ACID- BASE and ELECTROLYTE BALANCE

MGHS School of EMT-Paramedic Program 2011
ACID- BASE BALANCE

• Ions balance themselves like a see-saw. Solutions turn into acids when concentration of hydrogen ions rises and turns to a base when it falls.
• pH - The concentration of hydrogen ions
• Normal pH values are 7.35- 7.45
• <7.35 pH indicates an acid
• >7.45 pH indicates an base (Alkalosis)
• A neutral solution such as water has a pH of 7.0
• Blood has a pH of 7.4 with a variance of .05
COMPENSATORY MECHANISMS

- The kidneys help through three mechanisms.
- First is the recovery of Bicarbonate, which is filtered into the tubules.
- Second is the excretion of Hydrogen ions against the gradient to acidify the urine. Normally, the kidney can acidify urine to a pH of 5.0.
- Third is the excretion of ammonium ions (NH4+).
- This occurs slowly over several hours or days.
COMPENSATORY MECHANISMS

- There are 3 mechanisms: The Bicarbonate-Carbonic acid buffer system in plasma, lungs, and kidneys.
- Buffers: Bicarbonate, Carbon Dioxide and Carbonic Acid are always present in the balance of blood.
- Carbonic Acid is formed in extracellular fluid when CO2 unites with H2O. When cations unite with anion Bicarbonate, a base Bicarbonate is formed-
- Example would be CO2+H2O=H2CO3=H+HCO3
COMPENSATORY MECHANISMS

The lungs, after releasing oxygen to peripheral tissues, hemoglobin binds with carbon dioxide and Hydrogen ions.

As blood reaches the lungs, actions reverse. Hemoglobin binds with O2, releasing CO2 and hydrogen ions.

Hydrogen ions combine with Bicarbonate ions, forming Carbonic acid, breaking down to CO2 and H2O, and lungs expel CO2.

The amount of CO2 in the blood determines the rate of breathing in healthy individuals.
ACIDOSIS- ALKALOSIS

• Any condition that increases Carbonic acid or decreases Bicarbonate base causes acidosis.
• Any condition that increases Bicarbonate base or decreases Carbonic acid causes alkalosis.
• Metabolic disturbances tend to affect the Bicarbonate side and respiratory disturbances tend to affect the Carbonic acid side.
ACIDOSIS- ALKALOSIS

• 4 divisions off acidosis- alkalosis
  • 1. Respiratory Acidosis
  • 2. Respiratory Alkalosis
  • 3. Metabolic Acidosis
  • 4. Metabolic Alkalosis
RESPIRATORY ACIDOSIS

- Caused by retention of Carbon dioxide, leading to an increase in pCO2.
- Reduction in alveolar ventilation may occur as a result of the following:
  - Respiratory Depression including respiratory and cardiac arrest, neuromuscular impairment, and medications such as sedatives and hypnotics.
  - Chest wall injury including flail chest and pneumothorax.
  - Pulmonary processes including obstructed airway, COPD, and pulmonary edema.
RESPIRATORY ACIDOSIS

- Patients with respiratory acidosis should be treated by improving ventilation to eliminate CO₂. Assisting the ventilation will decrease pCO₂. Supplemental oxygen should be administered to help correct hypoxia, which can lead to acidosis.
RESPIRATORY ALKALOSIS

- Hyperventilation may cause decreased pCO2 because of excessive CO2 elimination, resulting in elevated blood pH.
- Treatment involves treating the underlying cause of hyperventilation.
- Causes of hyperventilation: Sepsis, peritonitis, shock, and respiratory ailments.
METABOLIC ACIDOSIS

• Results from an accumulation off acid or loss of a base
• 4 most common Prehospital encounters are lactic acidosis, diabetic ketoacidosis, acidosis from renal failure, and acidosis from ingestion off toxins.
• Treatment off metabolic acidosis varies but may include induced respiratory alkalosis, IV administration off Bicarbonate..
METABOLIC ALKALOSIS

• Results from loss off Hydrogen ions including IV injection of a base, diuretics, or vomiting

• Treatment involves correcting underlying problem, IV Lasix (a diuretic), isotonic IV solutions, hypokalemia treated with Potassium.
MIXED ACID-BASE DISTURBANCES

- Various forms of shock may produce abnormalities of acid-base regulation. Patients can have a combination of either metabolic or respiratory acidosis or alkalosis.
- When this is present, there can be either a mixed state acidosis or alkalosis, compensated or partially compensated.
BLOOD GAS ANALYSIS

• Blood gases are obtained for two reasons:
  • 1.. To determine if patient is well oxygenated
  • 2.. To determine the patients acid-base balance

• Test are measured using arterial blood and procedure is known as “ABG”, arterial blood gas..
NORMAL ARTERIAL BLOOD GAS VALUES

- pH - 7.35 - 7.45
- P02 - 80-100 mmHg
- O2 Saturation - 95% or higher
- pCO2 - 35- 45 mmHg
- HCO3 - 22-26 mEq/L
ARterial Blood Gases

- pH 7.25, pCO2 50, HCO3 24, Sp02 96%
  = Respiratory Acidosis
- pH 7.50, pCO2 38, HCO3 32, Sp02 95%
  = Metabolic Alkalosis
- pH 7.30, pCO2 32, HCO3 26, Sp02 97%
  = Respiratory Acidosis
- pH 7.28, pCO2 39, HCO3 20, Sp02 95%
  = Metabolic Acidosis
ARTERIAL BLOOD GASES...continued

