Physiology Practical

Renal Block

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Diuresis

Objectives:

✓To measure the volumes and determine the compositions of urine excreted by 4 groups:

✓ (Fasting / drunk 1 L water/ drunk 1L saline / took 1 tab of lasix).

✓To be able to discuss the mechanisms by which the body maintain the water and sodium homeostasis in the 4 different conditions.

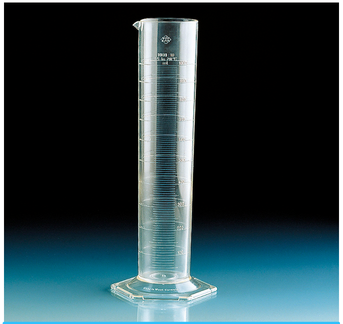
Diuresis:

physiological process by which urine production in the kidneys in increased as part of the body's homeostatic maintenance of fluid balance.

We will take 4 groups and make an experiment on diuresis after epmtying their bladder at 8am, then testing urine sample at different times:

Group #1 Fasting “not given any water or solution or drugs”
Group #2 Given 1liter of water
Group #3 Given 1 liter of 0.9% Saline “isotonic solution”
Group #4 Given 1 tablet of 40mg lasix “diuretic” with the help of 25 ml of water

Urine Samples Examination:



Measuring Cylinder

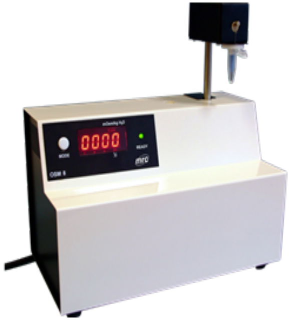
Measure Volume

PH Meter

Measure PH

Flame Photometry

Measure Na & K concentration

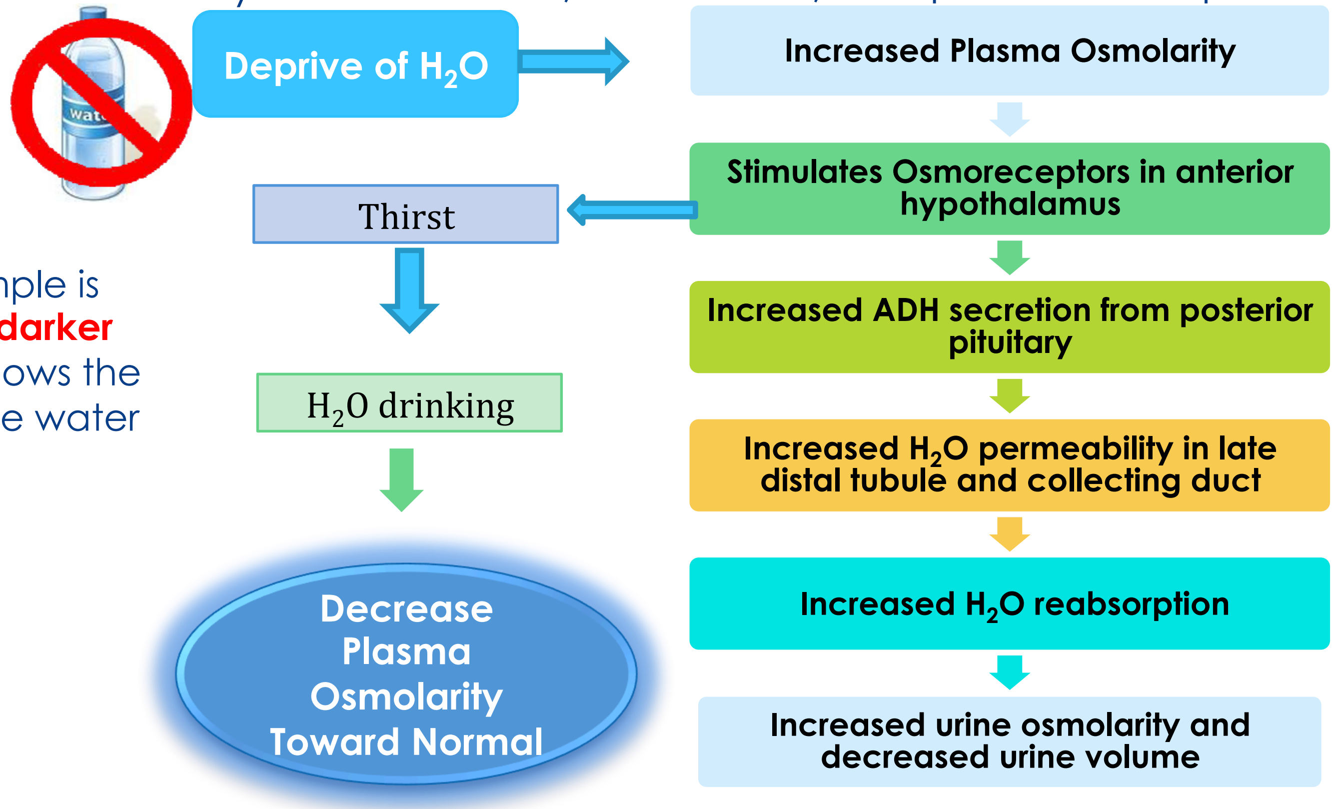


Osmometer

Measure Osmolality

Group 1 Fasting

- Emptied their bladders at 6:00 am and discarded the urine.
