

Diuresis

By

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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.
- Definition and clinical applications of:
 - GFR (Glomerular Filtration Rate)
 - C_{Cr} (Creatinine Clearance)

Group 1

- Emptied their bladders at 8:00 am and discarded the urine.
- 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.



Group 1

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

Deprive of H₂O

1

↑ Plasma osmolarity

2

Stimulates Osmoreceptors in anterior hypothalamus

3

↑ Thirst

3

↑ ADH secretion from posterior pituitary

↑ H₂O drinking

4

↑ H₂O permeability in late distal tubule and collecting duct

5a

↑ H₂O reabsorption

5b

↑ Urine osmolarity and ↓ urine volume

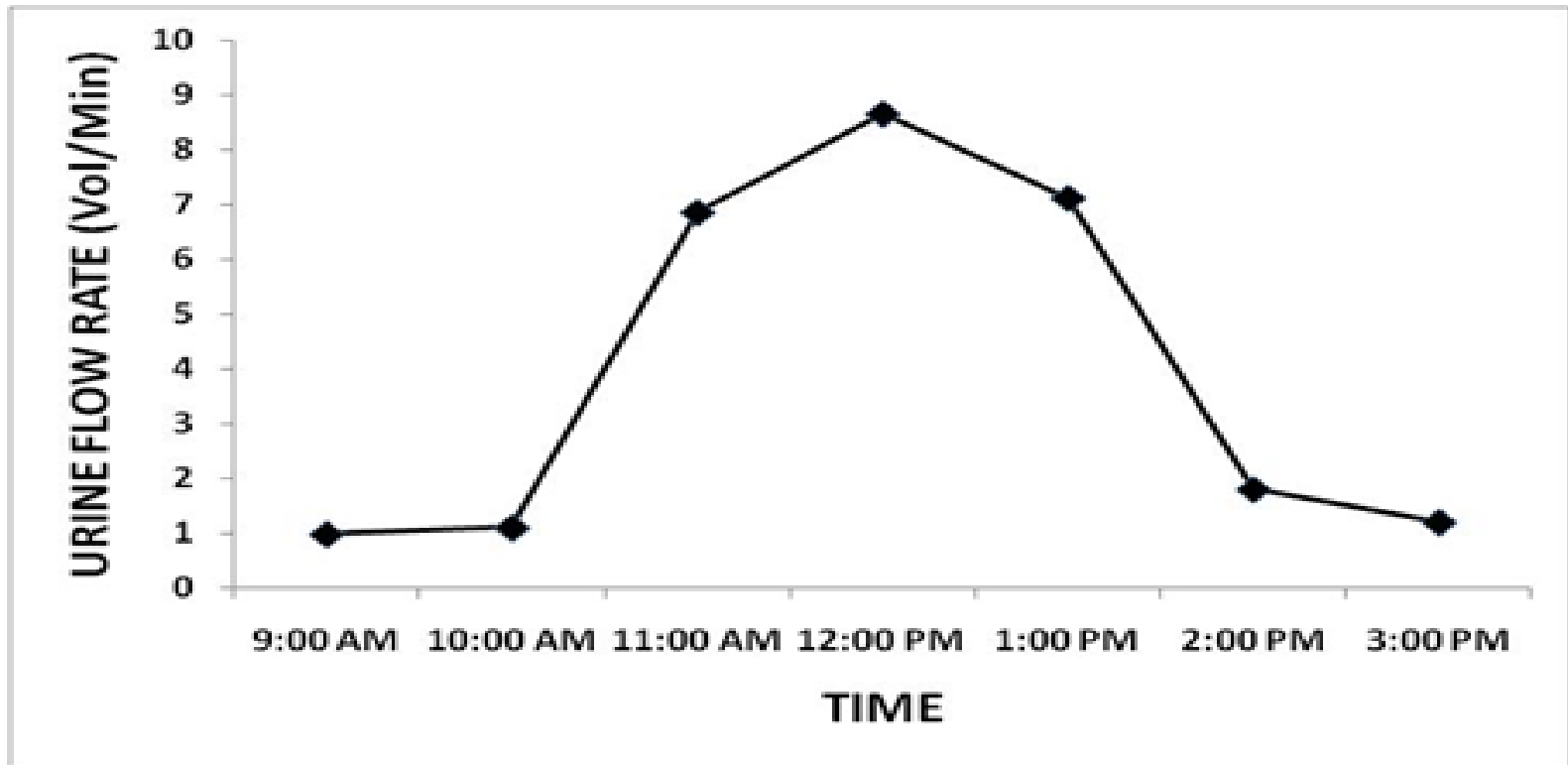
↓ Plasma Osmolarity
Toward Normal

6

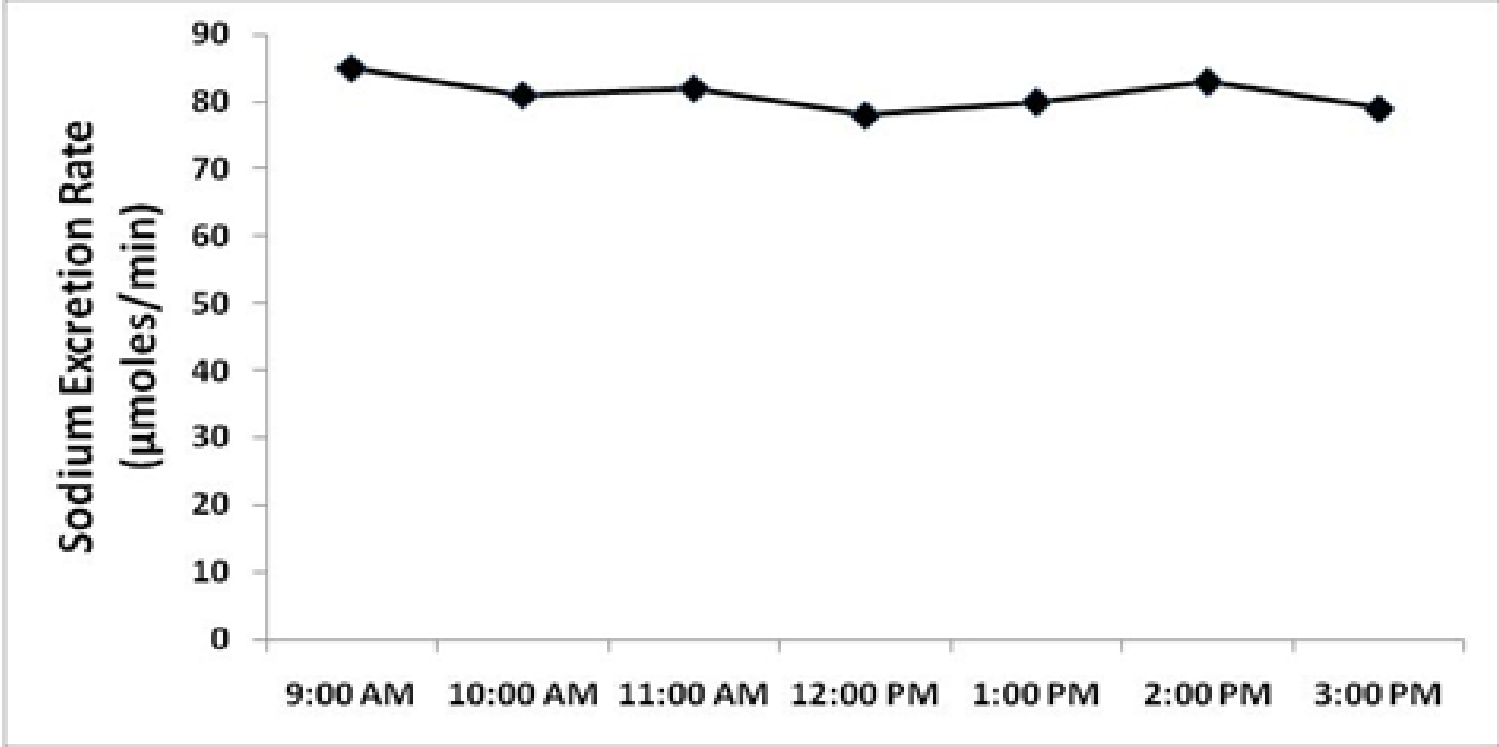
Group 2 (Water Diuresis)

- Emptied their bladder at 08:00 am and discarded the urine.
- At 10:00 am emptied their bladder again, but this time they measured its volume and provided a sample for analysis. This sample will be pre-experimental sample.
- Drank 1 liter of water immediately after providing the pre-experimental sample.
- Were then asked to empty their bladders and provide post-experimental samples every half an hour after drinking water until 3:00 pm.

