Medical Speech Pathology: 
The Influence of Body Systems on Communication and Swallowing 
Section I 
Introduction, Fluid Balance System, Electrolyte Imbalances, & Acid-Base Disturbances 
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Course Overview:
Each section will contain the following:
1) Case Study Introduction.
2) An overview of a given body system.
3) Some common pathophysiologies for the system.
4) Lab value indicators for each pathophysiology.
5) Pharmacological considerations.
6) Case study conclusion.

Scientific Method
• Definition and delimitation of the problem area: Understanding the subject matter.
• Development of hypothesis to be tested.
• Development of procedures for testing the hypothesis: Research Design.
• Collection of Data.
• Analysis of Data.
• Interpretation of Data: Support or Reject the hypothesis.
• Generalize from the Data: Conclusions.
Important Questions

• What is a given patient’s overall degree of wellness?

• What are the relationships between a given medical diagnosis and a patient’s ADL capabilities, communication function, and/or swallow physiology?

Important Questions

• Are there other medical complications which may have an adverse impact or prevent/minimize progress with ADL capabilities, communication function, and/or swallow physiology?

Basic Structure of a Neuron

• Soma

• Dendrites

• One Axon
Basic Structure of a Neuron

• Organelles:
  – Nissl Bodies = Synthesize proteins for maintaining cellular health.
  – Mitochondria = critical to cell respiration as well as energy production.
  – Golgi Apparatus = secrete proteins and sugars.

Anatomy & Physiology: Body Systems

• Neurological System
• Fluid Balance System
• Hematological System
• Cardiovascular System
• Lymphatic System
• Pulmonary System
• Endocrine System
• Renal & Urogenital Systems
• Digestive System
• Musculoskeletal System
• Integumentary System
• Reproductive System

Pathophysiology

• What is pathophysiology?
Pathophysiology

- Pathos = Greek for suffering.
- Logos = Greek for system of formal study.
- Physio = Pertains to the function(s).

Pathophysiology

- The study of the biologic and physical manifestations of disease as they correlate with the underlying abnormalities and physiologic disturbances.
- Pathophysiology does not deal directly with the treatment of disease; rather, it explains the processes within the body that result in the signs and symptoms of a disease.

'Mosby’s Dictionary of Medicine, Nursing, & Health Professions, 7th edition'

Basic Foundations of Pathophysiology

- Cellular Biology.
- Biochemistry.
- Anatomy and physiology.
For those interested in pathophysiology:

For those interested in cellular biology:

For those interested in biochemistry:
Some useful tools re: pathophysiology


Traditional Pathophysiological Classification of Diseases

- Neurological System
- Fluid Balance System
- Hematological System
- Cardiovascular System
- Lymphatic System
- Pulmonary System
- Endocrine System
- Renal & Urologic Systems
- Digestive System
- Musculoskeletal System
- Integumentary System
- Reproductive System

Functional Applications of Pathophysiology

- For OTs and SLPs today, may divide the medical causes of ADL dysfunctions, Cognitive Deficits, Communication Disorders, and Swallow Disorders into two parts:
  - Traditional Pathophysilogies
  - Nontraditional Pathophysilogies
Traditional Diagnosis affecting the Nervous System

• CVA/TIA
• TBI
• Progressive Neurological Diseases
• Dementia
• Neoplasms

Non-Traditional Diagnosis affecting the Nervous System

As we know, many disease states primarily involving systems other than the nervous system can often have direct and/or indirect consequences for the nervous system.

Fluid Balance System

• Intracellular Space & Intracellular Fluid.
• Extracellular Space & Extracellular Fluid.