- Emptied their bladders at 8:00 am and bring the urine sample for analysis.
- From 8:00 they are restricted to take any fluids and they are asked to provide various urine samples for analysis at: 10:00 am, 12:00 noon, 2:00 pm and 3:00 pm.



What will happen?

Subsequent urine sample is **lesser** in volume and **darker** yellow in color that shows the kidneys try to conserve water in fasting state.

Group 1 Fasting cont.

- **What is the difference between Osmotic diuresis and Water diuresis?**

Osmotic diuresis: increase volume of urine, but the same urine osmolarity

Water diuresis: increase volume of urine along with decrease urine osmolarity

- **What are the changes in his plasma?**

Increase plasma osmolarity and decrease plasma volume

- **What is the hormonal regulation that will take place in his condition?**

Increase ADH secretion from posterior pituitary gland

- **What is the role of ADH in his condition?**

Increase permeability of H_2O in late distal convoluted tubules and collecting ducts (increase H_2O reabsorbation)

- **What are the changes in his urine?**

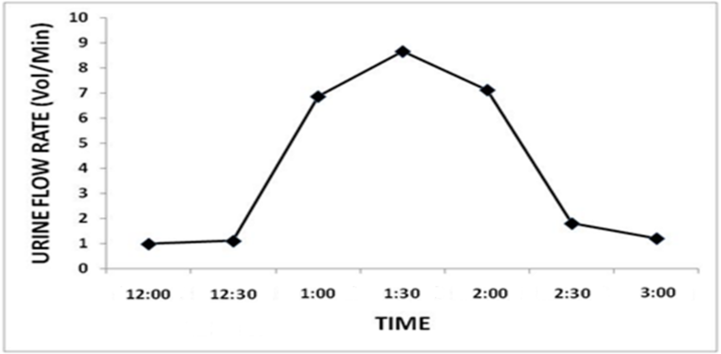
Increase urine osmolarity and decrease urine volume

- **What is the consequences in his condition?**

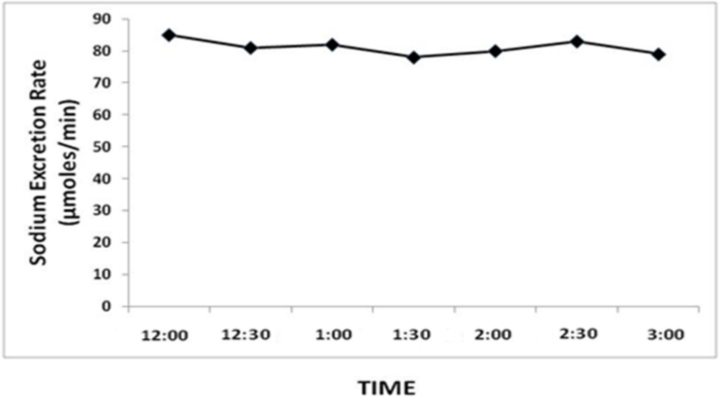
Plasma volume and osmolarity will back to normal

