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

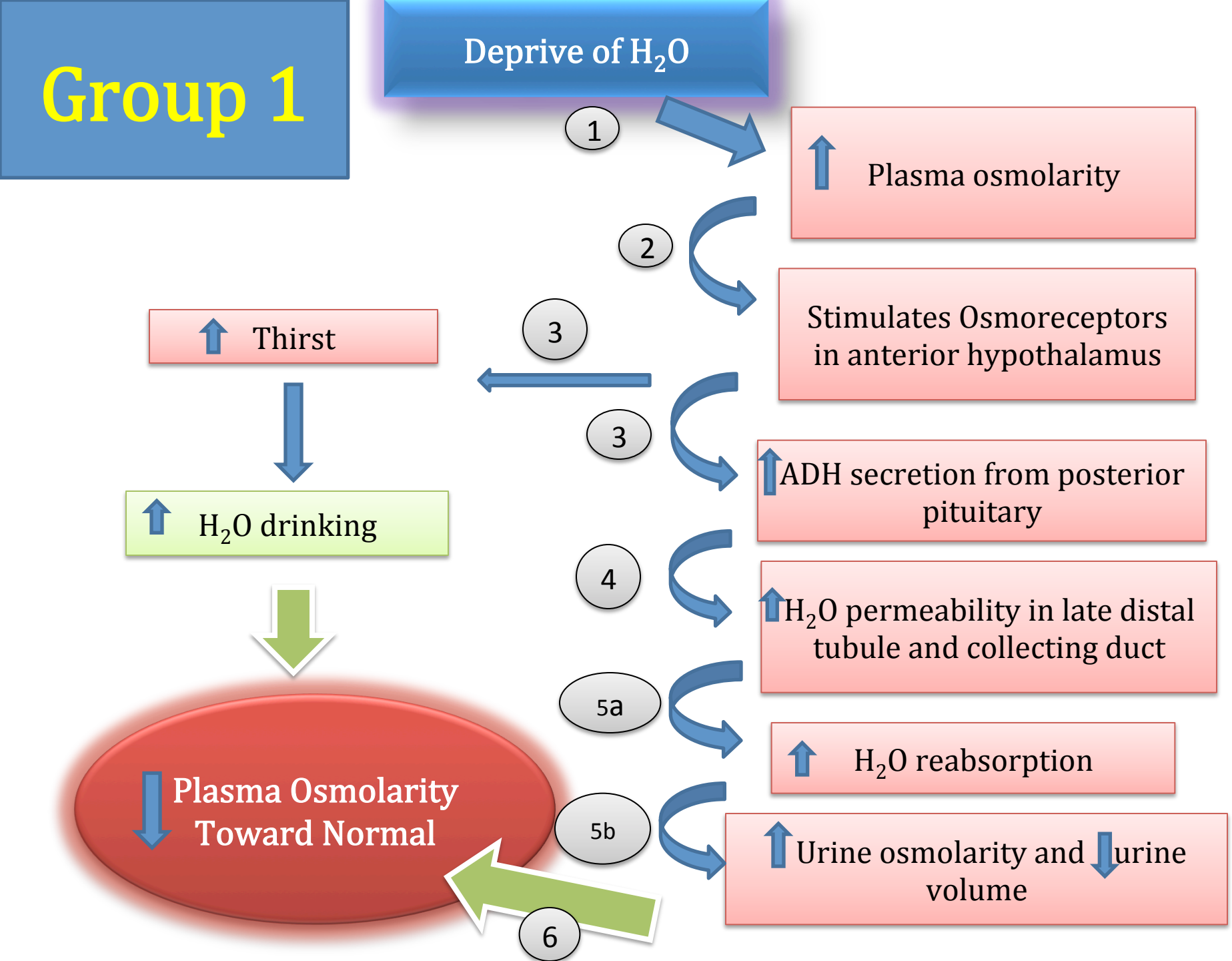
- Emptied their bladders at 8:00 am and discarded the urine.
- From 8:00 they are restricted to take any fluids and they are asked to provide various urine samples for analysis at:

  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 H_2O
1
Plasma osmolarity
2
Stimulates Osmoreceptors in anterior hypothalamus
3
Thirst
3
ADH secretion from posterior pituitary
H_2O drinking
4
H_2O permeability in late distal tubule and collecting duct
5a
H_2O reabsorption
Plasma Osmolarity Toward Normal
5b
Urine osmolarity and urine volume
6