Group 2



Group 2



Group 2

Drink 1L H₂O

1

↓ Plasma Osmolarity

↓ Inhibits osmoreceptors in anterior hypothalamus

↓ ADH secretion from posterior pituitary

↓ H₂O permeability in late distal tubule and collecting duct

↓ H₂O reabsorption and excretion

↓ Urine Osmolarity and urine volume

↓ Thirst

↓ H₂O drinking

↑ Plasma osmolarity toward Normal

3

2

3

4

5a

5b

6

Group 3

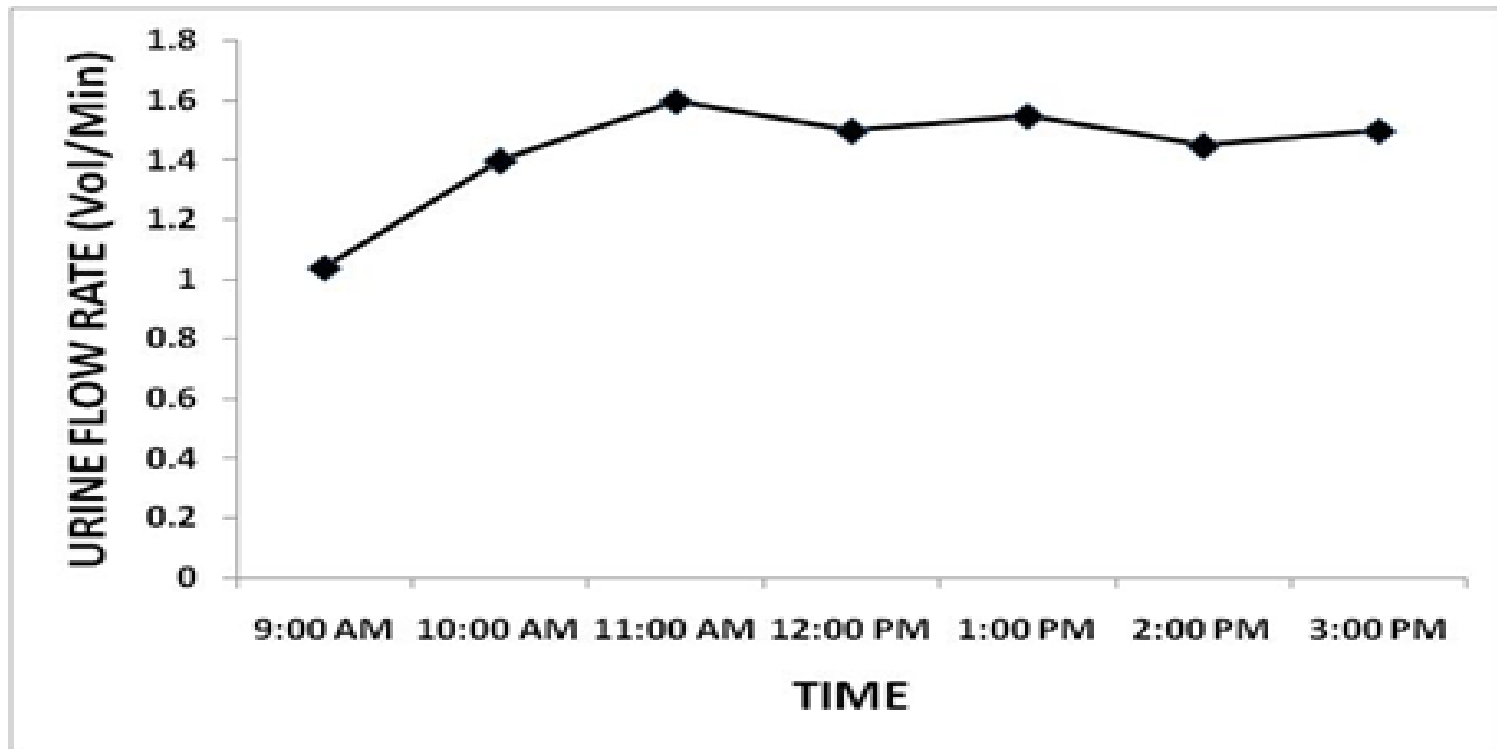
- Emptied their bladder at 7:00 am and discarded the urine.
- At 9:00 am emptied their bladder again, but this time they measured its volume and provided a sample for analysis. This sample will be pre-experimental sample.
- Drank 1 liter of 0.9% saline (isotonic saline) immediately after providing the pre-experimental sample.
- Were then asked to empty their bladders and provide post-experimental samples every hour after drinking saline until 3:00 pm.