Group 2 "Drank 1L of Water"

- At 10 am emptied their bladder and discarded the urine
- At 12 noon emptied their bladder to provide Pre-Experimental sample.
- Drank 1 liter of water immediately after providing the sample.
- Group were asked to empty their bladder every half an hour to provide Post-Experimental samples after drinking water until 3pm.



Urine volume will be about the same in the first post-experimental sample as of the pre-experimental sample, then will **increase** dramatically in the subsequent samples and will again decrease back to the level of pre-experimental sample in the last samples.



Sodium concentration will remain constant

Group 2 "Drank 1L of Water" cont.

- **When does the change in the urine volume start ?** after 30 minutes .
- **How much time does it take to back to normal?**
  3 hours
- **Dose the sodium excretion constant or variable ?** Constant
- **Is it water diuresis or osmotic diuresis ?** Water diuresis
- **What are the changes in his plasma?** Decrease plasma osmolarity and Increase plasma volume
- **What happened if the osmolarity of plasma decreased?** Inhibits osmoreceptors from anterior hypothalamus
- **What happened if osmoreceptors inhibited?**

1. Decrease secretion of ADH 2. Inhibit Thirst center

- **What is the hormonal regulation that will take place in his condition?** decrease ADH secretion from posterior pituitary gland
- **What is the role of ADH in his condition?** Decrease permeability of H2O in late distal convoluted tubules and collecting ducts (decrease H2O reabsorbation)

Decreased Plasma Osmolarity

↓

Inhibit Osmoreceptors in anterior hypothalamus

↓

Decreased ADH secretion from posterior pituitary

↓

Decreased H_2O permeability in late distal tubule and collecting duct

↓

Decreased H_2O reabsorption and increased excretion

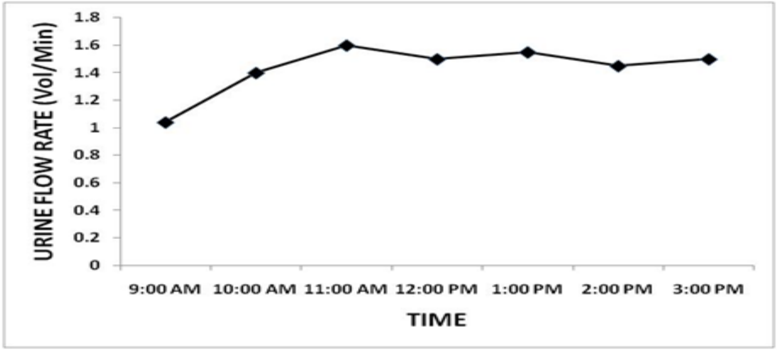
↓

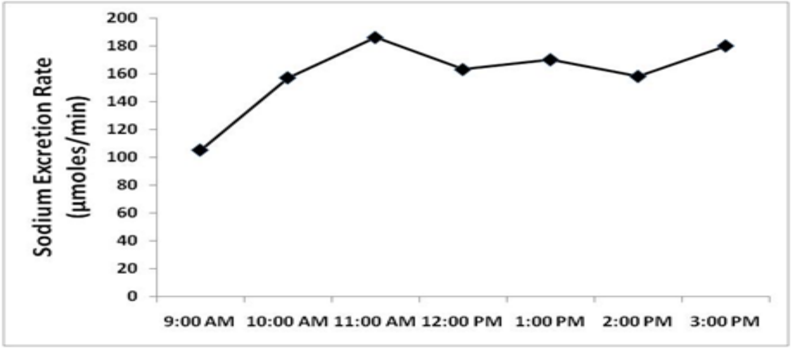
Decreased urine osmolarity and increased urine volume