– What is the importance of Sodium to the Fluid Balance System?
Case Study #1
The Case of the Old Salt

• 67 YOM retired naval officer:
• Mr. No was referred to OT in a SNF due to an onset of impaired abilities to perform his ADLs.
• Mr. No was referred to SLP in the SNF due to impaired cognitive communication abilities and impaired swallow function.
• H/o HTN, Hypernatremic dehydration, UTI, Benign Prostate Hypertrophy, and early onset Parkinson’s disease.
• 3 months prior to admission to SNF, Mr. No was independent with all ADLs, drove himself to store and church, and reported no difficulty with communication or swallow functions.
• Daughter reports Mr. No was seen through the ER for severe dehydration 3 months ago and that he has been confused and disoriented ever since. She also reports he has had a long history of recurrent dehydration & UTI.

Case Study #1
The Case of the Old Salt

• HTN = ?
• Hypernatremia = ?
• UTI= ?
• Benign Prostate Hypertrophy = ?
• Early onset Parkinson’s disease = ?

Let’s go back to Chemistry Class

• Sodium (Abbreviated Na for Natrium from the Latin).
• Osmosis
Disorders of Fluid Balance System

- Hyponatremic Dehydration
- Hyponatremia occurs when serum sodium (Na) falls below 136 mEq/L or 136 mmol/L.
- Hyponatremia is considered critical when serum sodium falls below 120 mEq/L or 120 mmol/L.
- Causes water to be pulled intracellularly (into the inside of cells).
- The brain is known to be seriously affected by increase of intracellular water.

- The increase of intracellular water causes the brain to swell.
- Progressive neurological symptoms develop when serum Na levels approach 125 mEq/L or mmol/L.
- Some neurological changes may be irreversible.
Disorders of Fluid Balance System

- Hyponatremic Dehydration
  - Progressive neurological symptoms include:
    - Subtle mental changes.
    - Lethargy.
    - Apathy.
    - Headache.
    - Disorientation
    - Confusion
    - Gross Motor Weakness
    - Seizures
    - Coma
    - Death
Pharmacological Considerations re: Hyponatremia

- Generally speaking, the goal is to restore Na balance.
  - Restoration of serum Na should not exceed a rate faster than 0.5 mEq/L/hour.
  - Restoration of serum Na also should not exceed a rate faster than 10 mEq/L in the first 24 hours.

- There should be a concurrent goal to identify and treat the etiology of the hyponatremia.
  - Severe hyponatremia in asymptomatic patients may at times be treated safely with strict restriction of water intake.
  - If diuretic induced, then temporary elimination or reduction of the diuretic (e.g. Lasix, Furosemide) may suffice.
  - If induced by an inappropriate parenteral fluid in a patient with impaired water excretion, then cessation of the hypotonic fluid may suffice.
  - If patient is hypovolemic but has normal adrenal function, then an IV solution of Normal Saline (0.9%) will often correct both the hyponatremia and the hypovolemia.
Further Considerations re: Hyponatremia

• Remember, when hyponatremia is suspected, referral should be made back to the physician.
• Osmotic demyelination syndrome (Also referred to in past as central pontine myelinolysis) can occur if the Na correction is too rapid.
  • Demyelination can affect other areas of brain as well.
  • Lesions will be more common with H/o alcoholism, malnutrition, and/or chronic debilitating illness.
  • Flaccid paralysis, dysarthria, and dysphagia may evolve over the course of a few days to a few weeks.
  • If the lesion(s) extend dorsally from pons to include the sensory tracts, may result in onset of locked-in syndrome.

Disorders of Fluid Balance System

• Hypernatremic Dehydration
  • Remember: Normal Serum Na Levels = 136 to 145 mEq/L or mmol/L.
  • Hypernatremia occurs when serum Na rises above 148 mEq/L or mmol/L.
  • Hypernatremia is considered critical when serum sodium rises above 160 mEq/L or mmol/L.
  • Causes water to be pulled extracellularly (into the interstitial space outside of cells).
  • The brain is known to be seriously affected by decrease of intracellular water.

