



## Effects of Anesthetics on Renal Function

### Urine Concentration & Dilution

Urine normally exits the nephron in a dilute state, however under hormonal controls; water reabsorption occurs and can create an extremely concentrated urine.

### Hormonal control of Water Reabsorption

- Aldosterone & Anti-diuretic hormone (ADH) are the two main hormones that drive this water reabsorption:

1. Aldosterone creates an obligatory response

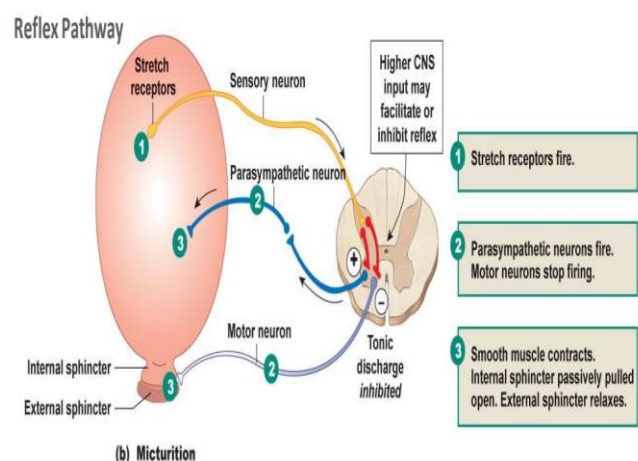
- Aldosterone increases  $\text{Na}^+/\text{K}^+$  ATPase activity and therefore reabsorption of  $\text{Na}^+$ ... where  $\text{Na}^+$  goes, water is obliged to follow.

2. ADH creates a facultative response

– Opens up water channels in the collecting duct, allowing for the reabsorption of water via osmosis.

## Micturition

- Once excreted, urine travels via the paired ureters to the urinary bladder where it is held (about ½ L)
- Sphincters control movement out of the bladder
  - Internal sphincter – smooth muscle (invol.)
  - External sphincter – skeletal muscle (vol.)





## Clinical Applications

- I. Diuretic drugs are used clinically to increase the urine volume and thus to lower the blood volume and pressure.
  - a. Loop diuretics inhibit active  $\text{Na}^+$  transport in the ascending limb and early portion of the distal tubule, respectively.
  - b. Osmotic diuretics are extra solutes in the filtrate that increase the osmotic pressure of the filtrate and inhibit the osmotic reabsorption of water.
  - c. Potassium-sparing diuretics act on the distal tubule to inhibit the reabsorption of  $\text{Na}^+$  and secretion of  $\text{K}^+$
- II. In glomerulonephritis the glomerular can permit the leakage of plasma proteins into the urine.
- III. The technique of renal dialysis is used to treat people with renal insufficiency

## Effects of Regional & General Anesthesia

**Regional anesthesia** has less effect than general anesthesia.

- It is related to changes in systemic haemodynamics.
- Peri-operative alterations of renal function are usually transient and clinically insignificant.

**General anesthesia** employed clinically have significant and reversible effects on:

1. Renal hemodynamics.
2. Water and electrolyte excretion.

## Effects of Mechanical ventilation

- Mechanical ventilation may lead to:
  1. Decreases in urine volume.
  2. Decrease in sodium excretion.
  3. ADH release.
  4. Activation of the renin-angiotensin system.



## **Methoxyflurane**

### **Effect:**

- Methoxyflurane has been demonstrated to produce renal dysfunction when administered in high concentrations for prolonged periods of time to obese patients.

### **Reason:**

- Metabolites of methoxyflurane including fluoride and/or oxalate appear to be the cause of this problem.

## **Effect of Inhalational Anesthetics on Renal Function**

1. Reduce glomerular filtration rate.
2. Reduce urine output.

### **Reason:**

Mainly by extra-renal effects that are weakened by pre-operative hydration.

## **Indirect Effect of Anaesthesia on Renal Function**

Anaesthesia and surgical stress can affect renal function and body fluid regulation indirectly as well as directly.

➤ The indirect effects, through influences on:

1. Haemodynamics.
2. Sympathetic activity.
3. Humoral regulation.

➤ Patients with compromised, or threatened renal

Both anaesthesia and surgery may adversely affect renal function, and must be taken into account when administering anaesthesia to patients with already compromised, or threatened renal function to prevent further deterioration of renal function, or renal failure.



## **The Direct Effects of Anesthesia**

The direct effects of anesthesia which are dose and agent-dependent include effects on:

1. Autoregulation of renal blood flow.
2. Alteration in the effect of ADH.
3. Effects on tubular transport of sodium and organic acids.
4. Toxic effect: Ex. Direct toxic effect of the fluoride-related toxicity of methoxyflurane.

## **Effects of Trauma and Surgery**

### **1. Redistribution of blood flow**

- Trauma, surgery, and hypovolemia all increase sympathetic nervous system activity which causes a redistribution of intrarenal blood flow.
- While the total renal blood flow may decrease or remain the same, blood flow to the cortical regions decreases relative to the medullary blood flow.

### **2. Hormonal Secretions**

- a. Increased adrenal hormone secretion
  - The net effect of aldosterone secretion is sodium & water retention with increased potassium excretion.
- b. Increased antidiuretic hormone (ADH) secretion.
  - It causes perioperative retention of water only.