Result: Plasma volume and osmolarity will back to normal

Group 3 "1L of Saline"

- At 7am emptied their bladder and discarded the urine
- At 9am emptied their bladder to provide Pre-Experimental sample.
- Drank 1 liter of 0.9% Saline "isotonic solution" immediately after providing the sample.
- Group were asked to empty their bladder every hour to provide Post-Experimental samples after drinking saline until 3pm.





Urine volume and sodium excretion will remain **slightly increased** in the post-experimental samples as compared to pre-experimental samples. Changes in urine volume starts immediately.

Duration : 24 hours

Group 3 "1L of Saline" cont.

- **What is Isotonic Saline?**

Solution containing 154 mmol of NaCl, equivalent to 9g of salt.

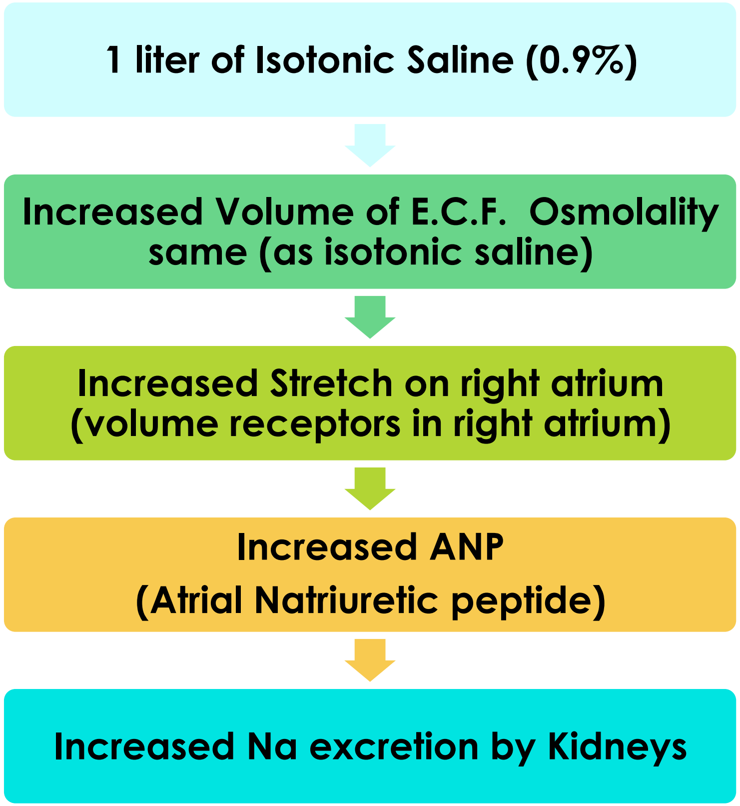
Sodium Concentration of isotonic saline is equivalent to the normal sodium concentration of plasma water

- **What are the changes in his plasma?** Plasma osmolarity remains the same and Increase plasma volume
- **What will happen if plasma volume increased?** Stimulate stretch receptors in the right atrium
- **What will happen if stretch receptors activated?** Secretes ANP (Atrial natriuretic peptides)
- **What is the role of ANP in his condition?** Increase excretion of Sodium
- **What are the changes in his urine?**

Urine osmolarity remains the same as sodium and water excretion both increases proportionately

