
  - Glucose = 324
- A. What is the acid-base disorder?

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO3 = 6
  - PCO2 = 15
  - PO2 = 102
  - pH = 7.19
  - Glucose = 324

- A. Is the patient acidemic or alkalemic?
- Acidemic, pH < 7.4

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO3 = 6
  - PCO2 = 15
  - PO2 = 102
  - pH = 7.19
  - Glucose = 324
- B. Is the primary disorder respiratory or metabolic?

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO3 = 6
  - PCO2 = 15
  - PO2 = 102
  - pH = 7.19
  - Glucose = 324
- B. Is the primary disorder respiratory or metabolic?
- Metabolic, PCO2 < 40

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO_3 = 6
  - PCO_2 = 15
  - PO_2 = 102
  - pH = 7.19
  - Glucose = 324
- C. What is this patient's anion gap?

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO3 = 6
  - PCO2 = 15
  - PO2 = 102
  - pH = 7.19
  - Glucose = 324

- C. What is this patient's anion gap?
- AG = 128 – (94 + 6) = 28
- High AG metabolic acidosis

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Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO3 = 6
  - PCO2 = 15
  - PO2 = 102
  - pH = 7.19
  - Glucose = 324

- D. Is there a mixed metabolic acidosis and alkalosis?
- Delta AG = 28 – 12 = 16

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO3 = 6
  - PCO2 = 15
  - PO2 = 102
  - pH = 7.19
  - Glucose = 324

- D. Is there a mixed metabolic acidosis and alkalosis?
- Pre-acidosis HCO3 = 16 + 6 = 22
- No underlying metabolic alkalosis

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO_3 = 6
  - PCO_2 = 15
  - PO_2 = 102
  - pH = 7.19
  - Glucose = 324

- E. Is the compensation for metabolic acidosis appropriate?

Problem #1

- 22M w/ DM develops a severe URI.
  - Na = 128
  - K = 5.9
  - Cl = 94
  - HCO3 = 6
  - PCO2 = 15
  - PO2 = 102
  - pH = 7.19
  - Glucose = 324

- E. Is the compensation for metabolic acidosis appropriate?
- Expected PCO2 = 1.5 x 6 + 8 ± 2
- Expected PCO2 = 17 ± 2
- Simple compensated metabolic acidosis

Problem #1

- What is the cause of this patient's increase in anion gap?

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Problem #1

- Diabetic ketoacidosis

Problem # 2

- 47F w/ CRF & severe alcohol intoxication.
  - Na = 134
  - K = 6.1
  - Cl = 112
  - HCO3 = 10
  - PCO2 = 30
  - PO2 = 52
  - pH = 7.10
  - Creatinine = 3.7
- A. What is the acid-base disorder?

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Problem # 2

- 47F w/ CRF & severe alcohol intoxication.
  - Na = 134
  - K = 6.1
  - Cl = 112
  - HCO_3 = 10
  - PCO_2 = 30
  - PO_2 = 52
  - pH = 7.10
  - Creatinine = 3.7

- A. Is the patient acidemic or alkalemic?
- Acidemic, pH < 7.4

Problem # 2

- 47F w/ CRF & severe alcohol intoxication.
  - Na = 134
  - K = 6.1
  - Cl = 112
  - HCO_3 = 10
  - PCO_2 = 30
  - PO_2 = 52
  - pH = 7.10
  - Creatinine = 3.7

- B. Is the primary disorder respiratory or metabolic?

Problem # 2

- 47F w/ CRF & severe alcohol intoxication.
  - Na = 134
  - K = 6.1
  - Cl = 112
  - HCO3 = 10
  - PCO2 = 30
  - PO2 = 52
  - pH = 7.10
  - Creatinine = 3.7

- B. Is the primary disorder respiratory or metabolic?
- Metabolic, pCO2 < 40

Problem # 2

- 47F w/ CRF & severe alcohol intoxication. RR = 10.
  - Na = 134
  - K = 6.1
  - Cl = 112
  - HCO3 = 10
  - PCO2 = 30
  - PO2 = 52
  - pH = 7.10
  - Creatinine = 3.7

  - C. What is the AG?

