Water-Electrolyte Disturbances - Dr. Peterson

Instruction for Computer Lab

Purpose:

To illustrate the effects of salt (sodium/osmolarity) and/or water gains and losses on body fluid distribution and osmolarity.

General Information:

Program name: "Darrow-Yannet(pm).rt2"
Location: Any of the Power Mac computers in the MSL computing room.

Directions:

1) Double click on the "Darrow-Yannet(pm).rt2" icon to load the program.

2) Click on the ARROW symbol or select "RUN" from the "Operate" menu to examine the effects of the disturbances presented in the problems below.

3) The boxes are typical Darrow-Yannet or osmolarity and volume diagrams with volumes for extracellular fluid (ECF) and intracellular fluid (ICF) represented horizontally and osmolarity vertically.

4) The slide controls on the left increase and decrease the amount of ECF solute and volume or these changes can be entered by clicking on the small up/down arrows next to the digital displays.

   * Remember, all salt and water gains and losses are due to changes in ECF. Any effects on ICF are a result of a disturbance in the ECF-ICF osmotic equilibrium. As in class, for purposes of illustration, the total initial effect on ECF will be shown before any water shifts occur. Recall that, in reality, these shifts begin occurring as soon as the osmotic equilibrium is disturbed.

5) The final fluid compartment volumes, osmolarities and total solute content will be shown on the right.

6) To reset all parameters to their default values, go to the "operate" menu and select "reinitialize all to default."

7) A second intervention such as a correction to the initial disturbance can be imposed without resetting by clicking on "Step 2" **before** entering the new values and running the program. This can be done repeatedly as long as Step 2 is selected.

Problems:

1) Losses of salt and/or water

Determine the effects of the following:

A) Loss of 2 liters of water without any loss of solute (e.g. lack of water intake). To set this up use the slide or digital entry control to decrease volume by 2000 ml but do not change the solute content. What are the changes (increase, decrease or no effect) in body fluid osmolarity _____, ECF volume _____ and ICF volume _____. Using the traditional two-word term for a salt and water disturbance condition, this is _____ _____.

Using the Step 2 switch, determine the effects of replacing this loss with a solution that does not match the fluid or solute deficit. For example, in this case, try 1 liter of normal saline (300 mOsm/L) as a replacement. Is the original disturbance corrected? Condition now = _____ _____.

B) Loss of 3 liters of volume with an osmolarity of 100 mOsm/L (e.g. sweating).

* Remember to change the total ECF solute loss which in this case would be 300 mOsm (3L x 100 mOsm/L). Effects on body fluid osmolarity = _____ , ECF volume = _____ and ICF volume = _____. Condition = _____ _____. Again, try different replacement therapies such as different volumes of pure water or mixtures of solute and water.

C) Loss of 2 liters of volume with an osmolarity of 300 mOsm/L. An example would be _____. Effects on body fluid osmolarity = _____ , ECF volume = _____ and ICF volume = _____. Condition = _____ _____.

D) Loss of 0.5 liters of volume with an osmolarity of 800 mOsm/L. An example is _____. Effects on body fluid osmolarity = _____ , ECF volume = _____ and ICF volume = _____. Condition is _____ _____.

2) Gains of salt and/or water

Determine the effects of the following:

A) Gain of 1 liter of solute-free water (e.g. drinking pure water or pathophysiologic water retention). Effects on body fluid osmolarity = _____ , ECF volume = _____ and ICF volume = _____. Condition is termed _____ _____.

B) Oral intake or renal retention of excess sodium equal to 600 mOsm with accompanying water retention of 0.5 L. Effects on body fluid osmolarity = _____, ECF volume = _____ and ICF volume = _____. Condition is _____ _____.

C) Body fluid retention of 2 L of fluid with osmolarity of 300 mOsm/L. An example is _____ _____. Effects on body fluid osmolarity = _____, ECF volume = _____ and ICF volume = _____. Condition is _____ _____.

3) Stranded at Sea!

You are stranded on a life raft in the ocean and all your drinking water is gone. Initial disturbance = lack of water intake or loss of 2 liters of volume without any loss of solute. Run as Step 1. You can't stand it any longer and must have something to drink. Foolishly (and forgetting your body fluid physiology from your first year of medical school) you drink 500 ml of sea water (1000 mOsm/L). Run as Step 2. Is the extent of cellular dehydration (ICF volume) improved, unchanged or worsened? _____. This condition before drinking the sea water was _____ _____ and now is _____ _____.

A Final Review

The six basic types of salt and water disturbances are incompletely described below with respect to their effects on body fluid osmolarity and ECF and ICF volumes and the term describing the condition. Fill in the table.

Fill in the table.

Osmolarity: decreased, ECF Volume: decreased, ICF Volume:_____,
Condition:_____ _____

Osmolarity:_____, ECF Volume: increased, ICF Volume:_____,
Condition: isotonic expansion

Osmolarity:_____, ECF Volume: decreased, ICF Volume: unchanged,
Condition:_____ _____

Osmolarity: increased, ECF Volume: _____, ICF Volume:_____,
Condition: hypertonic contraction

Osmolarity:_____, ECF Volume: increased, ICF Volume: decreased,
Condition:_____ _____

Osmolarity: decreased, ECF Volume:_____, ICF Volume:_____
Condition: hypotonic expansion