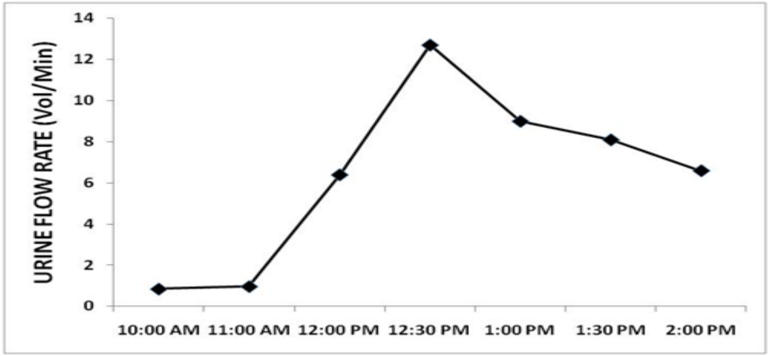
Increase urine volume (by increase water excretion)

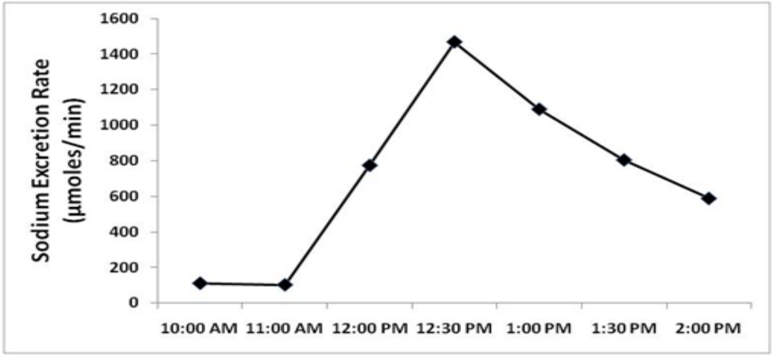
- **What is the consequences in his condition?** Plasma volume ONLY will back to normal



Group 4

- At 8am emptied their bladder and discarded the urine
- At 10am emptied their bladder to provide Pre-Experimental sample
- Swallowed a Lasix “Furosemide” 40 mg tablet + 25 ml of water
- Group were asked to empty their bladder every hour to provide Post-Experimental sample after taking lasix until 12noon then every half an hour until 3pm





Urine volume and sodium excretion **dramatically increased** after 1 hour of taking Lasix tablet and remained increased for further duration of experiment.

Duration : 4-6 hours

Group 4 cont.

- **What is Lasix?**

Furosemide is a loop diuretic used in the treatment of hypertension, congestive heart failure and edema

- **What is the Mechanism of Action of Lasix?**

It inhibits the sodium-potassium-2 chloride co-transport system located within the thick ascending limb of the **Loop of Henle**

- **What are the changes in his urine due to this drug?**

Increase sodium excretion (urine osmolarity remains the same)

Increase urine volume (by increase water excretion)

1 tablet of lasix "40mg" with 25 ml of water

↓

Action starts 1-2 hours and lasts for 4-6 hours (1/2 life of furosemide is 6hr)

↓

Acts on thick ascending limb of loop of Henle and blocks the Na-K-2Cl co-transport (called loop diuretic)

↓

Na excretion in urine and water excretion (osmotic drag)

Sodium Excretion & Sodium Excretion Rate

The following is a sample table that we will fill out during these experiments:

SAMPLE NO.	1	2	3	4	5	6	7
COLLECTION TIME (minutes)	120	30	30	30	30	30	30
VOLUME OF URINE (ml)	118	33	200	280	240	60	50
URINE FLOW RATE (ml / min)	0.98	1.1	6.66	9.33	8	2	1.66
SODIUM CONCENTRATION (mmoles/liter)	87	65	12	10	8	30	40
TOTAL SODIUM EXCRETION (mmoles)	10.3	2.2	2.4	2.8	1.9	1.8	2.00
SODIUM EXCRETION RATE (μmoles/min)	85.6	71.5	80	93.3	64	60	66.7

Measured by Flame Phtometery

$$\text{Sodium excretion} = \frac{\text{Sodium concentration x Volume of urine}}{1000}$$

$$\text{Sodium excretion rate} = \frac{\text{Sodium concentration x Volume of urine}}{\text{Time}}$$

Calculation in the schedule obtained by applying the equations

Example

$$\text{Sodium excretion rate} = \frac{\text{Sodium concentration} \times \text{Volume of urine}}{\text{Time}}$$

= Urine Flow Rate

$$\text{Sodium excretion} = \frac{\text{Sodium concentration} \times \text{Volume of urine}}{1000}$$

AS SAID PREVIOUSLY WE MEASURE THE SODIUM EXCRETION AND SODIUM EXCRETION RATE BY THEIR EQUATIONS.