Isotonic saline 0.9%

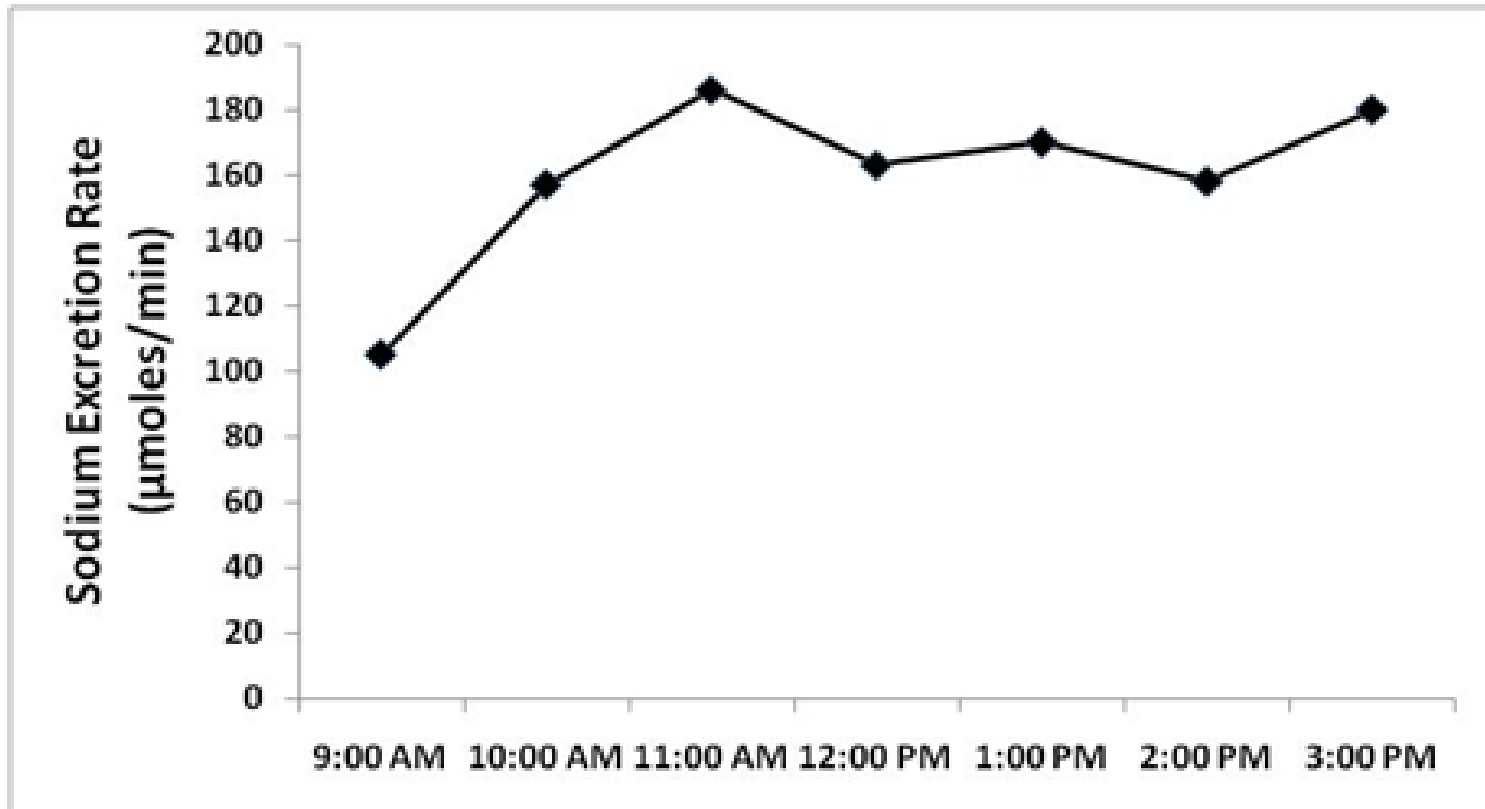
- Contains 154 mmol of NaCl, equivalent to 9 g of salt or 3.6 g of sodium.
- The sodium concentration of isotonic saline is equivalent to the normal sodium concentration of plasma water.