• Hypernatremic Dehydration
  • The decrease of intracellular water causes the brain to shrink.
  • Progressive neurological symptoms develop when serum Na levels approach 155 mEq/L or mmol/L.
  • Some neurological changes may be irreversible.
Disorders of Fluid Balance System

- Hypernatremic Dehydration
  - Progressive Neurological Symptoms include:
    - Confusion
    - Neuromuscular excitability
    - Seizures
    - Coma
    - Death

- Cerebrovascular damage with subarachnoid or subcortical hemorrhage as well as venous thrombosis are frequently seen during autopsy.
Pharmacological Considerations re: Hypernatremia

- The main treatment goal may be the replacement fluid with free water.
- If vomiting or AMS is noted, then may consider IV therapy.
  - ½ Normal Saline (0.45%)
  - 5% Dextrose in Water (5% D/W with possibly a loop diuretic [e.g. Lasix, Demadex, etc.]).
  - Consideration for KCl.

Further Considerations re: Hypernatremia

- Remember, when hypernatremia is suspected, referral should be made back to the physician.
- If 5% D/W is infused too quickly, it can result in glycosuria which in turn will cause increase urination of salt-free water especially in patients with DM.

Disorders of Fluid Balance System

- Isotonic Dehydration
  - Remember: Normal Serum Na Levels = 136 to 145 mEq/L or mmol/L
Other Laboratory Indicators of Dehydration may be:

- Other than Na,
  - Consider:
    - K
    - BUN
    - BUN to Creatinine Ratio
    - Low Creatinine Clearance

Case Study #1
The Case of the Old Salt

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- Daughter reports: Mr. No was seen through the ER for severe dehydration 3 months ago and that he has been confused and disoriented ever since. She also reports he has had a long history of recurrent dehydration & UTI.

Case Study #1 Wrap Up
The Case of the Old Salt

- HTN = ?
- Hypernatremia = ?
- UTI = ?
- Benign Prostate Hypertrophy = ?
- Early onset Parkinson’s disease = ?
**A Review of Fluid Imbalances**

- Clinical Indicators of Dehydration:
  - Sudden onset of AMS
  - Generalized weakness
  - Thick, tenacious,ropy oropharyngeal secretions
  - Poor skin turgor
- Laboratory indicators
  - Blood
    - Serum Sodium?
    - K?
    - Creatinine?
  - Urine
    - pH

**Electrolyte Imbalances (Other than Na)**

- Hypokalemia
- Hyperkalemia
- Hypocalcemia
- Hypercalcemia
- Hypophosphatemia
- Hyperphosphatemia
- Hypomagnesemia
- Hypermagnesemia

**The Sodium-Potassium Pump**
Electrolyte Imbalances

- Hypokalemia = Low K (Serum K concentration is < 3.5 mEq/L). Normal Range = 3.5-5.5 mEq/L
  - Nerve Impulses & Contractions of Skeletal, Smooth & Cardiac Muscles (Hyperpolarization)
  - Acid/Base Balance
  - Fluid Imbalance

Pharmacological Considerations re: Hypokalemia

- The main treatment goal is to consider the use of K+ supplements.
- In severe cases, may replace K+ parenterally.
Electrolyte Imbalances

• Hyperkalemia = elevated K (Serum K concentration > 5.5 mEq/L)

An extreme rise in K+ can result in:
- paresthesia
- flaccid paralysis
- cardiac arrest due to ventricular arrhythmias.

Note - Na+ Substitutes are often replaced with K+

Pharmacological Considerations re: Hyperkalemia

• The main treatment goal is to lower the serum K+

• If mild hyperkalemia, then may try to decrease K+ intake. Also, may consider cessation of K+ elevating medications.

• If Severe, then:
  - May consider Kayexelate.

Electrolyte Imbalances

• Hypocalcemia = Low total plasma Ca concentration of < 8.8 mg/dL (Normal Range = 8.2 to 10.4 mg/dL in adults).
  - Can result in the slow onset of a mild, diffuse encephalopathy & should be considered in any patient exhibiting an unexplained dementia, depression, or psychosis.
  - Mild to Moderate hypocalcemia can result in paresthesia, abdominal cramps, muscle cramps, and personality changes.
  - Severe Hypocalcemia may result in cardiac dysrhythmias, generalized convulsions, and laryngospasm.