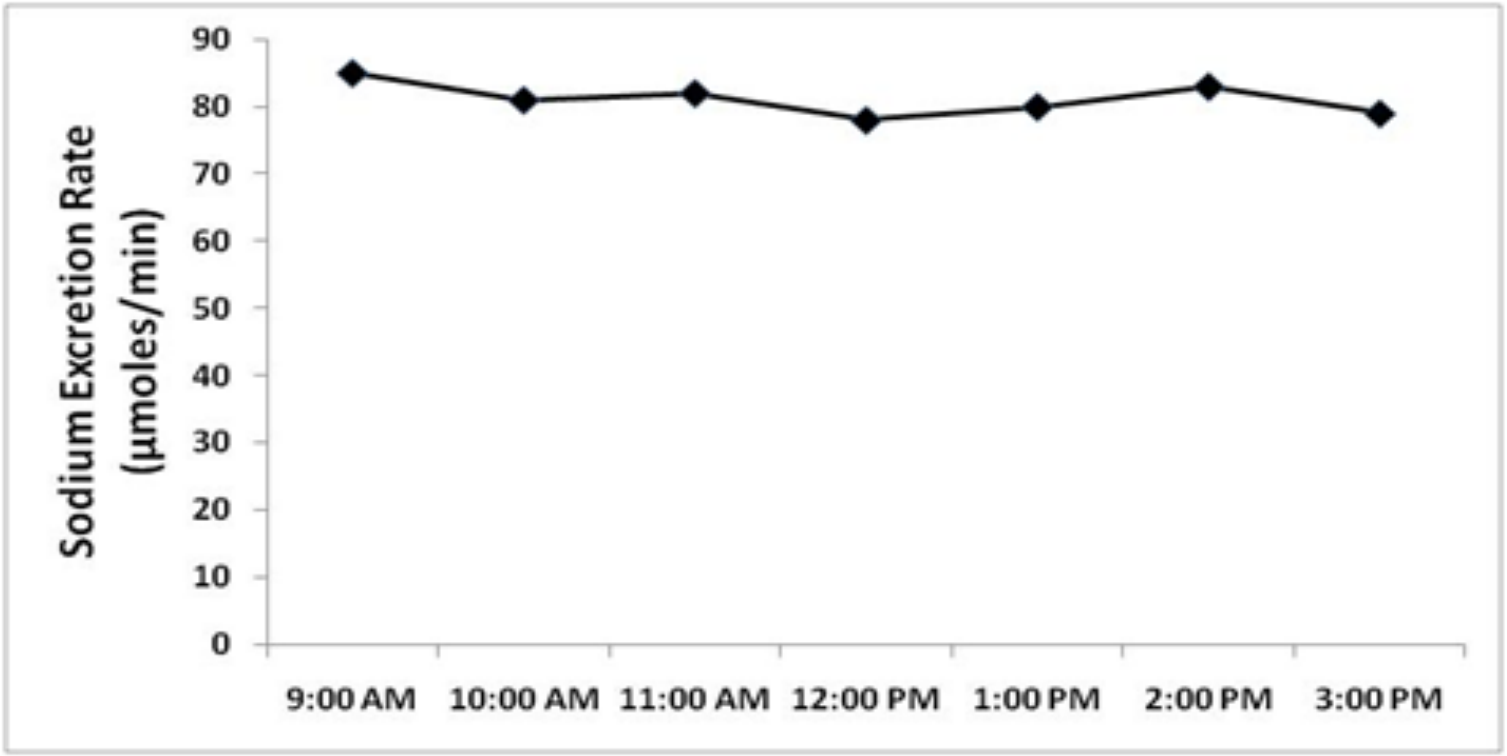
Group 2(Water Diuresis)

- 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.