Problem # 2

- 47F w/ CRF & severe alcohol intoxication. RR = 10.
  - Na = 134
  - K = 6.1
  - Cl = 112
  - HCO3 = 10
  - PCO2 = 30
  - PO2 = 52
  - pH = 7.10
  - Creatinine = 3.7
- C. What is the AG?
- AG = 134 – (112 + 10) = 12
- Normal AG metabolic acidosis

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Problem # 2

- 47F w/ CRF & severe alcohol intoxication. RR = 10.
  - Na = 134
  - K = 6.1
  - Cl = 112
  - HCO3 = 10
  - PCO2 = 30
  - PO2 = 52
  - pH = 7.10
  - Creatinine = 3.7

- D. Is the compensation for the metabolic acidosis appropriate?

Problem # 2

- 47F w/ CRF & severe alcohol intoxication. RR = 10.
  - Na = 134
  - K = 6.1
  - Cl = 112
  - HCO3 = 10
  - PCO2 = 30
  - PO2 = 52
  - pH = 7.10
  - Creatinine = 3.7

- D. Is the compensation for the metabolic acidosis appropriate?
- Expected PCO2 = $1.5 \times 10 + 8 \pm 2$
- Expected PCO2 = 23 ± 2
- Mixed metabolic and respiratory acidosis.

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Problem # 2

- What could cause this patient's mixed metabolic and respiratory acidosis?

Problem # 2

- Metabolic acidosis may be related to CRF.
- Respiratory acidosis may be related to alcohol intoxication with reduced respiratory drive.

Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO_3 = 18
  - PCO_2 = 49
  - PO_2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates
- A. What is the acid-base disorder?

Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO3 = 18
  - PCO2 = 49
  - PO2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates

- A. Is the patient acidemic or alkalemic?
- Acidemic, pH < 7.4

Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO3 = 18
  - PCO2 = 49
  - PO2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates

- B. Is the primary disorder respiratory or metabolic?

Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO_3 = 18
  - PCO_2 = 49
  - PO_2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates
- B. Is the primary disorder respiratory or metabolic?
- Respiratory, $PCO_2 > 40$

Problem # 3

- What is the expected HCO3 in metabolic compensation for acute respiratory acidosis?

Problem # 3

- Expected $HCO_3 = 24 + (PCO_2 - 40) / 10$

Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO_3 = 18
  - PCO_2 = 49
  - PO_2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates

- C. Is the compensation for the respiratory acidosis appropriate?

Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO3 = 18
  - PCO2 = 49
  - PO2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates

- C. Is the compensation for the respiratory acidosis appropriate?
- Expected HCO3 = 24 + (49 – 40) / 10
- Expected HCO3 = 25
- Mixed respiratory and metabolic acidosis

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Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO_3 = 18
  - PCO_2 = 49
  - PO_2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates
- D. What is the AG?

Problem # 3

- 47F w/ binge drinking, N/V, fever.
    - Na = 140
    - K = 2.9
    - Cl = 96
    - HCO3 = 18
    - PCO2 = 49
    - PO2 = 45
    - pH = 7.15
    - Glucose = 96
    - UA: 4+ ketones
    - CXR: infiltrates

- D. What is the AG?
- AG = 140 – (96 + 18) = 26
- High AG metabolic acidosis

Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO_3 = 18
  - PCO_2 = 49
  - PO_2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates
- E. Is there a mixed metabolic acidosis and alkalosis?

Problem # 3

- 47F w/ binge drinking, N/V, fever.
  - Na = 140
  - K = 2.9
  - Cl = 96
  - HCO3 = 18
  - PCO2 = 49
  - PO2 = 45
  - pH = 7.15
  - Glucose = 96
  - UA: 4+ ketones
  - CXR: infiltrates

- E. Is there a mixed metabolic acidosis and alkalosis?
- Delta AG = 26 – 12 = 14
- Pre-acidosis HCO3 = 14 + 18 = 32
- Mixed respiratory acidosis, metabolic acidosis, and metabolic alkalosis.

Problem # 3

- What is the explanation for this patient's triple acid-base disturbance?

Problem # 3

- Chronic alcoholic
  - Metabolic acidosis
    - Alcaholic ketoacidosis
      - UA w/ 4+ ketones
  - Respiratory acidosis
    - Pneumonia
      - CXR w/ infiltrates
  - Metabolic alkalosis
    - Nausea / vomiting

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