NOTE: Hypocalcemia may be caused by Vitamin D Deficiency, Hypoparathyroidism, Chronic Renal Failure, Sepsis, Mg Deficiency, Pancreatitis, and Burns.
Pharmacological Considerations re: Hypocalcemia

- The main treatment goal is the replacement of Ca or improvement of its absorption:
  - Oral Ca supplement
  - Vitamin D consideration
  - If tetany, then may consider Ca gluconate via IV

Electrolyte Imbalances

- Hypercalcemia = elevated total plasma Ca concentration of > 10.4 mg/dL. This electrolyte imbalance may result in:
  - Polyuria
  - Constipation
  - Nausea & Vomiting
  - Anorexia
  - Emotional lability
  - Confusion
  - Delirium
  - Psychosis
  - Stupor
  - Coma
  - Neuromuscular involvement may include prominent skeletal muscle weakness
  - Prolonged or severe hypercalcemia may result in a reversible acute renal failure or even irreversible kidney damage.

  - NOTE: Hypercalcemia may be caused by excessive bone resorption (e.g., Cancer with bone metastasis, Hyperparathyroidism, Immobilization [especially in elderly with osteoporosis as well as paraplegics & quadriplegics], Excessive GI Ca absorption, & Elevated Plasma Protein Concentration).

Pharmacological Considerations re: Hypercalcemia

- The main treatment goal is to lower serum Ca via one of the following strategies:
  - May decrease Ca absorption via the intestine
  - May increase urinary excretion of Ca
  - May decrease bone resorption of Ca
  - May remove the excess Ca via dialysis
Electrolyte Imbalances

• Hypophosphatemia = Low plasma phosphate (PO4) concentration of < 2.5 mg/dL
  - This electrolyte imbalance may result in:
    • Muscle Weakness
    • Respiratory Failure
    • Heart Failure
    • Seizures
    • Coma

NOTE: This electrolyte imbalance may result from alcoholism, burns, starvation, and diuretic use.

Pharmacological Considerations re: Hypophosphatemia

• The main treatment goal is to replace the PO4:
  • Oral replacement of PO4 in asymptomatic patients is usually sufficient.
  • However, Parenteral PO4 should be considered whenever one or more of the following have occurred:
    • Plasma PO4 is < 0.5 mEq/L
    • Rhabdomyolysis
    • Hemolysis
    • Presence of s/s of CNS dysfunction

Electrolyte Imbalances

• Hyperphosphatemia = Elevated plasma phosphate (PO4) concentration of > 4.5 mg/dL
  - This electrolyte imbalance may result in:
    • Symptoms of hypocalcemia including tetany can occur if there is a comorbidity with hypocalcemia.
    • However, these patients are usually asymptomatic.

NOTE: This electrolyte imbalance may result from chronic renal failure, hypoparathyroidism, and metabolic or respiratory acidosis.
Pharmacological Considerations re: Hyperphosphatemia

- The main treatment goal is usually to restrict oral intake of PO4.
- Avoidance of foods with high concentration of PO4
- Cessation of PO4 laxatives
- May need to consider PO4 binding drugs to be taken with meals.

Electrolyte Imbalances

- Hypomagnesemia = low plasma magnesium concentration of < 1.4 mEq/L
  - This electrolyte imbalance may result in:
    - Symptoms/clinical features which are often secondary to a simultaneous comorbidity with both hypokalemia and hypocalcemia.
      - Tetany & Seizuring
      - Anorexia
      - Weakness (at times with muscle fasciculations)
      - Personality Change
      - Nausea & Vomiting
      - Tetany
      - Anorexia
      - Anxiety
    NOTE: This electrolyte imbalance may result from inadequate magnesium intake, inadequate magnesium absorption, or increased magnesium excretion due to hypercalcemia or due to diuretics.