Group 3

SAMPLE NO.	1	2	3	4	5	6	7
COLLECTION TIME (minutes)	120	30	30	30	30	30	30
VOLUME OF URINE (ml)	125	39	50	42	47	32	45
URINE FLOW RATE (ml / min)	1.04	1.30	1.67	1.40	1.57	1.07	1.50
SODIUM CONCENTRATION (mmoles/liter)	101	98	112	109	120	137	127
TOTAL SODIUM EXCRETION (mmoles)	12.6	3.8	5.6	4.6	5.6	4.4	5.7
SODIUM EXCRETION RATE (µmoles/min)	105.2	127.4	186.7	152.6	188.0	146.1	190.5

Let's take **Sample No.2 in group 4** as an example:

Sodium Excretion Rate = 107 x 0.97 = 103 µmoles/min

Sodium Excretion = 107 x 58 / 1000 = 6.2 mmoles

Group 4

SAMPLE NO.	1	2	3	4	5	6
COLLECTION TIME (minutes)	120	60	42	18	30	30
VOLUME OF URINE (ml)	102	58	269	230	270	125
URINE FLOW RATE (ml / min)	0.85	0.97	6.4	12.7	9.0	4.2
SODIUM CONCENTRATION (mmoles/liter)	132	107	121	115	121	117
TOTAL SODIUM EXCRETION (mmoles)	13.5	6.2	32.5	26.4	32.6	14.6
SODIUM EXCRETION RATE (µmoles/min)	112.2	103	774	1467	1089	487.5

NOW DO THE SAME THING ON THE OTHER SAMPLES AND CHECK YOUR ANSWERS FROM THE TABLES ☺!

Glomerular Filtration Rate "GFR"

Definition:
It is the volume of fluid filtered from the renal glomerular capillaries into the Bowman's capsule per unit time.

$$GFR = \frac{\text{Urine Concentration} \times \text{Urine Flow}}{\text{Plasma Concentration}}$$

Normal GFR Results
- **90-120** ml/min/1.73 m

Abnormal Results
- Less than **<60** ml/min/1.73 m → Indication: Chronic Kidney Disease
- Less than **<15** ml/min/1.73 m → Indication: Kidney Failure

Test Recommended In
- **Diabetes**
- **Family History of Kidney Disease**
- **Frequent UTI**
- **Heart Disease**
- **High Blood Pressure**
- **Urinary Blockage**

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Creatinine Clearance

Definition:
The volume of blood plasma that is cleared of creatinine per unit time.

$$C_{Cr} = \frac{U_{Cr} \times V}{P_{Cr}}$$

- C_{Cr}: Creatinin Clearance
- U_{Cr}: Creatinine concentration in The collected urine sample mg/ml
- V: Urine flow rate L/min
- P_{Cr}: Plasma Concentration mg/ml

EXAMPLE: $$C_{Cr} = \frac{1.25mg/mL \times \frac{60mL}{60min}}{0.01mg/mL} = \frac{1.25mg/mL \times 1mL/min}{0.01mg/mL} = \frac{1.25mg/min}{0.01mg/mL} = 125mL/min$$

Normal values

Male
97-137 ml/min

Female
88-128 ml/min

Abnormal Results

Acute Tubular Necrosis	Bladder Outlet Obstruction	Cogestive Heart Failure	Dehydration
End-stage Kidney Disease	Glomerulo-nephritis	Kidney Failure	Renal Ischemia
	Renal Outflow Obstruction	Shock	

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THANK YOU FOR CHECKING OUR WORK!

BEST OF LUCK

Done By:

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