Group 3



Group 3



Group 3

- ▶ Isotonic Saline (0.9%)
 - ▶ 1 liter

↑ Volume of E.C.F. Osmolality same
(as isotonic saline)

↑ Stretch on right atrium (volume
receptors in right atrium)

↑ ANP (Atrial Natriuretic peptide)

↑ Na excretion by Kidneys

Group 4(Osmotic Diuresis)

- Emptied their bladder at 8:00 am and discarded the urine.
- At 10:00 am emptied their bladder again, but this time they measured its volume and provided a sample for analysis. This sample will be pre-experimental sample.
- Swallowed a Lasix (Furosemide) tablet 40 mg with the help of 25 ml of water immediately after providing the pre-experimental sample.
- Were then asked to empty their bladders and provide post-experimental samples every hour after taking Lasix until 12:00 noon and then every half an hour until 3:00 pm.

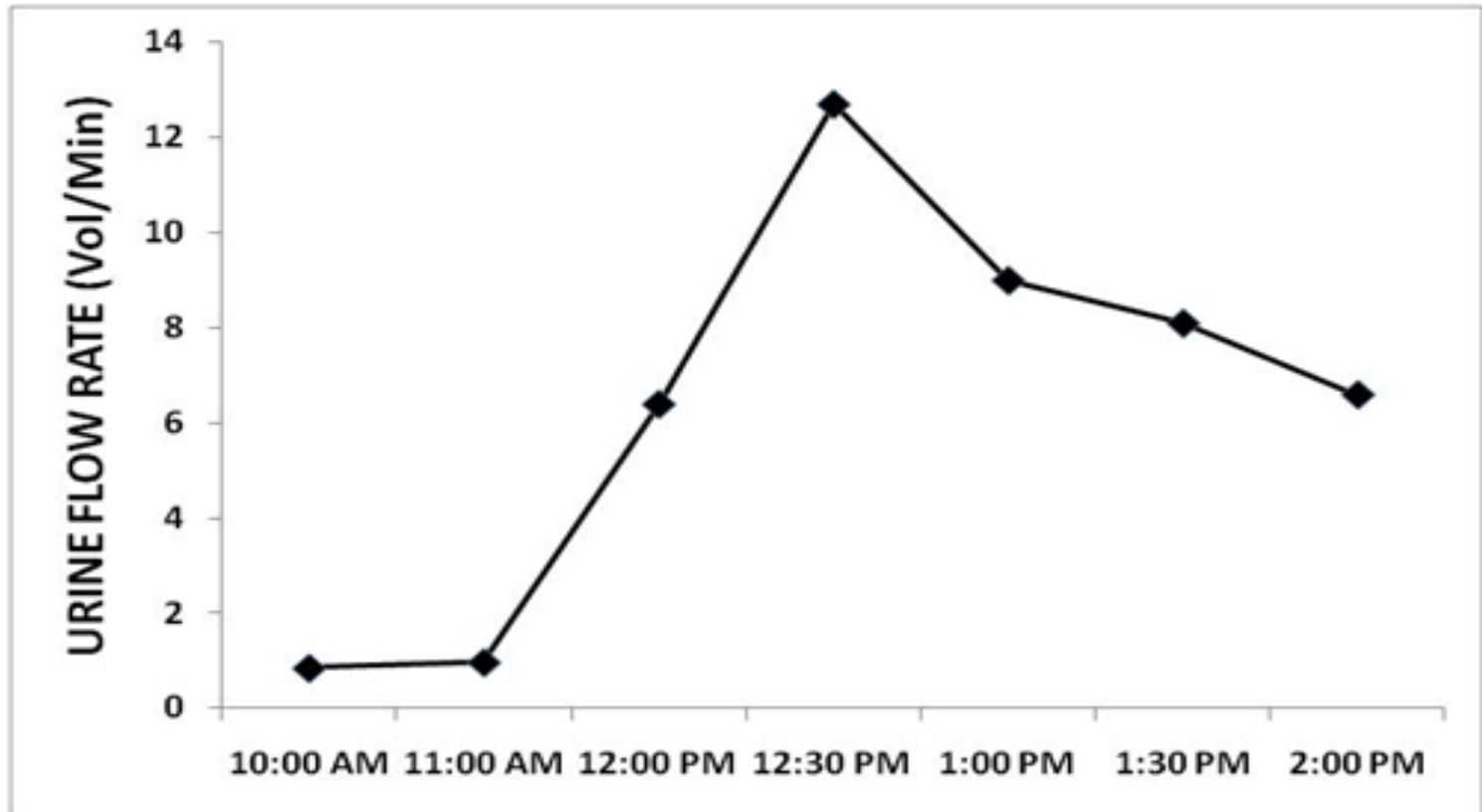
What is Lasix?