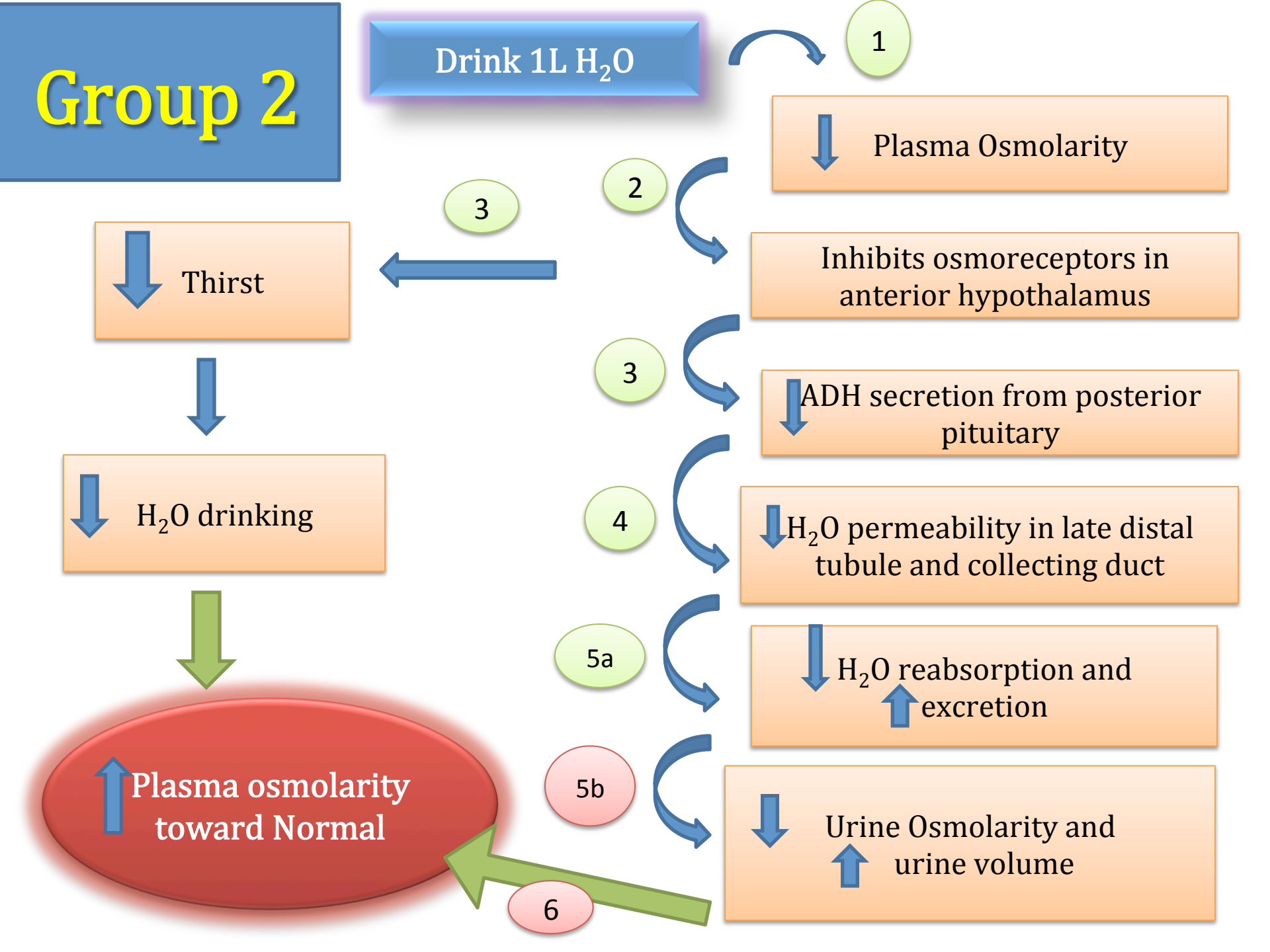
Group 2


URINE FLOW RATE (Vol/Min)
10
9
8
7
6
5
4
3
2
1
0
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
TIME

Group 2


Sodium Excretion Rate (µmoles/min)
90
80
70
60
50
40
30
20
10
0
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM

Group 2


Drink 1L H_2O
1
Plasma Osmolarity
2
Inhibits osmoreceptors in anterior hypothalamus
3
ADH secretion from posterior pituitary
4
H_2O permeability in late distal tubule and collecting duct
5a
H_2O reabsorption and excretion
5b
Urine Osmolarity and urine volume
6
Plasma osmolarity toward Normal
3
Thirst
H_2O drinking

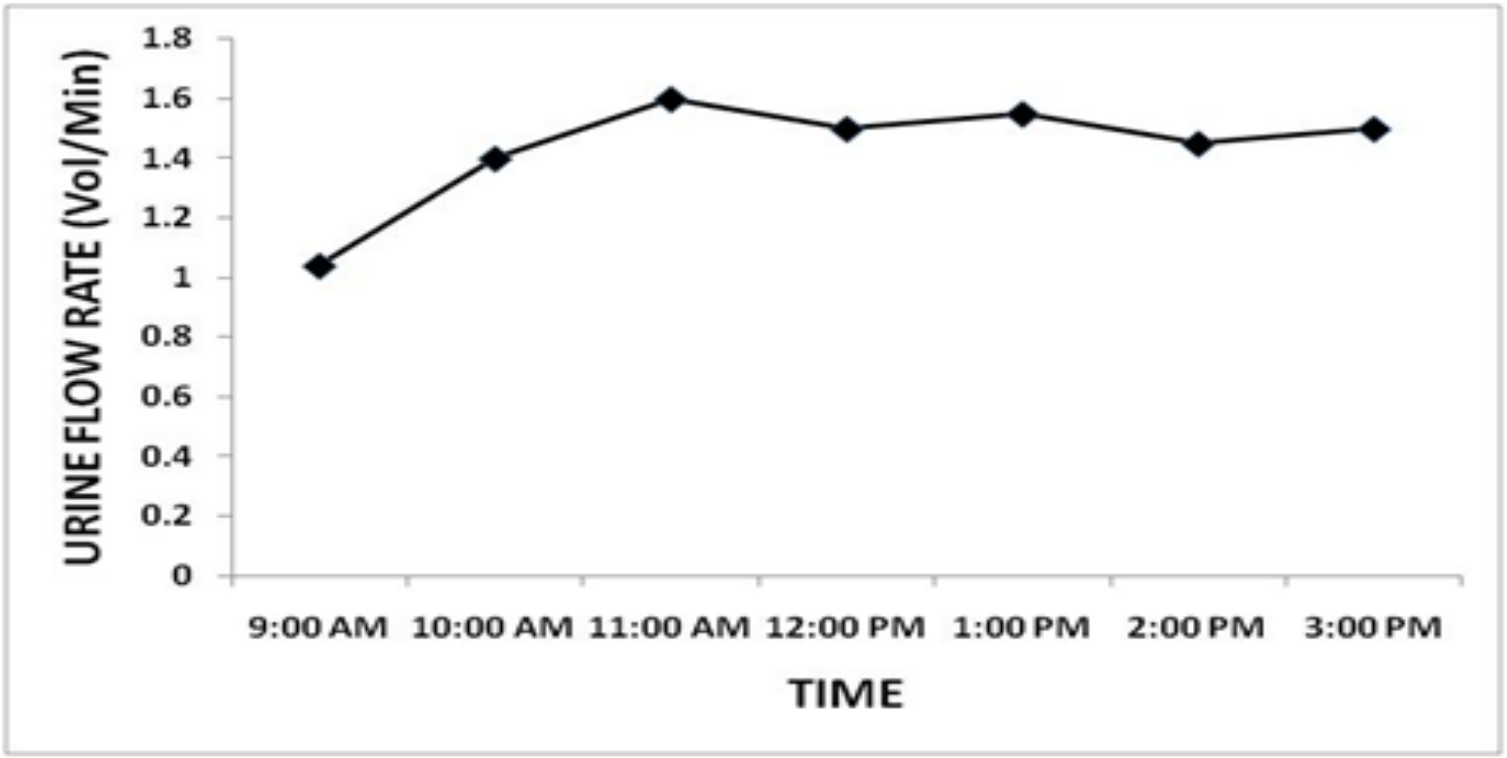
Group 3

- 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.

