Water Load

Water intake in excess of the body’s needs is readily excreted in the urine. Diuresis following a water load is caused by

1. Absorption of water into the blood from the gut. Added water decreases plasma osmolarity.
2. Decreased osmolarity inhibits antidiuretic hormone (ADH) release and lower ADH concentration causes the kidney to increase water excretion.

Water Absorption Is Quite Rapid

Water absorption from the gut is quite rapid following a 1L oral water load.



Absorption is nearly complete at about 60 minutes (data above from Baldes & Smirk, 1934; Findley & White,1937).

A 1L oral water load will decrease plasma osmolarity about 10 mOsm/L with the nadir occurring at about 60 minutes.

Hypoosmolarity Inhibits ADH Secretion

A decrease in plasma osmolarity of 20 mOsm/L will completely inhibit ADH secretion (data at right from Robertson *et.al.*, 1973).



Water excretion increases about 8-fold with a 1L water load. Excretion remains elevated until the entire load is excreted (shown above).

A water load does not increase excretion in patients with diabetes insipidus (Findley & White).

The Water Load Protocol

In this exercise, we will administer a large, oral water load and then observe its distribution and disposition over the following 24 hours.

Begin by clicking Restart to reset the model’s variables to their initial values. Record control (0 Min) data in the table below. Then click RX Misc. Treatments. In the oral water / glucose load box set the quantity to 1000 ml, the duration to 10 Min, and the glucose (%) to 0. Click the oral water / glucose load switch to on. Advance the solution and record data.

|  |  |
| --- | --- |
|  | G.I. Lumen H2O Volume (mL) |
|  |  |
|  | Plasma Volume (mL)  Plasma Osmolarity (mOsm/L)  Interstitial Fluid Volume (L) |
|  |  |
| H_MAIN | Plasma [ADH] (pG/mL) |
|  |  |
| Nephron | Urine Flow (mL/Min)  Urine Osmolarity (mOsm/L) |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Time | 0  Min | 1  Hr | 2  Hrs | 3  Hrs | 6  Hrs | 1  Day |
| GI H2O Volume | 527 | 601 | 531 | 527 | 523 | 520 |
| Plasma Volume | 3000 | 3219 | 2845 | 2810 | 2950 | 3046 |
| Plasma Osm | 290 | 286 | 289 | 290 | 292 | 293 |
| IFV | 12.2 | 12.0 | 12.3 | 12.3 | 12.1 | 11.9 |
| Plasma [ADH] | 2.0 | 0.1 | 0.6 | 1.1 | 1.7 | 2.0 |
| Urine Flow | 0.77 | 11.14 | 5.78 | 3.07 | 1.09 | 0.87 |
| Urine Osm | 812 | 83 | 106 | 163 | 536 | 897 |

Where does the water go as a function of time? Monitor water in the gut, plasma volume and urine formation.

What factors control the synthesis and release of antidiuretic hormone?

Role Of Antidiuretic Hormone In Water Balance

In the exercise above changes in antidiuretic hormone concentration [ADH] appeared to be an important part of the response. We will investigate the importance of ADH more completely in this exercise by giving a water load with [ADH] clamped at its normal value.

Begin again by clicking Restart to reset the model’s variables to their initial values. Record control (0 Min) data in the table below. Click H_MAIN Antidiuretic Hormone. Turn the ADH secretion clamp on to clamp plasma [ADH] at its normal value.

Next click RX Misc. Treatments. In the oral water / glucose load box set the quantity to 1000 ml, the duration to 10 Min, and the glucose (%) to 0. Click the oral water / glucose load switch to on. Advance the solution and record data.

|  |  |
| --- | --- |
|  | G.I. Lumen H2O Volume (mL) |
|  |  |
|  | Plasma Volume (mL)  Plasma Osmolarity (mOsm/L)  Interstitial Fluid Volume (L) |
|  |  |
| H_MAIN | Plasma [ADH] (pG/mL) |
|  |  |
| Nephron | Urine Flow (mL/Min)  Urine Osmolarity (mOsm/L) |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Time | 0  Min | 1  Hr | 2  Hrs | 3  Hrs | 6  Hrs | 1  Day |
| GI H2O Volume | 527 | 670 | 548 | 546 | 545 | 540 |
| Plasma Volume | 3000 | 3584 | 3201 | 3068 | 3019 | 3067 |
| Plasma Osm | 290 | 281 | 280 | 280 | 281 | 283 |
| IFV | 12.2 | 11.7 | 11.9 | 12.0 | 12.0 | 11.9 |
| Plasma [ADH] | 2.0 | 1.9 | 2.0 | 2.0 | 2.0 | 2.0 |
| Urine Flow | 0.77 | 5.02 | 1.81 | 1.25 | 1.00 | 0.94 |
| Urine Osm | 812 | 694 | 491 | 569 | 661 | 789 |

References

Baldes, E.J. and F.H. Smirk. The effect of water drinking, mineral starvation and salt administration on the total osmotic pressure of the blood in man, chiefly in relation to the problems of water absorption and water diuresis. *J.Physiol.* 82:62-74, 1934.

Findley, T., Jr. and H.L. White. The response of normal individuals and patients with diabetes insipidus to the ingestion of water. *J.Clin.Invest.* 16:197-202, 1937.

Robertson, G. L., E. H. Mahr, S. Athar and T. Sinha. Development and clinical application of a new method of radioimmunoassay of arginine vasopressin in human plasma. *J. Clin. Invest.* 52:2340-2352, 1973.