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

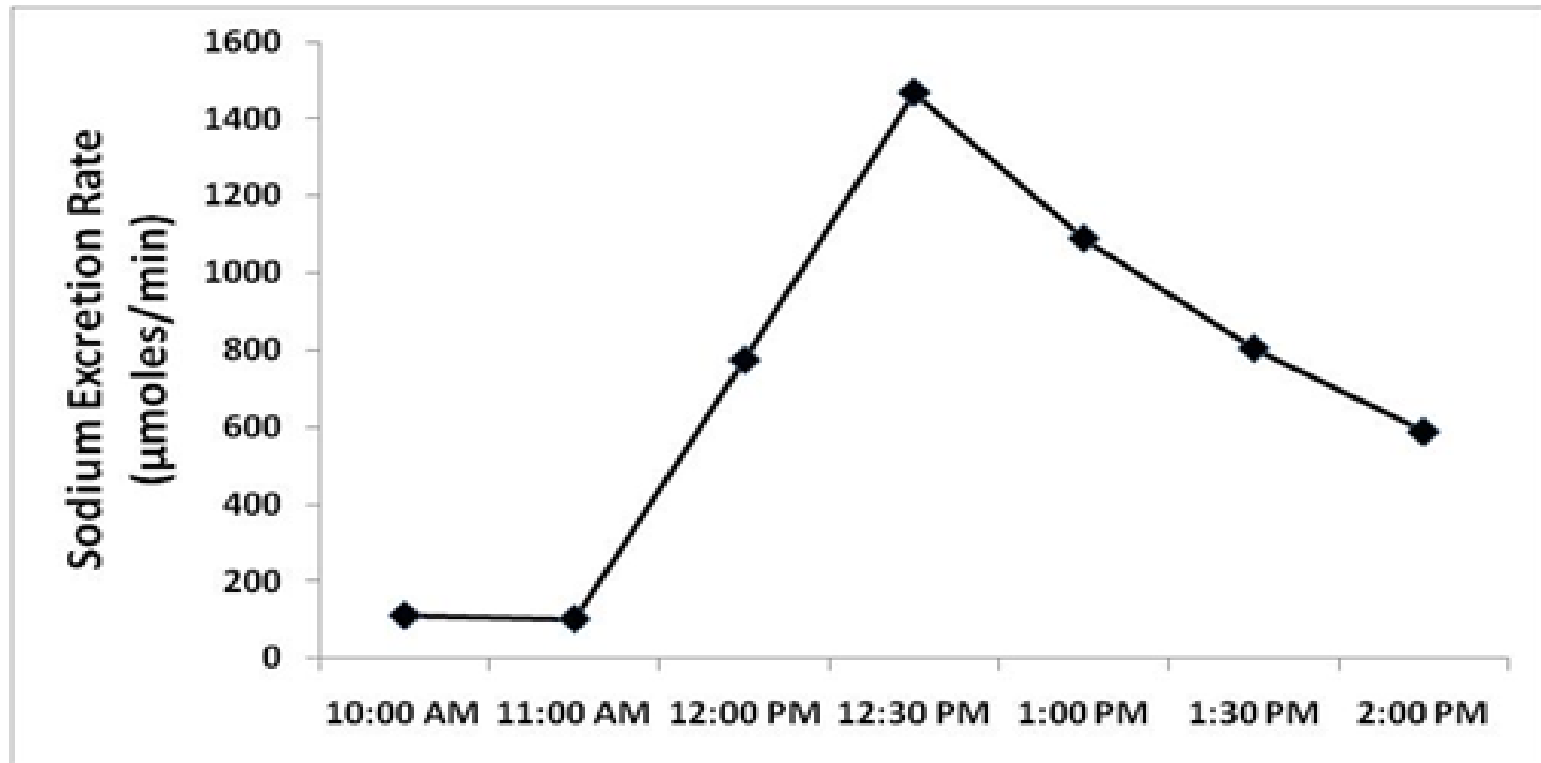


It inhibits the sodium-potassium-chloride co-transport system located within the ascending limb of the Loop of Henle.

Group 4



Group 4



Group 4

- ▶ 1 tab of Lasix (furosemide) (40mg)
- ▶ with 25ml 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 drug)



Urine samples examination

- Volume (measuring cylinder)
- Sodium and potassium concentration (flame photometry)
- PH (PH meter)
- Osmolality (Osmometer)



Measuring cylinder



PH meter



Flame photometry



Osmometer

The table that we 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

Calculation

- ▶ Total sodium excretion is obtained by applying following equation:

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

- ▶ Sodium excretion rate is obtained by applying the following equation:

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

Group 2

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	206	260	214	54	36
URINE FLOW RATE (ml / min)	0.98	1.1	6.87	8.67	7.13	1.8	1.2
SODIUM CONCENTRATION (mmoles/liter)	87	56	12	9	10	25	53
TOTAL SODIUM EXCRETION (mmoles)	10.3	1.8	2.5	2.3	2.1	1.4	1.9
SODIUM EXCRETION RATE (μ moles/min)	85.6	61.6	82.4	78	71.3	45	63.6

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 (μ moles/min)	105.2	127.4	186.7	152.6	188.0	146.1	190.5

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)						
SODIUM EXCRETION RATE (μ moles/min)						

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 (μ moles/min)	112.2	103	774	1467	1089	487.5