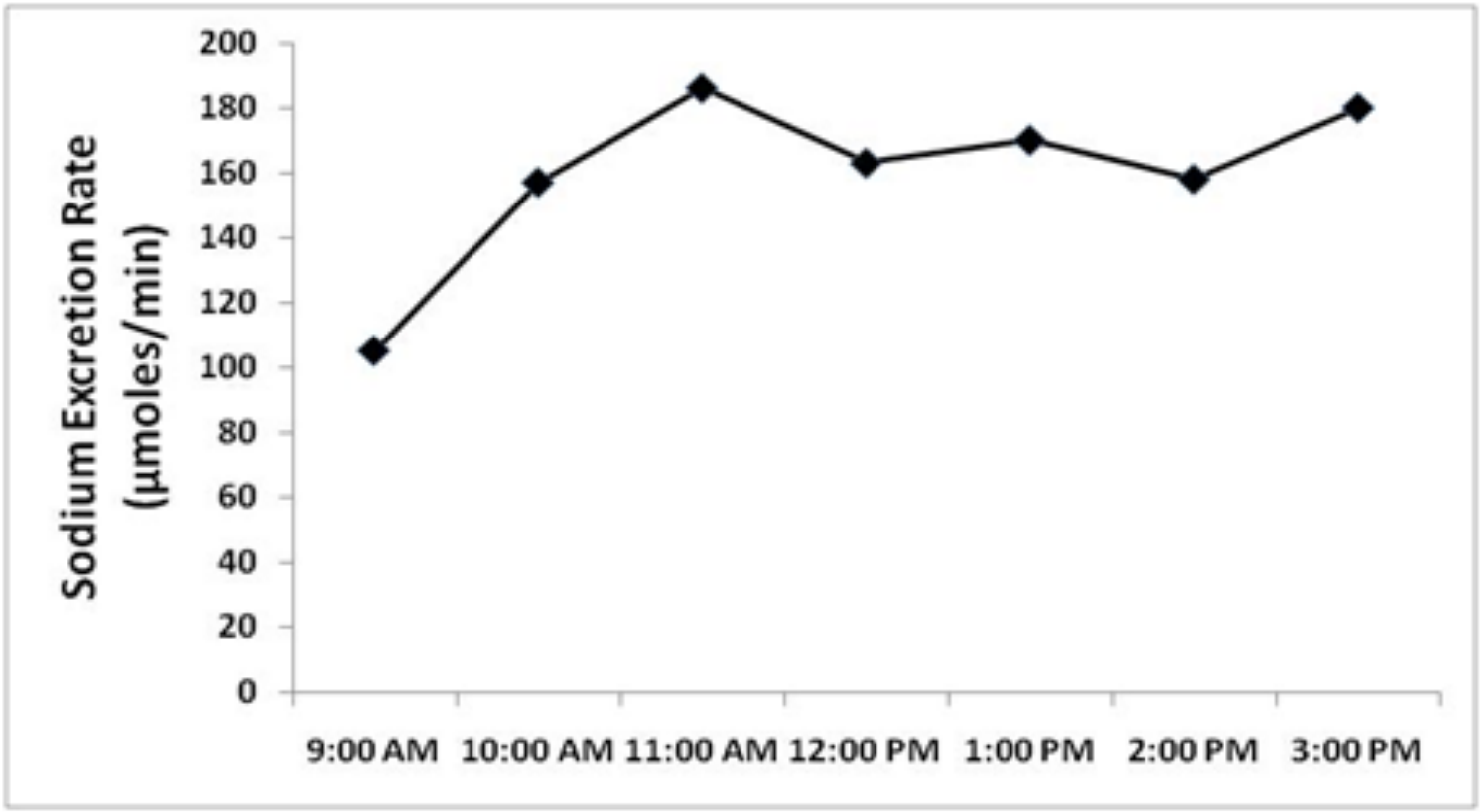
Isotonic saline 0.9%

- Contains 154 mmol of NaCI, 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


URINE FLOW RATE (Vol/Min)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
TIME

Group 3


Sodium Excretion Rate (µmoles/min)
200
180
160
140
120
100
80
60
40
20
0
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM

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)

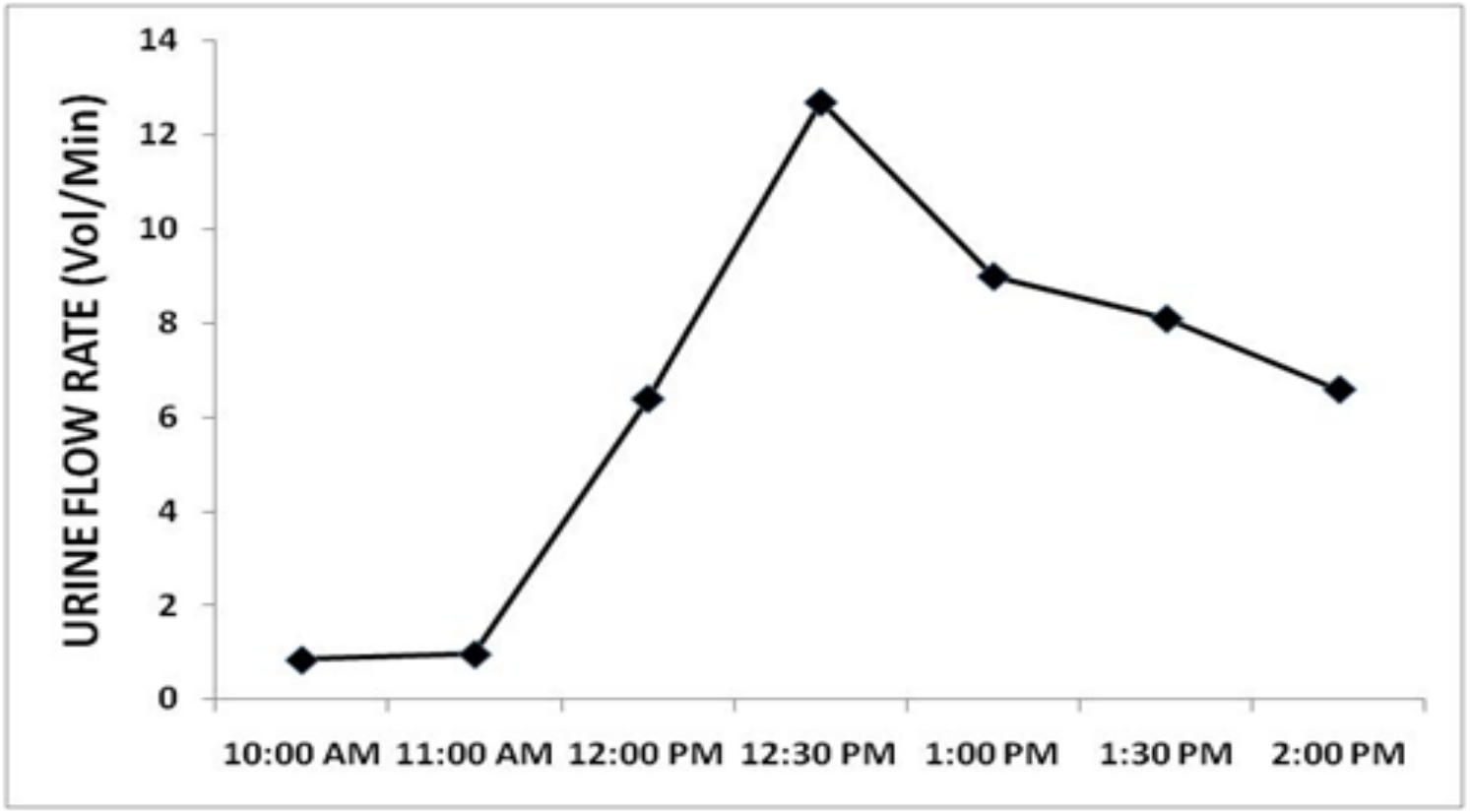
- Emptied their bladder at 8:00 am and discarded the urine.
- At 10:00 am emptied their bladder again, but this time they measured its volume and provided a sample for analysis. This sample will be pre-experimental sample.
- Swallowed a Lasix (Furosemide) tablet 40 mg with the help of 25 ml of water 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?