Pharmacological Considerations re: Hypomagnesemia

- The main treatment goal is magnesium replacement
  - Often with Mg salts by mouth.
  - May consider Mg via IV route in more severe cases.
Electrolyte Imbalances

- **Hypermagnesemia** = elevated plasma Mg concentration > 2.1 mEq/L.
  - This electrolyte imbalance may result in:
    - Hypotension
    - Respiratory Depression
    - Cardiac Arrest

**NOTE:** The primary cause of this electrolyte imbalance is renal failure.

Pharmacological Considerations re: Hypermagnesemia

- The main treatment goal is to lower & stabilize the Mg level
- IV administration of Ca gluconate
- Consideration of a loop diuretic (e.g. Lasix/Furosemide)
- May consider hemodialysis in severe cases

Electrolytes in Lab Work

- **Blood Analysis**
  - Na
  - K
  - Ca
  - P (PO4)
  - Mg

- **Urine Analysis**
  - Na
  - K
  - Ca
  - P (PO4)
  - Mg
Acid-Base Disturbances

- Acid-Base Disturbances
  - Respiratory Acidosis
  - Respiratory Alkalosis
  - Metabolic Acidosis
  - Metabolic Alkalosis

Acid-Base Disturbances

- So what is an acid?
- And what is a base (alkali)?
- How do we measure acids and alkali? pH

Acid-Base Disturbances

- Respiratory Acidosis = caused by the retention of carbon dioxide (CO2). Reduced alveolar ventilation may occur as the result of one of the following:
  - A) Respiratory Depression
  - B) Chest Wall Injury
  - C) Pulmonary Disease
Acid-Base Disturbances

• Respiratory Alkalosis
  • Usually caused by hyperventilation.
  • Hyperventilation causes a decrease in carbon dioxide.

Acid-Base Disturbances

• Metabolic Acidosis
  • Lactic Acidosis
  • Diabetic Ketoacidosis

Acid-Base Disturbances

• Metabolic Alkalosis
2 Cases of Impaired Metabolism

Case of Suspected Metabolic Encephalopathy:
- 61 YOM
- MD ordered OT & SLP consults
- OT evaluated patient
  - Dx: Severe Cognitive Deficits & Severe ADL Deficits
- SLP evaluated patient
  - Dx: Severe Cognitive Communication Deficits and Moderate Oropharyngeal Dysphagia
- 24 Hours Later:
  - OT reported Cognitive Deficits & ADL Deficits had almost completely resolved.
  - SLP reported Cognitive Communication Deficits & Dysphagia had also almost completely been resolved.

Case of Confirmed Metabolic Encephalopathy:
- 70 YOF
- MD ordered OT & SLP consults
- OT evaluated patient
  - Dx: Severe Cognitive Deficits & Severe ADL Deficits
- SLP evaluated patient
  - Dx: Severe Cognitive Communication Deficits and MildModerate Oropharyngeal Dysphagia
- 24 Hours Later:
  - OT & SLP both reported persistence of the deficits.
- 48 Hours Later:
  - MD ordered a CT which revealed diffuse cortical atrophy consistent with metabolic encephalopathy

How do staff document the justification in such a scenario?
- Document the prior level of function
- Document the date of onset of the rehab DX
- Document the facts of how the deficit areas have persisted in spite of the specific medical care provided.
- If the deficits have persisted in spite of the medical care provided, then a skilled evaluation may be indicated.

Summary
- In this section, we have covered the basics pathophysiology concepts, relevant basic laboratory values, and rudimentary pharmacology implications for the management of Fluid Imbalances, Electrolyte Imbalances, & Acid-Base Disturbances.
- Our next section will examine pathophysiology concepts, lab values, and pharmacology concepts for the Hematological System and the Cardiovascular System.