**NMNEC Concept: Acid-Base Balance**

**Mega Concept:** Health and Illness

**Category:** Homeostasis & Regulation

**Concept Name:** Acid-Base Balance

**Concept Definition:**
Factors that affect the regulation of pH and conditions that contribute to imbalances.

**Scope and Categories:**
- **Scope:** Ranges on a continuum: Acidotic (pH less than 7.35) to optimal balance (maintained by compensatory mechanisms) to alkalotic (pH greater than 7.45)
- **Categories**
  - Respiratory etiologies and processes
  - Metabolic etiologies and processes

**Risk Factors:**
Acid-base imbalances can affect all individuals regardless of age, gender, race, or socioeconomic status and usually occur as a consequence of an underlying condition or a disease process.

**Individual risk factors that result in failure of compensatory mechanisms:**
- Underlying conditions: Diabetes, chronic respiratory conditions, renal failure, pain, anxiety, and hypoperfusion states are a few examples.
- Nutrition: Starvation, malnutrition, malabsorption syndrome.
- Smoking: Structural changes including changes from chronic obstructive pulmonary disease (COPD), chronic bronchitis, or asthma.
- Infection: Systemic inflammatory Response Syndrome (SIRS) and Sepsis.
- Complications of treatments: medications, NG suction, and mechanical ventilation.

**Physiological Processes and Consequences:**
- **Physiological Processes:**
  - Respiratory processes
    - Controls carbon dioxide (CO₂) → carbonic acid
    - Dependent on respiratory minute volume, alveolar gas exchange
  - Metabolic processes
Controlled by renal system
- Distal tubule
- Elimination of hydrogen (H+) ion
- Conservation of bicarbonate

H+ ion produced during metabolic processes
- Anaerobic metabolism
- Homeostasis of shifting electrolytes
- Ketone production

Compensatory processes
- Respiratory responses: Increasing or decreasing carbonic acid from lungs and increasing or decreasing ventilation (occurs in minutes to twenty-four hours).
- Renal responses: retention or excretion of bicarbonate in distal tubule. Retention of bicarbonate begins within six to twelve hours with most effect in three to four days.

Buffer system
- Carbonic acid/ bicarbonate
  - Extracellular

Protein buffer system
- Intracellular and plasma proteins (amphoteric)

Potassium-Hydrogen exchange
- Intracellular, plasma, and renal

Phosphate, Chloride-Bicarbonate exchange
- Renal tubules

Acid excretion
- Carbonic acid excretion: Respiratory carbon dioxide (CO₂) excretion (increased rate)
- Metabolic acid excretion: Renal excretion of H+ ions or bicarbonate loss

Consequences:
Acid-base imbalances may alter the function of most cells, tissues, organs, with overall systemic consequences.
- Electrolyte Imbalances
  - Hyperkalemia
    - Shift of potassium out of cell, H+ ions into cell in acidosis.
  - Hypercalcemia
    - Calcium released from albumin increasing amount of ionized calcium.
CO₂ narcosis
- Cognitive function decline
- Musculoskeletal dysfunction
- Intracranial regulation alteration
- Altered drug metabolism, distribution, and elimination
- Cellular and organ function impairment: such as cerebral function. Acidosis puts the brain to sleep, alkalosis wakes it up.

Assessment/Attributes:
Manifestations due to underlying conditions, disease processes, and/or underlying fluid and electrolyte imbalances.

Subjective:
- Baseline history: Focus on underlying medical conditions including a focused assessment of the respiratory, renal, or other conditions; including but not limited to metabolic disorders, altered elimination, altered perfusion, poor nutrition, and medication therapies.
- Alterations in body functions: Focus on target organs and alterations.
- Concerning symptoms reported, aggravating or relieving factors.
- Medication use: Diuretics (altered elimination), medications containing bicarbonate, salicylates, narcotics and sedatives (respiratory depression)

Objective:
- Examination findings-disruptions usually overshadowed by underlying cause of imbalance:
  - Respiratory assessment
    - Respiratory rate and depth (fast, deep, slow, shallow)
    - Breathe odor (fruity in diabetic ketoacidosis [DKA])
    - Lung sounds (rales, rhonchi, none) noting location
  - Renal assessment
    - Urine output (too much, too little)
    - Presence of ketones in blood or urine
    - Accurate intake and output (I & O) measurements

Diagnostic Tests:
- Laboratory testing
  - Arterial blood gas-pH, partial pressure of carbon dioxide (PaCO₂), partial pressure of oxygen (PaO₂), and bicarbonate (HCO⁻₃) concentrations; Base excess would reflect activation of compensatory mechanisms.
Venous blood gas - same as arterial blood gas (ABG), but reflects oxygen utilization
- Basic metabolic panel - CO₂, electrolytes (potassium and calcium), and anion gap.
- Lactate (anaerobic metabolism)
- Complete Blood Count (CBC), White Blood Cells (WBCs) (infection), Hemoglobin and Hematocrit (Hgb & Hct) – evaluating oxygen carrying capacity

Clinical Management - Interdisciplinary:
Primary: Prevention by health Promotion or minimization of risk factors.
- Patient education and community-based interventions
  - Tobacco prevention and cessation
  - Diabetes management
  - Reduction in infection risk
  - Immunization management
- Target healthy lifestyle - regular physical activity, balanced diet, and avoid tobacco use

Secondary: Screening
- Diabetes screening

Tertiary: Treating the underlying cause.
- Collaborative interventions
  - Respiratory support: improved ventilation and gas exchange (O₂ and CO₂ regulation), ventilatory support
  - Fluid and electrolyte support: correction of fluid, potassium and other electrolyte imbalances

Interrelated Concepts:
- Nutrition: Starvation or malnutrition results in breakdown and utilization of fats for energy resulting in increasing ketone formation causing ketoacidosis.
- Elimination: Diarrhea causes an increased loss of base and electrolytes resulting in imbalance of acid-base.
- Fluids and Electrolytes: Changes in acid-base results in alterations in potassium and calcium. Fluid imbalance complicates cellular functions
- Perfusion: Decreased perfusion results in a shift from aerobic to anaerobic metabolism, which increases lactic acid formation resulting in lactic acidosis.
- Gas Exchange: Alterations in respiratory function shifts acid-base balance through the retention in the blood, or excretion of CO₂ through ventilation.
Metabolism: Abnormal glucose regulation results in metabolism of ketones and can lead to metabolic acidosis.

Anxiety: Respiratory alkalosis from hyperventilation.

Exemplars:

New Mexico Nursing Education Consortium (NMNEC) Required Exemplars:
- Respiratory acidosis
- Metabolic acidosis
- Acidosis compensation

Optional Exemplars:
- Respiratory alkalosis
- Metabolic alkalosis
Resources:


