



Second Year MBBS - Batch 51 Renal Module Case Based Learning Body Fluid Compartments and Edema

DR. NAYAB ZONISH NAWAZ PGT Physiology

19-04-2024



Table of Contents

Sr #	Content	Slide #
1	Motto, Vision	4
2	Professor Umar Model of Integrated Lecture	5
3	Bloom's Taxonomy(Domains of learning)	6
4	Diagrammatic Representation of Blooms Taxonomy	7
5	Learning Objectives	8
6	Horizontal Integration	9,10,16,17,18
7	Core knowledge	9 - 18
8	Vertical Integration	20,21,22
9	Biomedical Ethics(lesson of the day)	24
10	Suggested Research Article	25
11	Brainstorming(SEQ relevant with lecture)	28,29
12	Promoting IT and research culture(Digital Library)	26
13	References of this lecture	30



Motto

Vision; The Dream/Tomorrow



- To impart evidence based research oriented medical education
- To provide best possible patient care
- To inculcate the values of mutual respect and ethical practice of medicine





Professor Umar Model of Integrated Lecture





Bloom's Taxonomy : Domains Of Learning

Sr. #	Domain of learning	Abbreviat ion	Levels of the domain	Meaning
1	cognition	С	C1	Recall / Remembering
2			C2	Understanding
3			C3	Applying / Problem solving
4	Psychomotor	Ρ	P1	Imitation / copying
5			P2	Manipulation / Follows instructions
6			Р3	Precision / Can perform accurately
7	Attitude	A	A1	Receiving / Learning
8			A2	Respond / Starts responding to the learned attitude
9			A3	Valuing / starts behaving according to the learned attitude



Diagrammatic Representation Of Blooms Taxonomy





Learning Objectives

Sr. #	Learning Objective	Domain of Learning
1	To understand the concept of body fluid compartments	C2
2	To explain edema and its types	C1
3	To understand the causes of edema	C2



Horizontal Integration







Figure 25-3. Nonelectrolytes of the plasma.

Horizontal integration (Biochemistry)



Body Fluid Compartments and Edema

SEQUENCE OF EVENTS:

- Case (shared with students)
- Time given to read.
- Initial discussion.
- Groups formed.
- Detailed discussion



Case

A 55 years lady has been diagnosed with chronic kidney disease (CKD). She visits her nephrologist for a routine check-up. Sarah complains of swelling in her legs and ankles that seems to worsen throughout the day, especially when she sits or stands for long periods.



Table 25-1 Daily Intake and Output of Water (ml/day)

Intake or Output	Normal	Prolonged Heavy Exercise
Intake		
Fluids ingested	2100	?
From metabolism	200	200
Total intake	2300	?
Output		
Insensible: skin	350	350
Insensible: lungs	350	650
Sweat	100	5000
Feces	100	100
Urine	1400	500
Total output	2300	6600 Core k
-		







Intracellular Fluid Compartment

- About 28 of the 42 liters of fluid in the body are inside the cells
- Constitutes about 40% of the total body weight.
- Mixture of **different constituents**, but the concentrations are similar from one cell to another.



Extracellular Fluid Compartment

- Fluids outside the cells.
- **20%** of the body weight, or about **14 liters**.
- The two largest compartments are:
- 1. The *interstitial fluid*, three-fourths (11 liters).
- 2. The plasma, one-fourth or about (3 liters).
- The plasma and interstitial fluids have about the same composition, except for proteins, which have a higher concentration in the plasma.



Blood Volume

- Blood contains ECF (plasma) and ICF (red blood cells).
- Considered as separate fluid compartment because it is contained in a chamber of its own, the circulatory system.
- The average blood volume is 7% of body weight, or 5 liters.
- 60% is plasma
- 40% is red blood cells



Hematocrit (Packed Red Blood Cell Volume)

'The fraction of the blood composed of red blood cells'

- Men, it is normally about 0.40
- Women, it is about 0.36.
- *Anemia:* the hematocrit may fall as low as 0.10
- *Polycythemia:* the hematocrit can rise to 0.65.

Core knowledge

HULLAND MEDICAL MORE

Constituents Of Extracellular And Intracellular Fluids



Figure 25-2. Major cations and anions of the intracellular and extracellular fluids. The concentrations of Ca²⁺ and Mg²⁺ represent the sum of these two ions. The concentrations shown represent the total of free ions and complexed ions.



Measurement Of Body Fluid Compartment Volumes



Figure 25-4. Indicator-dilution method for measuring fluid volumes.



Table 25-3 Measurement of Body Fluid Volumes

Volume	Indicators
Total body water	³ H ₂ O, ² H ₂ O, antipyrine
Extracellular fluid	²² Na, ¹²⁵ I-iothalamate, thiosulfate, inulin
Intracellular fluid	(Calculated as total body water— extracellular fluid volume)
Plasma volume	¹²⁵ I-albumin, Evans blue dye (T-1824)
Blood volume	⁵¹ Cr-labeled red blood cells, or calculated as blood volume = plasma volume/(1 – hematocrit)
Interstitial fluid	Calculated as extracellular fluid volume – plasma volume



Clinical Abnormalities of Fluid Volume Regulation

- Hyponatremia: plasma sodium concentration is reduced (below normal i.e. 142 mEq/L).
- Hypernatremia: plasma sodium concentration is elevated above normal.



Abnormality	Cause
Hyponatremia—dehydration	Adrenal insufficiency; overuse of diuretics
Hyponatremia—overhydration	Excess ADH (SIADH); bronchogenic tumors
Hypernatremia—dehydration	Diabetes insipidus; excessive sweating
Hypernatremia—overhydration	Cushing disease; primary aldosteronism



Edema

'Excess fluid in the tissues'

- 1. Intracellular edema
- 2. Extracellular edema
- 3. Lymphedema



Intracellular Edema

- Causes:
- (1) Hyponatremia
- (2) depression of the metabolic systems of the tissues
- (3) lack of adequate nutrition to the cells.
- Inflammation usually increases cell membrane permeability, allowing sodium and other ions to diffuse into the cell, with subsequent osmosis of water.



Extracellular Edema

- Two general causes:
- (1)Abnormal leakage of fluid from the plasma to the interstitial spaces
- (2)Failure of the lymphatics to return fluid from the interstitium back into the blood.
- (3)The most common clinical cause of interstitial fluid accumulation is excessive capillary fluid filtration.



Lymphedema

- Blockage or loss of the lymph vessels.
- The rise in protein concentration raises the colloid osmotic pressure of interstitial fluid, which draws even more fluid out of the capillaries.
- Severity increases with infections such as *filarial nematodes (Wuchereria bancrofti);* severe lymphedema and *elephantiasis* and men can have swelling of the scrotum, called *hydrocele*.
- Also occur in persons with cancer or after surgery. For example, radical mastectomy.



Safety Factors That Normally Prevent Edema

- Three major safety factors prevent edema:
- (1) Low compliance of the interstitium when interstitial fluid pressure is in the negative pressure range; 3 mm Hg.
- (2) The ability of **lymph flow to increase** 10- to 50fold; 7 mm Hg
- (3) Washdown of the interstitial fluid protein concentration, which reduces interstitial fluid colloid osmotic pressure as **capillary filtration increases;** 7 mm Hg





- Therefore, the total safety factor against edema is about 17 mm Hg.
- This means that the capillary pressure in a peripheral tissue could theoretically rise by 17 mm Hg, or approximately double the normal value, before marked edema would occur.



Vertical Integration





Discussion

• The nephrologist suspects that patient's swelling is due to edema (a common complication of CKD).



Explanation

- Kidneys become less efficient at filtering waste and regulating fluid balance.
- Fluid accumulates in her body, leading to swelling, particularly in dependent areas like the legs and ankles.
- This swelling occurs because gravity causes fluid to pool in these areas when Sarah sits or stands.

Vertical Integration



Laboratory Investigations

- 1. Blood tests including electrolytes levels: reveal abnormalities, such as:
- elevated potassium (hyperkalemia)
- decreased bicarbonate (metabolic acidosis)
- elevated blood urea nitrogen (BUN) and serum creatinine levels.

Vertical Integration



- 2. Urinalysis: abnormalities such as;
- proteinuria (presence of protein in the urine)
- hematuria (presence of blood in the urine.



- **3. Serum Albumin:** indicate the presence of hypoalbuminemia, which contribute to edema formation.
- 4. **Kidney Function Tests:** including glomerular filtration rate (eGFR).
- A decreased eGFR indicates impaired kidney function.

Vertical Integration



- **5. Serum Lipid Profile:** elevated levels of triglycerides and LDL cholesterol and decreased HDL cholesterol.
- 6. **Renal Ultrasound:** A renal ultrasound may be performed to assess the size, shape, and structure of the kidneys.
 - It can also detect any structural abnormalities, such as cysts or tumors, which may contribute to CKD.

Vertical Integration



Management

- Dietary changes to restrict sodium intake.
- Adjustments to her medications, including diuretics to help her kidneys remove excess fluid.
- Regular follow-up appointments and adherence to treatment to prevent further complications of CKD.



Bioethics





CULTURAL PRIZE PUBLIC MORALITY



Bioethics

How Bioethics can be applied in this scenario?

Bioethics



Bioethics

Non-maleficence:

- Healthcare providers should strive to avoid causing harm to the patient.
- In the context of CKD, this may involve carefully considering the risks and benefits of treatment options, such as medications and dietary interventions, to minimize potential adverse effects.
- For example, the nephrologist should monitor the patient for complications of diuretic therapy, such as electrolyte imbalances and dehydration, and adjust treatment as necessary to prevent harm.

Bioethics



Family Medicine





- By involving family medicine in the care of patients with CKD, healthcare providers can ensure that patients receive comprehensive, coordinated care.
- Address their medical, psychological, and social needs, ultimately improving outcomes and enhancing their quality of life.



Role of Family Physician

- **Primary Care Management:** They can provide ongoing primary care management, including monitoring kidney function, managing hypertension and diabetes, and coordinating referrals to specialists as needed.
- **Comprehensive Assessment:** comprehensive approach to patient care, considering medical history, lifestyle factors, and social determinants of health.
- **Collaborative Care:** Family physicians work collaboratively with other healthcare providers, including nephrologists, dietitians, pharmacists, and social workers, to optimize patient outcomes.

Family Medicine



- Patient Education: In the case of CKD, dietary restrictions (e.g., sodium and protein intake), taking medications as prescribed, monitoring blood pressure and blood sugar levels, and managing fluid balance.
- Longitudinal Follow-up: In the scenario, the family physician can schedule regular follow-up appointments to assess the patient's kidney function, monitor for complications, and address any concerns or questions.



Research





Suggested Research Article

The roles of sodium and volume overload on hypertension in chronic kidney disease

Author information > Article notes > Copyright and License information <u>PMC Disclaimer</u>

Abstract

Go to: 🕨

Chronic kidney disease (CKD) is associated with increased risk of cardiovascular (CV) events, and the disease burden is rising rapidly. An important contributor to CV events and CKD progression is high blood pressure (BP). The main mechanisms of hypertension in early and advanced CKD are renin-angiotensin system activation and volume overload, respectively. Sodium retention is well known as a factor for high BP in CKD. However, a BP increase in response to total body sodium or volume overload can be limited by neurohormonal modulation. Recent clinical trial data favoring intensive BP lowering in CKD imply that the balance between volume and neurohormonal control could be revisited with respect to the safety and efficacy of strict volume control when using antihypertensive medications. In hemodialysis patients, the role of more liberal use of antihypertensive medications with the concept of functional dry weight for intensive BP control must be studied.

Reference: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8685361/

Promoting Research Culture



Crux of Suggested Research Article

- Sodium retention can be demonstrated in both early and late CKD.
- The BP response to sodium retention could be modulated by neurohormones to maintain stable BP to a certain limit.
- RAS seems to be involved in a common pathophysiology for nephron injury in CKD with reduced renal mass.



- Recent clinical trial data favoring intensive BP lowering in CKD imply that the balance between volume and neurohormonal control could be shifted by using more AHMs other than diuretics than previously believed.
- More liberal use of AHMs could be allowed for effective BP control and CV protection even after HD is initiated with the concept of functional dry weight.



Research Culture

How To Access Digital Library

- Steps to Access HEC Digital Library
- 1. Go to the website of HEC National Digital Library.
- 2. On Home Page, click on the INSTITUTES.
- A page will appear showing the universities from Public and Private Sector and other Institutes which have access to HEC National Digital Library HNDL.
- 4. Select your desired Institute.
- 5. A page will appear showing the resources of the institution
- 6. Journals and Researches will appear

7. You can find a Journal by clicking on JOURNALS AND DATABASE and enter a keyword to search for your desired journal. Link:https://www.topstudyworld.com/2020/05/access-hecdigital-library.html?m=1



How to Apply for HEC Digital Library if you are not Member

 If you are not a member of HEC national digital library then you can fill the application after downloading it from

http://www.digitallibrary.edu.pk/app_form.html

- Fill the form that will appear like this
- Mail it to mailto:

Promoting Research Culture