GFR (Glomerular Filtration Rate)



Definition:

- ▶ Is the volume of fluid filtered from the renal glomerular capillaries into the Bowman's capsule per unit time.

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

- ▶ According to the National Kidney Foundation, normal results range from **90 - 120 ml/min/1.73 m²**.

Abnormal Results of GFR

- A GFR < 60 mL/min/1.73 m² for 3 or more months
 chronic kidney disease.
- A GFR < 15 mL/min/1.73 m²  kidney failure.

GFR (Glomerular Filtration Rate)

The test is recommended in:

- Diabetes
- Family history of kidney disease
- Frequent urinary tract infections
- Heart disease
- High blood pressure
- Urinary blockage

Creatinin Clearance (C_{Cr})

Definition:

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

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

(U_{Cr}) = creatinine concentration in the collected urine sample

(V) = urine flow rate

(P_{Cr}) = plasma concentration

Creatinin Clearance (C_{Cr})

Example:

A person has a plasma creatinine concentration of 0.01 mg/ml and in 1 hour produces 60ml of urine with a creatinine concentration of 1.25 mg/mL.

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

Normal values

Male: 97 to 137 ml/min.

Female: 88 to 128 ml/min.

Abnormal results for C_{Cr}

Abnormal results may indicate:

- Acute tubular necrosis
- Bladder outlet obstruction
- Congestive heart failure
- Dehydration
- End-stage kidney disease
- Glomerulonephritis
- Kidney failure
- Renal ischemia
- Renal outflow obstruction
- Shock

Thank You