• pH 7.31, pCO2 47, HCO3 20, SpO2 97%
  = Mixed state acidosis
• pH 7.48, pCO2 32, HCO3 28, SpO2 98%
  = Mixed state alkalosis
• pH 7.45, pCO2 32, HCO3 19, SpO2 96%
  = Compensated respiratory alkalosis
• pH 7.32, pCO2 48, HCO3 20, SpO2 99%
  = Partially compensated metabolic acidosis
FYI-ARTERIAL BLOOD GASES

• When charted on hospital paperwork, the physician will chart the ABG’s as follows:

• pH/pCO2/pO2/HCO3-/saO2
ELECTROLYTES and ELECTROLYTE IMBALANCES

- Electrolytes are salt substances whose molecules dissociate into charged components when in water.
- Water makes up 50-60% of body weight in adults.
- Cation - Positive charged ion such as Na, K, Ca, H, Mg, Fe.
- Anion - Negative charged ion such as Cl, HCO3-, PO43-
- The human body also contains non-electrolytes such as glucose and urea (Nitrogen containing waste product) which have no electrical charge.
ELECTROLYTES and ELECTROLYTE IMBALANCES

• Hypertonic Solution- Solution that has higher solute concentration than that of the cell. This causes water molecules to move out of the cell and shrink. Examples are: D50 and Sodium Bicarbonate.

• Hypotonic Solution- Solution that has lower solute concentration than that of the cell. This causes water molecules to be drawn into the cell. Examples include: D2.5W and .45% normal saline.

• Isotonic Solution- Solution that has the same solution inside the cell and no movement of molecules. Examples include: 0.9% saline and lactated ringers.
ELECTROLYTE IMBALANCES

• Some electrolytes and lab values are:
  • Calcium 4.5- 5.5 mEq/L
  • Glucose 65-110
  • Magnesium 1.5- 2.5 mEq/L
  • Potassium 3.5- 5.0 mEq/L
  • Sodium 136- 147 mEq/L
ELECTROLYTE IMBALANCE

• Remember to get a GOOD history. This will tell you most off what you need to know to adequately treat the patient.
POTASSIUM

- Major cation in intracellular fluid
- Must maintain serum level of 3.5-5 mEq/L for normal nerve, cardiac, and skeletal muscle function.
- Excess potassium is normally excreted through the kidneys.
- Potassium imbalances interfere with neuromuscular function and cardiac rhythm disturbances.
HYPOKALEMIA

• Hypokalemia- Lack of potassium
• Can be caused by reduced dietary intake, vomiting or diarrhea, renal disease, and medications such as diuretics.
• S & S include skeletal muscle weakness, decreased reflexes, weak pulse, shallow respirations, low B/P, vomiting, excessive thirst.
HYPOKALEMIA

- Treatment off hypokalemia involves IV or oral administration of potassium in the hospital setting.
HYPERKALEMIA

• Hyperkalemia results from excessive potassium
• Can be caused by acute or chronic renal failure, burns, crush injuries, severe infections, excessive use of potassium salts, and shift from intracellular to extracellular.
• S & S include irritability, abdominal distension, nausea, diarrhea, weakness and paralysis. Also, observe for possible peaked “T” waves on the ECG.
HYPERKALEMIA

- In an emergency situation, treatment off hyperkalemia involves IV administration of glucose and insulin (25g D50 and 10 units insulin “R”). This helps by forcing potassium intracellular. Sodium Bicarbonate also causes this. Calcium may also be used IV as an antagonist to cardiac effects off hyperkalemia..
CALCIUM

• Calcium is essential for neuromuscular transmission, hormone secretion, growth and ossification of bones, and all muscle type contraction. Hypocalcemia is a decrease in calcium. May be caused by parathyroid dysfunction, renal insufficiency, decreased intake.
HYPOCALCEMIA

• S & S include parathesia, abdominal cramps, muscle cramps, personal changes, abnormal behavior, convulsions.
• In hospital treatment involves IV administration off calcium. Calcium salt and Vitamin D are given orally for maintenance.
HYPERCALCEMIA

• Hypercalcemia is excessive calcium in the extracellular space
• May be caused by thyroid dysfunction, diuretic therapy, excessive administration of vitamin D.
• S & S include decreased muscle tone, renal stones, altered mental status, deep bone pain.
HYPERCALCEMIA

• Treatment is aimed at treating underlying disease, hydration, and sometimes drug therapy.

• In the event of an emergency, forced diuresis with normal saline and Lasix are given.
MAGNESIUM

• Approximately 50% off body's Magnesium exist in an insoluble state in bone.

• Magnesium is excreted by the kidneys and has effects such as growth and ossification of bones and muscle contraction.
HYPOMAGNESESEMIA

- Hypomagnesaemia is a magnesium deficit.

- May be encountered in alcoholism, starvation, diarrhea, and diuresis.

- S&S include increased irritability off the nervous system, tremors, N/V, diarrhea, confusion including hallucinations, seizures, and cardiac dysrhythmias.
HYPMAGNESEMIA

• In hospital treatment involves IV administration of Magnesium Sulfate.
HYPERMAGNESESEMIA

• Hypermagnesemia is excess magnesium.

• Occurs primarily in patients with chronic renal insufficiency. Can also occur in patients ingesting large amounts of magnesium containing compounds such as magnesium citrate or antacids.

• Causes central nervous system depression, profound muscle weakness, cardiac rhythm disturbances, confusion, respiratory paralysis.
HYPERMAGNESEMIA

• The most effective treatment is hemodialysis.

• Calcium salts can also be used as an antagonist to magnesium.

• IV dextrose can be given to drive magnesium intracellular when respiratory depression or cardiac dysrhythmias are present.
Questions-

• Exercises to follow-