Body Fluids

Ref: Textbook of Medical Physiology
Guyton and Hall, 13th Ed: pp: 305-321
Regulation of Fluid volumes and osmolality
Regulation of Na+ and Water

Involves regulation of:

- Osmolality
- Volume of ECF

different regulations with many overlapping mechanisms.
Regulation of Na+ and Water

Involves regulation of:

- **Osmolality:**

  - Increased osmolality $\rightarrow$ thirst (Increase water intake).

  - Increased osmolality $\rightarrow$ stimulates release of ADH $\rightarrow$ acts on renal collecting ducts $\rightarrow$ increased water reabsorption (Decrease water output)

- Volume of ECF
Body Water

• Regulation of intake
  – Regulated by hypothalamic “thirst center”
  – “Thirst center” responds to osmoreceptor impulses, angiotensin II
Body Water

- Regulation of output
  - Regulated by hypothalamus
- ADH release from posterior pituitary
Regulation of Na+ and Water

Involves regulation of:

- **Osmolality:**
- **Volume of ECF:**
  - Depends on Na+ excretion in urine.
  - Controlled by renin-angiotensin aldosterone system

Reduced Volume → Juxtaglomerular Cells (Kidney) release Renin → Angiotensinogen → Angiotensin I → Angiotensin II (Lung) → Aldosterone
Body Water

- Regulation of output
  - Regulated by renin-angiotensin mechanism
- Angiotensin II stimulates aldosterone secretion
Body Water

- Regulation of output
  - Regulated by atrial natriuretic peptide (ANP)

Effects: reduces BP, Salts and water by effects over vessels, decrease Angiotensin II, and Aldosterone secretions.
Disorders of Volumes

- **Hypovolemicma**
  Results by excessive loss of fluids

- **Hypervolemicma**
  Results by excessive intake or administration of fluids
Disorders of Osmolality

- **Hyponatremia**
  Results by excessive loss of Na+ or administration of hypotonic fluids.

- **Hypernatremia**
  Results by excessive intake of Na+ or administration of hypertonic fluids
Disorders of Volumes

- **Hypovolemia**
  Results by excessive loss of fluids

- **Hypervolemia**
  Results by excessive intake or administration of fluids
(a) Consequences of dehydration. If more water than solutes is lost, cells shrink.

(b) Consequences of hypotonic hydration (water gain). If more water than solutes is gained, cells swell.
Disorders of Volumes

- Hypovolemia
  Results by excessive loss of fluids

- Hypervolemia
  Results by excessive intake or administration of fluids
Disorders of Volumes and Osmolality

- Hyponatremia with dehydration
- Hyponatremia with overhydration
- Hypernatremia with dehydration
- Hypernatremia with overhydration
Oedema

• Caused by increasing capillary filtration:
  - Increased capillary hydrostatic pressure:
  - Decreased oncotic pressure
  - Increase capillary permeability
  - Decreased lymph drainage
Oedema

• Caused by increasing capillary filtration:
  ▪ Increased capillary hydrostatic pressure:
    - Kidney causes: more retention of water and salts (Renal failure)
    - Excess of Mineralocorticoids (aldosterone)
  ▪ High venous pressure:
    Heart failure, decrease of Venous return (obstruction, decreased venous pump activity)
  ▪ Decreased arteriolar resistance
Oedema

• Caused by increasing capillary filtration:
  ▪ Increased capillary hydrostatic pressure:
  ▪ High venous pressure:
  ▪ Decreased arteriolar resistance
    (Excessive body heat, Insufficiency of sympathetic nervous system, Vasodilators)
Oedema

• Decreased Oncotic pressure
  ▪ Increased loss of proteins
    - From Kidney in nephrotic syndrome
    - from skin in burns and severe wounds
  ▪ Decreased production of proteins:
    - Liver diseases
    - Decreased intake of proteins in malnutrition
Oedema

• Increase capillary permeability
  - During immune reactions by release of histamine
    - Toxins,
    - Infections
    - Vitamin C deficiency
    - Ischemia
    - Burns
• Decreased lymph drainage:
  - Cancer
  - Infections
  - Surgery
  - Absence or abnormality of lymphatic vessels
Safety factors for preventing oedema

- Low tissue compliance
- Increased lymph flow
- Increased protein wash-down from interstitial fluids
In negative pressure ranges, low compliance by presence of gel fluids results in relative increase in hydrostatic pressure to small changes in volume → prevents capillary filtration.
In positive pressure ranges, HIGH compliance by accumulation of free fluids results in smaller increase in hydrostatic pressure to high changes in volume → Pitting oedema
Safety factors for preventing oedema

• Low tissue compliance
• **Increased lymph flow**
• Increased protein wash-down from interstitial fluids
Increased lymph flow as safety factor

- Lymph flow can increase up to 10-50 folds
  - Carry away large amounts of fluids
  - Prevents interstitial pressure from rising into POSITIVE ranges
Safety factors for preventing oedema

- Low tissue compliance
- Increased lymph flow
- **Increased protein wash-down from interstitial fluids**
Increased lymph flow → increased Protein washout from interstitial fluids

- Increased Lymph flow
  → Carry away large amounts of proteins
     (Protein washed out from interstitial fluids) → decrease Colloid osmotic pressure in interstitial fluid → Lowering net filtration forces → Prevents accumulation of fluids
GOOD LUCK

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