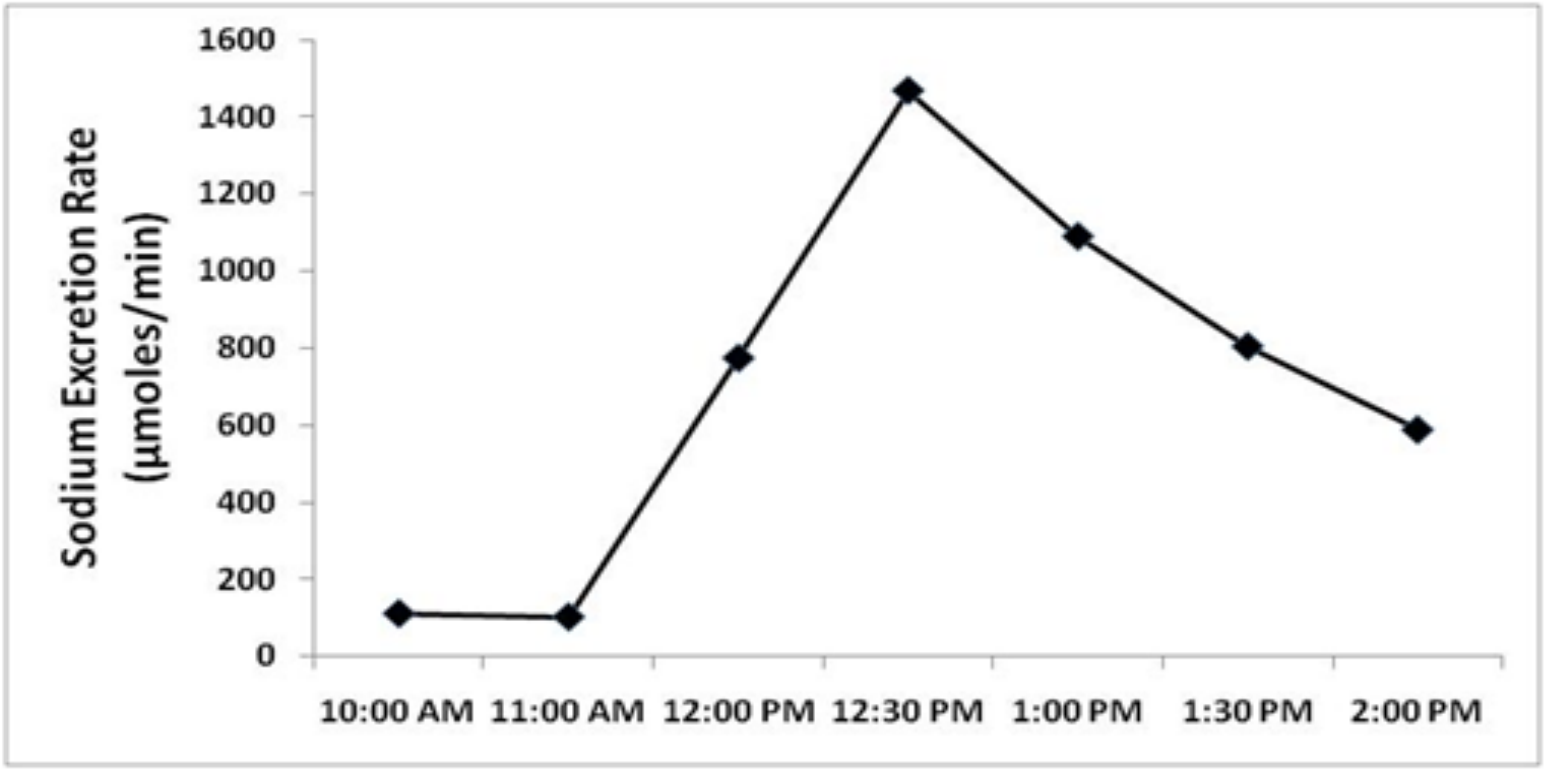
Furosemide is a loop diuretic used in the treatment of hypertension, congestive heart failure and edema.

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

Group 4


URINE FLOW RATE (Vol/Min)
14
12
10
8
6
4
2
0
10:00 AM
11:00 AM
12:00 PM
12:30 PM
1:00 PM
1:30 PM
2:00 PM

Group 4


Sodium Excretion Rate (µmoles/min)
1600
1400
1200
1000
800
600
400
200
0
10:00 AM
11:00 AM
12:00 PM
12:30 PM
1:00 PM
1:30 PM
2:00 PM

Group 4

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

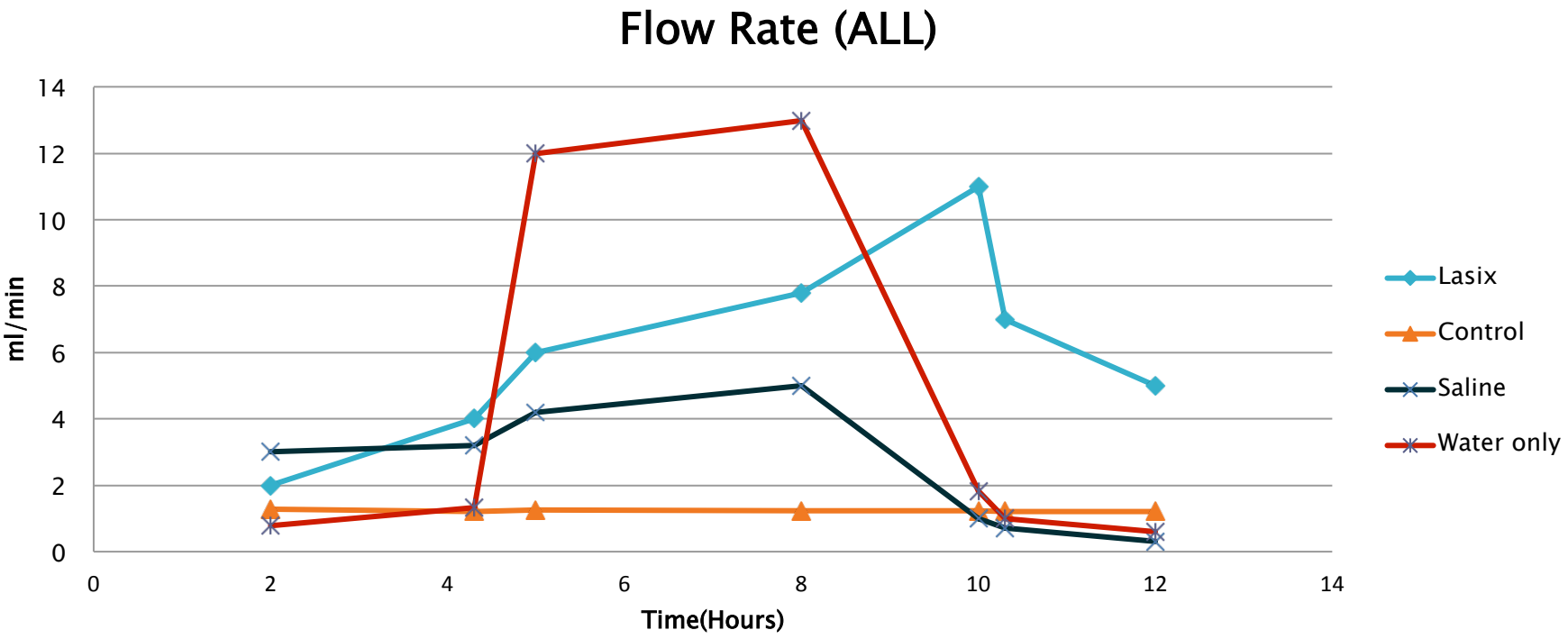
Action starts 1-2 hours and lasts for 4-6 hours
(1/2 life of furosemide is 6hr)

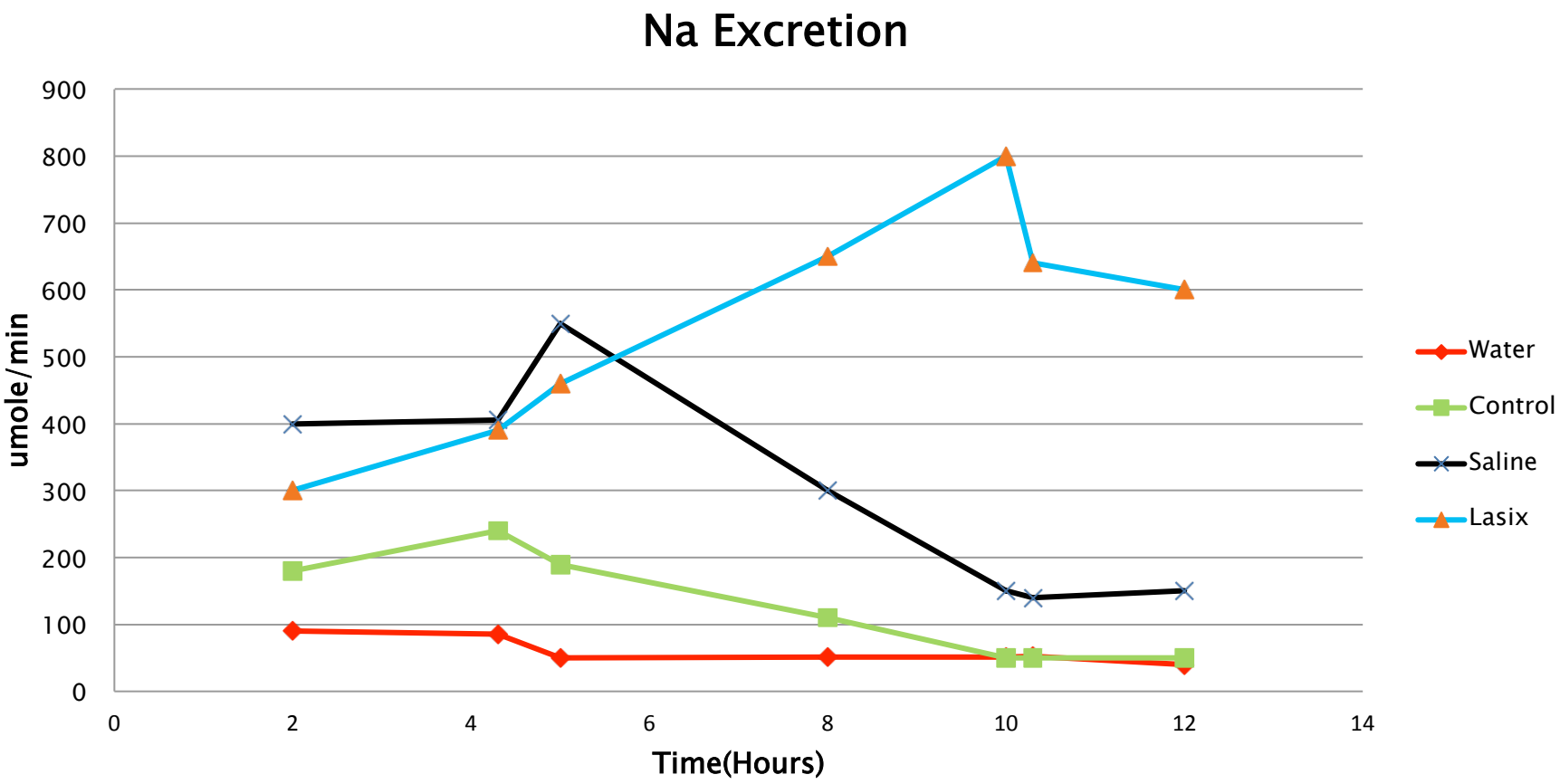
↓

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) ↑


Flow Rate (ALL)
14
12
10
8
6
4
2
0
ml/min
0
2
4
6
8
10
12
14
Time(Hours)
Lasix
Control
Saline
Water only


Na Excretion
umole/min
900
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
14
Time(Hours)
Water
Control
Saline
Lasix

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:

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

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

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

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 (µmoles/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 (µmoles/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 (µmoles/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 (µmoles/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.

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

- According to the National Kidney Foundation, normal results range from **90 - 120** ml/min/1.73 m^2.

Abnormal Results of GFR

- A **GFR <** 60 mL/min/1.73 m^2 for 3 or more months → **chronic kidney disease.**

- A **GFR <** 15 mL/min/1.73 m^2 → **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.

$$C_{Cr} = \frac{U_{cr} \, X \, V}{P_{Cr}}$$

(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.

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

Normal values

Male: 97 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